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TechnicalDocuments

2015

LUCAS 2012
(Land Use / Cover Area Frame Survey)

Quality Report

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Introduction

In order to improve the availability and quality of the land cover/use statistics Eurostat is implementing the LUCAS survey, which is an area frame statistical survey on land use/cover.

Following the adoption of the Decision 1445/2000/EC of 22/5/2000 by the Council and the European Parliament dealing on the application of area frame techniques, DG Agriculture and Eurostat launched in 2000 the LUCAS project: Land Use/Cover Area frame statistical Survey. The project has been extended in duration from 2004 to 2007 by Decision 2066/2003/EC of 10/11/2003. The coverage of the EU-N10 Member states and the related financing is laid down by Decision 786/2004/EC of 21/4/2004. From January 2008 onwards, LUCAS has been part of Eurostat's activities and budget with a budgetary contribution from other DG of the Commission as from 2012. The LUCAS survey was implemented in 23 EU countries in spring-autumn 2009.

The aim of the LUCAS survey is to gather harmonised information on land use and land cover. The survey also provides territorial information facilitating the analysis of the interactions between agriculture, environment and countryside, such as irrigation and land management.

Since 2006, EUROSTAT has carried out LUCAS surveys every three years. 2006 data is considered pilot and has not been used to produce estimates. Since the LUCAS surveys are carried out in-situ, this means that observations are made and registered on the ground by field surveyors. A panel approach is used, so some points have been visited in subsequent years.

In the field, the surveyor classifies the land cover and the visible land use according to the harmonized LUCAS Survey land cover and land use classifications. Landscape pictures are taken in the four cardinal directions. A transect of 250m is walked from the point to the east direction, where the surveyor records all transitions of land cover and existing linear features.

From the LUCAS survey in situ data collection, different types of information are obtained:

- Micro data
- Images
- 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. Points to be visited in the field are selected among those:

- belonging to mainland (small islands not connected to mainland by bridges may be excluded)
- located in areas with elevation below 1500 meters

LUCAS 2012 Survey took place in 27 countries, (AT, BE, BG, CY, CZ, DE, DK, EE,EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, MT, NL, PL, PT, RO, SE, SK, SI, UK) covering 99% of total EU area.

For any data analysis and comparisons of LUCAS data at spatial and temporal level the following aspects have to be taken into account:

- in the 23 Countries covered by the 2009 round, 6 out of 248 NUTS2 regions were not surveyed and no estimates are available for them;
- types of land cover that mainly appear at a high altitude or in inlands could be underestimated (lakes, permanent snow);
- data are not fully comparable between 2 surveys and a number of measures have been put in place in order to improve the comparability of the aggregated results.

ROLE OF PHOTO-INTERPRETATION IN LUCAS SURVEY

In Lucas project, the activities of photointerpretation play an important role and they are used in different steps of the survey and for different purposes.

1)   First of all the photointerpretation was carried out once from May 26th to November 16th 2005 in order to classify the more than 1 million of points of master sample in the seven strata of land cover, described in Table 1, by means a set of "rules"; the results of this activity are given in Table 2. The land cover is the observed physical cover of the earth's surface and this operative definition explains some interpretation rules that are not commonly used in classification systems for stratification purposes. For example, a lawn in a domestic garden is classified as grassland. The master sample is obtained by a systematic selection of geo-referenced points, each of them representing an area of four Km2, covering the whole European territory. However the classification of land cover is done in a smaller window around the sampling point. Normally the point falls within a homogenous area, and the above-mentioned observation rule can be easily applied; in some other cases the process is more difficult and it requires the intervention of many competencies. The interpretation approach adopted for each country, in addition to the different agricultural features in each nation country, was necessarily affected by the quantity and quality of available material. Generally, several images and data are used: imagettes from orthophotos, mosaics of IMAGE 2000 Landsat images, Corinne Land Cover 2000 classification, altitude, administrative data, ground survey result of Lucas 2003 project, available agricultural production and land use statistics . The photointerpretation was performed by a team of photointerpreters, specifically trained in order to harmonise the work and to ensure a similar understanding and application of the classification nomenclature; the activities were assisted by specific softwares. A statistical quality control was also done during the process of photointerpretation, on the basis of a sample of points, selected at random and checked by an expert not belonging to the photointerpretation staff.

2)   Photo interpretation is also used during the survey taking, when it was not possible to get directly the needed information, according to the "accessibility" rules of the point. This can happen in two different phases: before and during the field work. In the first case, where the not accessible points were identified ex ante, the activity is carried out by the central staff while in the second, when the difficulty to reach the point is only detectable in field, it is performed by the collectors (see Table 8 and Table 9). In all the two situations the photointerpretation plays a role quite different than what is reported above. While in the stratification its purpose was to classify the points into strata, now the target is to fill in the questionnaire that is to replace the direct collection by getting the information from images and data already available. In a very limited case of points classified as cropland, a simplified nomenclature was sometimes used, due to the difficulties in distinguishing among more specific cultivations. In this case, a probabilistic procedure has been developed (see the paragraph   "Data imputation for photo-interpreted points in cropland").

Sampling design

LUCAS is a statistical area frame sample survey where the sampling unit is a point, namely a portion of land of circular shape. All the points belonging to the sample are geo-referenced. Data collection is based in principle on the visual observation of a sample of points, without the involvement of farmers; actually, because the difficulty to reach part of the surveyed points, part of them might be photointerpreted during the data collection.

The survey is based on a "double sampling": in the first phase a systematic sample (master sample) of 1,078,764 points, with points spaced 2 km in the four cardinal directions covering all European territory (EU), are selected. In 2005 each point of the first phase sample was photo-interpreted and assigned to one of the following 7 pre-defined land cover strata: arable land, permanent crops, grassland, wooded areas and shrub land, bare land, artificial land, water (see Table 1).

In double sampling we assume that in every NUTS2 region the strata weights $W_h = (N_h/N)$ with h=1....7,

estimated from the first phase sample, are correct estimates of the related percentage W_h^* in the population, that is $E(W_h) = W_h^*$.

Table 1: Strata definition

Stratum	Description	LUCAS 2005 land cover classes
1	Arable land	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)
2	Permanent crops	Fruit trees and bushes, other permanent crops: vineyards, olive trees, nurseries (B71–B84).
3	Grassland	Grassland, with or without sparse tree/shrub cover (E01–E02)
4	Wooded areas and shrub land	Forests, other wooded areas, shrub land (C11-C23, D01-D02)
5	Bare land, low or rare vegetation	Bare land: areas with no vegetation or areas covered less than 50% by dominant species of vegetation. (F00)
6	Artificial land	Artificial land (A11-A22)
7	Water	Surfaces covered by water, either permanently or for most of the year (G01-G05)

The master sample has been updated in 2014; consequently the 2012 survey data have been revised and all the related results are referred to these new data. In Table 2 the whole content of the master sample is reported, including the data regarding the not participating country (Croatia).

Table 2: Master sample: number of points per country

Country	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land	Artificial land	Water	Total
Austria	3178	278	3778	11925	711	818	291	20979
Belgium	2077	50	2508	2117	25	813	92	7682
Bulgaria	9923	115	3363	11682	462	1643	553	27741
Cyprus	654	129	285	946	123	159	15	2311
Czech Republic	7660	96	2699	8205	111	739	208	19718
Germany	33795	570	14925	30914	473	7685	1139	89501
Denmark	7570	1	765	1674	85	569	161	10825
Estonia	1833	7	1856	6760	195	129	574	11354
Greece	6597	2648	4079	17758	403	1105	455	33045
Spain	32339	11638	17620	55798	3106	3228	884	124613
Finland	5502	37	5098	60975	2731	1521	8678	84542
France	39954	3139	32298	51880	2243	6310	1482	137306
Croatia	4244	146	2075	7044	46	404	182	14141
Hungary	11921	455	3400	6202	108	709	476	23271
Ireland	929	0	12105	2943	593	522	465	17557
Italy	20653	6699	10208	30286	2215	4163	1111	75335
Lithuania	6241	26	3340	5594	653	480	0	16334
Luxembourg	165	4	163	257	4	47	6	646
Latvia	4474	21	2166	8207	914	363	0	16145
Malta	15	6	9	16	6	26	2	80
Netherlands	1880	59	3732	1563	186	964	480	8864
Poland	35351	243	10924	27393	203	2745	1282	78141
Portugal	4530	1967	2971	10918	610	975	290	22261
Romania	27297	867	6598	20414	340	2331	1763	59610
Sweden	7045	8	5526	83007	4632	2114	10162	112494
Slovenia	549	121	671	3483	55	165	23	5067
Slovak Republic	3704	110	1693	6180	105	367	104	12263
United Kingdom	14172	49	22607	19415	907	3499	1359	62008
EU	294252	29489	177462	493556	22245	44593	32237	1093834

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 interpretation are summarised. The percentage of double classification can be considered an indicator of uncertainty in photo-interpretation process; it is in average 6.3% but it is greater for "grassland" (21.5%) and "woodland" (13.4%) strata

Table 3: Master sample: principal strata by secondary strata

STRATA 1	STRATA 2								Total
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
1	275036	2	1881	12805	3381	106	1007	51	294269
2	27031	723	1	331	1369	7	26	1	29489
3	153807	8302	441	0	12637	1248	818	231	177484
4	480956	908	929	6619	0	1851	1345	1068	493676
5	17472	74	11	2043	2029	0	318	313	22260
6	40469	943	50	1084	1720	303	0	49	44618
7	34245	21	1	221	1008	274	41	0	35811
Total	**1029016**	**10973**	**3314**	**23103**	**22144**	**3789**	**3555**	**1713**	**1097607**

Table 4 is obtained from the master sample selecting only the participating countries and shows the cross distribution of points by country and strata, that is the frame from which the second phase sample is selected.

Table 4: Master sample - number of points by strata and by participating countries

Country	STRATA							Total
	1	2	3	4	5	6	7	
Austria	3178	278	3778	11925	711	818	291	20979
Belgium	2077	50	2508	2117	25	813	92	7682
Bulgaria	9923	115	3363	11682	462	1643	553	27741
Cyprus	654	129	285	946	123	159	15	2311
Czech Republic	7660	96	2699	8205	111	739	208	19718
Germany	33795	570	14925	30914	473	7685	1139	89501
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France	39954	3139	32298	51880	2243	6310	1482	137306
Hungary	11921	455	3400	6202	108	709	476	23271
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Sweden	7045	8	5526	83007	4632	2114	10162	112494
Slovenia	549	121	671	3483	55	165	23	5067
Slovak Republic	3704	110	1693	6180	105	367	104	12263
United Kingdom	14172	49	22607	19415	907	3499	1359	62008
EU	290008	29343	175387	486512	22199	44189	32055	1079693

The total area and the areas by strata of each country, corresponding to the number of points in first phase sample, is reported in Table 6. It is obtained from the master sample summing up the area of each strata calculated multiplying the corresponding number of points by the average area per point.

Table 5: Master sample - area and percentage over the total by strata and participating countries

| | Land cover | | | | | | | | | | | | | | Total |
| | Arable Land | | Permanent Crops | | Grassland | | Wooded Areas | | Bare Land | | Artificial Land | | Water | | |
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area
Austria	12.715	15,15	1.116	1,33	15.115	18,01	47.704	56,84	2.845	3,39	3.273	3,9	1.167	1,39	83.928
Belgium	8.293	27,04	199	0,65	10.013	32,65	8.452	27,56	101	0,33	3.245	10,58	368	1,2	30.668
Bulgaria	39.697	35,77	455	0,41	13.451	12,12	46.733	42,11	1.853	1,67	6.570	5,92	2.208	1,99	110.979
Cyprus	2.617	28,30	516	5,58	1.140	12,33	3.785	40,93	492	5,32	636	6,88	60	0,65	9.246
Czech Republic	30.641	38,85	386	0,49	10.797	13,69	32.818	41,61	442	0,56	2.958	3,75	828	1,05	78.870
Germany	135.092	37,76	2.290	0,64	59.675	16,68	123.572	34,54	1.896	0,53	30.732	8,59	4.544	1,27	357.766
Denmark	30.115	69,93	4	0,01	3.045	7,07	6.658	15,46	340	0,79	2.265	5,26	642	1,49	43.065
Estonia	7.323	16,14	27	0,06	7.418	16,35	27.015	59,54	780	1,72	517	1,14	2.296	5,06	45.372
Greece	26.286	19,96	10.549	8,01	16.251	12,34	70.771	53,74	1.607	1,22	4.399	3,34	1.817	1,38	131.692
Spain	129.370	25,95	46.563	9,34	70.493	14,14	223.245	44,78	12.414	2,49	12.912	2,59	3.540	0,71	498.537
Finland	21.993	6,51	135	0,04	20.372	6,03	243.649	72,12	10.912	3,23	6.081	1,8	34.662	10,26	337.839
France	159.777	29,10	12.573	2,29	129.139	23,52	207.435	37,78	8.950	1,63	25.257	4,6	5.930	1,08	549.061
Hungary	47.650	51,23	1.823	1,96	13.589	14,61	24.788	26,65	428	0,46	2.837	3,05	1.907	2,05	93.013
Ireland	3.700	5,29	-	0,00	48.228	68,95	11.723	16,76	2.364	3,38	2.077	2,97	1.854	2,65	69.946
Italy	82.403	27,41	26.726	8,89	40.736	13,55	120.854	40,2	8.839	2,94	16.625	5,53	4.419	1,47	300.633
Lithuania	24.798	38,21	104	0,16	13.272	20,45	22.228	34,25	2.596	4	1.908	2,94	-	0	64.899
Luxembourg	663	25,54	16	0,62	655	25,23	1.033	39,78	16	0,62	189	7,28	24	0,93	2.596
Latvia	17.897	27,71	84	0,13	8.667	13,42	32.829	50,83	3.656	5,66	1.453	2,25	-	0	64.586
Malta	59	18,75	24	7,50	35	11,25	63	20	24	7,5	103	32,5	8	2,5	315
Netherlands	7.533	21,21	238	0,67	14.953	42,1	6.262	17,63	746	2,1	3.864	10,88	1.925	5,42	35.518
Poland	141.116	45,24	967	0,31	43.608	13,98	109.362	35,06	811	0,26	10.949	3,51	5.116	1,64	311.928
Portugal	18.080	20,35	7.854	8,84	11.861	13,35	43.578	49,05	2.434	2,74	3.891	4,38	1.155	1,3	88.843
Romania	109.160	45,79	3.457	1,45	26.390	11,07	81.649	34,25	1.359	0,57	9.321	3,91	7.056	2,96	238.392
Sweden	28.152	6,26	45	0,01	22.081	4,91	331.847	73,79	18.528	4,12	8.455	1,88	40.610	9,03	449.718
Slovenia	2.196	10,83	485	2,39	2.685	13,24	13.938	68,74	221	1,09	661	3,26	91	0,45	20.277
Slovak Republic	14.806	30,20	441	0,90	6.770	13,81	24.709	50,4	422	0,86	1.466	2,99	417	0,85	49.026
United Kingdom	55.910	22,86	196	0,08	89.172	36,46	76.576	31,31	3.571	1,46	13.794	5,64	5.356	2,19	244.574
EU	1.158.043	26,86	117.273	2,72	699.611	16,23	1.943.277	45,07	88.646	2,06	176.438	4,092	127.999	2,969	4.311.286

From the stratified first phase sample, a second phase simple random sample (SRS) of points, namely the field sample, is chosen to be classified during field visit according to the full land classification. The stratified second phase sample is selected independently in each NUTS2 region and in every stratum, fixing precision targets on the estimates of the main land cover classes; the overall sampling rate is about

27%. Unfortunately access to points can be difficult in absence of adequate road network, for the landscape characteristics, or simply due to the denied access from land owners or because point is placed in forbidden areas. In LUCAS 2009 out of 234.000 points of the sample, around 55.000 points could not be visited and were photo interpreted[1] (26.000 in the field and 26.000 in the office). As the information recorded in LUCAS is used in the production of reference data in the selection strategy, in agreement with the data users, it was given priority to accessibility of the points. Points which were verified as inaccessible in 2009 have been excluded from the sample and, with the use of auxiliary information related to elevation, slope and closest road distance, other points were included. In addition, the level of elevation, above which points were excluded from field visit, was raised from 1000m to 1500m. Points above 1500 metres are excluded from the sample but they are taken into consideration by the estimation procedure, considering them as "missing" observations.

A longitudinal structure in the sample assures that a certain percentage of points is surveyed in successive campaigns; this common part, decreases the sampling errors of the estimated variations between two different survey years by the correlations of same points in different times.

In Table 5 the number of selected points in second phase sample is showed as well as the sampling rates. The overall sampling rate is about 25 % and it ranges from a minimum of about 16% in Finland to the maximum of about 33% in Luxemburg, excluding the particular cases of Malta (about 99%) and Cyprus (about 62%).

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[1] Surveyors are provided with Ground Documents including recent Orthophotos

Table 6: Second phase sample - number of selected points by countries and strata

| Country | STRATA | | | | | | | Totale | Sampling rate |
	Arable land	Permanent crops	Grassland	Wooded areas and shrub land	Bare land	Artificial land	Water		
Austria	1220	100	1265	3369	31	405	77	6467	30,83
Belgium	655	21	800	669	12	248	41	2446	31,84
Bulgaria	2909	0	979	2109	80	469	96	6642	23,94
Cyprus	168	107	217	726	106	106	12	1442	62,40
Czech Republic	2142	28	751	2292	38	203	60	5514	27,96
Germany	9420	190	4139	8608	146	2113	327	24943	27,87
Denmark	2424	0	238	531	25	193	33	3444	31,82
Estonia	368	4	371	1355	34	25	45	2202	19,39
Greece	1770	713	867	4037	87	267	87	7828	23,69
Spain	10899	3823	4639	14034	682	1027	273	35377	28,39
Finland	1775	8	823	8684	317	484	1391	13482	15,95
France	11258	882	9101	14485	451	1765	396	38338	27,92
Hungary	2378	89	676	1236	29	138	91	4637	19,93
Ireland	183	0	2409	581	137	101	73	3484	19,84
Italy	6603	2204	2434	7839	242	1365	326	21013	27,89
Lithuania	1503	7	805	1348	112	114	0	3889	23,81
Luxembourg	53	4	52	83	4	15	4	215	33,28
Latvia	1231	5	592	2245	253	94	0	4420	27,38
Malta	15	6	9	16	6	26	1	79	98,75
Netherlands	483	24	932	389	56	233	112	2229	25,15
Poland	9878	80	3036	7648	59	761	344	21806	27,91
Portugal	1509	671	947	3617	187	324	81	7336	32,95
Romania	7668	238	1829	3530	56	658	299	14278	23,95
Sweden	1424	4	1014	16737	785	419	2038	22421	19,93
Slovenia	196	40	227	1087	4	59	8	1621	31,99
Slovak Republic	740	24	338	1235	25	71	22	2455	20,02
United Kingdom	2838	15	4390	3937	180	676	216	12252	19,76
EU	81710	9287	43880	112427	4144	12359	6453	270260	25,03

Ground survey

Information collected

For each point belonging to the field sample, the following information was collected (see *LUCAS 2012 - Technical reference document C-2: Field form*):

> For each point belonging to the field sample, the following information was collected:
> - Land cover;
> - Land use;
> - A set of landscape photos comprising 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);
> - Geo-referenced point location parameters;
> - Some information and notes from the surveyors.

In 2012 the soil module was implemented in Bulgaria and Romania

A detailed list of the items recorded during the ground survey is provided, along with a short description of the parameters is in Table 7: 7.

Table 7: Description of the surveyed parameters.

Items recorded through the ground survey	Item modalities	Description
Surveyor ID		Unique identity code of surveyor.
Point ID		Unique code of the point as provided by Eurostat.
Soil Sample number	00.001 – 22.000	Unique code of the point
Date		Date of observation (DD/MM, e.g. 25/03).
Start time		Observation time starts when leaving the car (HH/mm, e.g. 14:02).
End time		Observation time ends after returning to the car (HH/mm, e.g. 14:50 h)
Observed	The point is observed	Point regularly observed
	Out of national territory	Point located beyond the national borders
	Point not visible	Point is not visible or located in an area with restricted access (observed from distance or photo-interpreted in the field)
	Marine See	Point located in marine sea or on an island without a bridge connection (if the island is not in the sample)
Type of observation	Field survey, point visible, 0-100 m	Observation of the point in the field
	Field survey, point visible, >100	Point not accessible in the field, but still visible, observation from distance can be do in the field. LC and LU identifiable unambiguously.
	Photo interpretation in office	Interpretation of the ortho-photo done in the office (due to the impossible access to the point)
	Photo-interpretation, point not visible	Point is not accessible and not visible in the field, an interpretation of the ortho-photo has to be done in the field.
	The point is not observed	Point not observed because of inaccessibility and orthophoto unavailability or bad quality.
GPS projection system	(1) / (2) / (8)	"WGS 84" / No signal / Not used
Precision		Indication of average location error as given by GPS receiver (in m)
Latitude/Longitude		GPS position of the location from which observation is done (DD.dddddd)
Elevation		GPS elevation of the location from which observation is done (in m above sea level).
Distance to the point	0-3 m	Indication of the distance between observation location and

Items recorded through the ground survey	Item modalities	Description
	3-50 m 50-100 m >100 m not relevant	the LUCAS point. as provided by the GPS (in m).
Direction	On the point	Point regularly observed.
	North/East	"Look to the North/East" rule applied, if point located on a boundary edge or a small linear feature directed North/South or East/West(<3m wide).
	Not relevant	Not applicable.
Land cover 1		Coding of primary land cover
Land cover 2		Coding of secondary land cover if necessary
Radius	1.5 m	Observation of LC within a radius of 1.5 m.
	20 m	Observation of LC within the extended observation window (20m radius) for specific LC
Area size (in ha)	Area<0.5	The size of the observed plot is smaller than 0.5 ha.
	0.5 ≤ Area < 1	The size of the observed plot ranges between 0.5 and 1 ha.
	1≤Area<10	The size of the observed plot ranges between 1 and 10 ha.
	Area≥10	The size of the observed plot is larger than 10 ha.
Height of trees at The moment of observation	Less than 5 m More/equal 5 m	Assessment of the height of the trees for specific land covers.
Height of trees at maturity	Less than 5 m More/equal 5 m	Assessment of the height of the trees for specific land covers.
Width of feature	Less than 20 m More/equal 20 m	Assessment the width of the feature for specific land covers.
Land cover 1 and 2 plant species		Registration of the crop type in case of a specific crop cover observation. In case area size is larger than 0.5 ha, height of the trees above 5 meters and the feature wider than 20m the plant species is annotated.
Percentage of land coverage (%) of land cover 1 and 2	%LC < 10	Estimation of the coverage of land cover 1 and 2.
	10 ≤ %LC < 25	
	25 ≤ %LC < 50	
	50 ≤ %LC < 75	
	%LC ≥ 75	
Land use 1		Coding of land use according to nomenclature.
Land use 2		Coding of land use according to nomenclature if necessary.
Land management	Grazed	Tracks of permanent or occasional grazing of the plot can be found.
	Not grazed	No tracks of grazing of the plot can be found.
	Not relevant	
Special remark on land cover / land use	Tilled and/or Sowed Harvested Field Clear Cut Burnt Area Fire Break Nursery No remark	This remark is for the regional / central office.
Special Status	Protected Hunting Protected and Hunting No special status	If the area is protected under a special regulation on nature conservation (e.g. NATURA2000) and/or signs of hunting are visible.
Presence of water	Irrigation	Photo acquisition of the irrigation device

Items recorded through the ground survey	Item modalities	Description
management	Potential irrigation	Photo acquisition of the evidence of irrigation
	Drainage	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
	Irrigation and drainage	Photo acquisition
	No visible water management	No photo acquisition
	Not relevant	No photo acquisition
Type of irrigation	Gravity	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.
	Pressure (2): Sprinkle irrigation	Water is delivered to the farm and/or field in pump or elevation induced pressure pipelines; and water is distributed across the field by Sprinkle or Micro-irrigation systems respectively.
	Pressure (3): Micro-irrigation	
	Gravity/Pressure	Farm delivery and field distribution of irrigation water are a combination of gravity and pressure facilities.
	Other/not identifiable	
	Not relevant	
Source of irrigation	Well	A hole drilled or bored into the earth providing access to water.
	Pond/Lake/Reservoir	Lake: a natural inland body of water, fresh or salt. Pond: a water impoundment made by constructing a dam or an embankment. Reservoir. a pond, lake, basin, or other space created in whole or in part by the water.
	Stream/Canal/Ditch	Ditch: a long, narrow trench or furrow dug in the ground, as for irrigation. Canal: an artificial waterway used for irrigation. Stream: a flow of water in a channel or bed, as a brook, rivulet, or small river.
	Lagoon/Wastewater	Lagoon-waste treatment: an impoundment made by excavation or earthfill for biological treatment of animal or other agricultural waste. Wastewater: water that carries wastes from homes, agricultural businesses, and industries.
	Other/not identifiable	
	Not relevant	
Delivery System	Canal	An artificial waterway used for irrigation.
	Ditch	A long, narrow trench or furrow dug in the ground, as for irrigation.
	Pipeline	A conduit of pipe used for the conveyance of water.
	Other/not identifiable	
	Not relevant	
Is the soil sample taken?	Yes (1) No (2) Not in the sample (3)	Indicates that the soil sample has been taken.
Percentage of residual crops on the surface:	RC<10% (1) 10 ≤RC < 25 (2) 25≤ RC<50 (3) RC ≥50 (4) Not relevant (8)	Estimation of the percentage of residual crops above the ground.

Items recorded through the ground survey	Item modalities	Description
Can you see any sign of ploughing in the plot?	Yes (1) No (2) Not relevant (8)	Indicates that the field where the soil sample was taken is ploughed (if any sign of ploughing can be seen).
Percentage of stones on the surface:	S<10% (1) 10 ≤S< 25 (2) 25≤ S<50 (3) S≥50 (4) Not relevant (8)	Estimation of the percentage of stones above the ground.
Remarks about the soil sample		Free text and comments. This field is mandatory if the soil sample could not be taken.
Transect	Codification	For all land cover areas ≥ 3 m, use relevant land cover codifications (A, Bxx, Cxx, Dxx, Exx, Fxx, Gxx).
	First entry	Land cover of the point
	Following entries	All LC codifications possible (except A codes, which are marked as "A"). BX1 or BX2 for arable land and permanent crops if the transect is photointerpreted and detailed crop is not identifiable.
	(PI	Photo-Interpretation of a not accessible part of the transect starts.
	PI)	Photo-Interpretation of a not accessible part of the transect ends.
	Last entry = X	Transect has not been finished. Explain in remarks (39) why transect could not be finished.
Remarks about the transect		Structured comments or free text might be filled in by surveyors. This field is mandatory if rules apply which are fixed in the surveyors' instructions (transect) or if problems arrive. Whenever the transect had been (partly) photo-interpreted, could not be finished or had not been mapped at all, the reasons should be noticed here.
Photo of the Point	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo of the point (aimed at facilitating to find the point in the next survey)
Photo of Crop/Cover	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo of the crop/cover (aimed at allowing the identification of the crop and its phenological stage or the land cover).
Photos (N, E, S and W)	Photo taken (1) Photo not taken (2) Not relevant (8)	Landscape photos taken in the four cardinal directions.
Photo of irrigation	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo of the irrigation system should allow its identification
Photo of the transect	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo of the transect has to be taken towards the starting point, thus direction W
Photo of the soil	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo of the soil sample hole
Conflict case photo	Photo taken (1) Photo not taken (2) Not relevant (8)	Photo describing reasons why the LUCAS survey could not be implemented respecting all rules set in this document
Photo IDs		Photo identification number
Photo anonymization		Tick the box if in the photo there are either people, car number plates or other features which make the identification of the place possible

Implementation and schedule

LUCAS 2012 was carried out in 27 MS[2], covering 99% of total EU area. The following territories/islands, reported in Table 8 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 this territories sum up to around 5/000 of the total area of EU.

Table 8: Territories/islands not included in the field survey

ES63 (Ciudad Autonoma de Ceuta)	0.03% of ES6 (SUR)
ES64 (Ciudad Autonoma de Melilla)	
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. The Contractors were responsible for the data collection in the 27 countries arranged in 5 Lots, the recruitment and management of the surveyors and the data delivery. The campaign started in March 2012 and was completed in January 2013; in the round more than 700 surveyors were recruited for a total of more than 270.000 points to be visited in the ground (Table 9).

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[2] LUCAS survey was carried out in all the EU countries with the exception of Croatia.

Table 9: Organization of the work.

COUNTRY	No. Surveyors	Surveyed Points	Ex-ante PI	Survey Time	
				Start	End
Austria	13	6467	9	15-apr-12	08-sep-12
Belgium	6	2446	0	17-may-12	01-nov-12
Bulgaria	28	6642	0	03-may-12	01-oct-12
Cyprus	15	1442	54	03-apr-12	04-oct-12
Czech Republic	11	5514	0	23-apr-12	20-aug-12
Germany	31	24943	0	04-may-12	29-oct-12
Denmark	6	3444	0	14-may-12	17-sep-12
Estonia	3	2202	0	30-apr-12	19-sep-12
Greece	39	7828	202	28-mar-12	26-sep-12
Spain	75	35377	0	02-mar-12	07-oct-12
Finland	24	13482	0	28-may-12	01-nov-12
France	115	38338	0	07-apr-12	21-oct-12
Hungary	19	4637	0	05-apr-12	26-aug-12
Ireland	13	3484	0	07-apr-12	19-dec-12
Italy	110	21013	19	17-apr-12	28-jan-13
Lithuania	7	3889	0	07-may-12	28-sep-12
Luxembourg	1	215	0	26-apr-12	08-aug-12
Latvia	10	4420	0	30-apr-12	28-sep-12
Malta	1	79	0	01-may-12	10-may-12
Netherlands	3	2229	0	12-may-12	14-sep-12
Poland	41	21806	0	30-apr-12	11-nov-12
Portugal	14	7336	0	28-mar-12	13-sep-12
Romania	44	14278	0	03-may-12	22-nov-12
Sweden	36	22421	0	11-may-12	01-oct-12
Slovenia	6	1621	123	01-may-12	30-aug-12
Slovak Republic	6	2455	0	23-apr-12	19-sep-12
United Kingdom	62	12252	0	23-apr-12	19-dec-12
EU	739	270260	407	02-mar-12	28-jan-13

Survey performance

In 2012 the surveyors recruited were 739 for a total of 270260 points to be visited in the ground (see table 6). The average number of points per surveyor in 2012 was 366, compared to 405 in 2009. There were however important differences between the countries (see graph 1). The maximum average number of points per surveyor were 805 in Germany followed from Netherlands (747 points) and Estonia (734 points); the minimum amount of points is found in Cyprus and Malta. A group of eight countries are very close in a range between 190 and 270 points per surveyors while the remaining eleven are spread in a range from 320 to 620 points.

Graph 1: Average number of points surveyed per surveyor by country
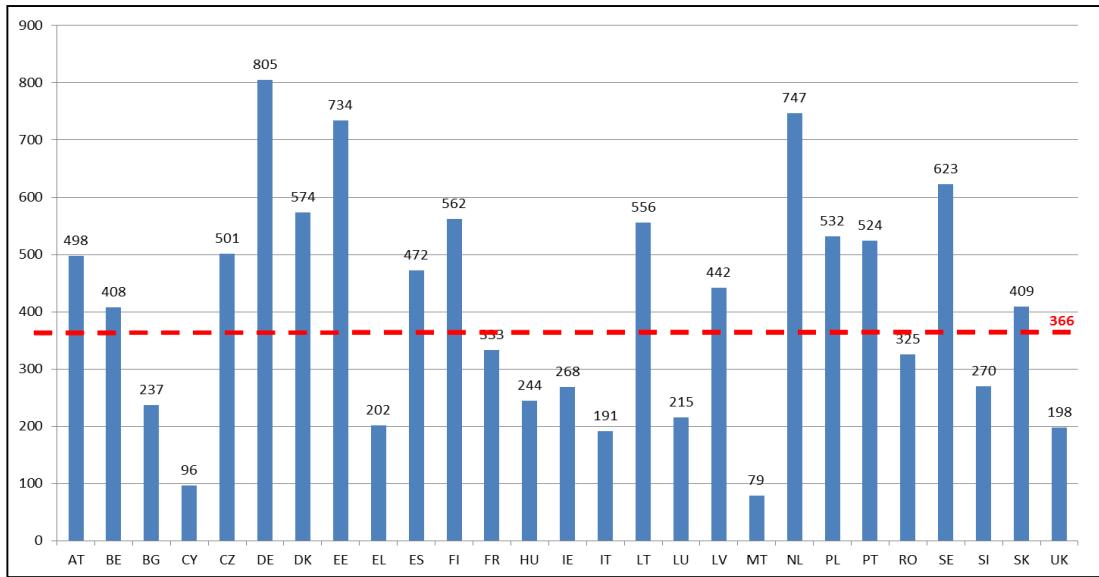
The average time spent per point is 24 minute and the indicator varies between 16 (Portugal) and 39 minutes (Luxemburg). The variability among the countries is low; excluding Bulgaria and Greece (34 minutes), the remaining countries are contained in a range of 10 minutes, from 20 to 30 minutes per point (see **Error! Reference source not found.**).

Graph 2: Average time spent per point by country (in min)
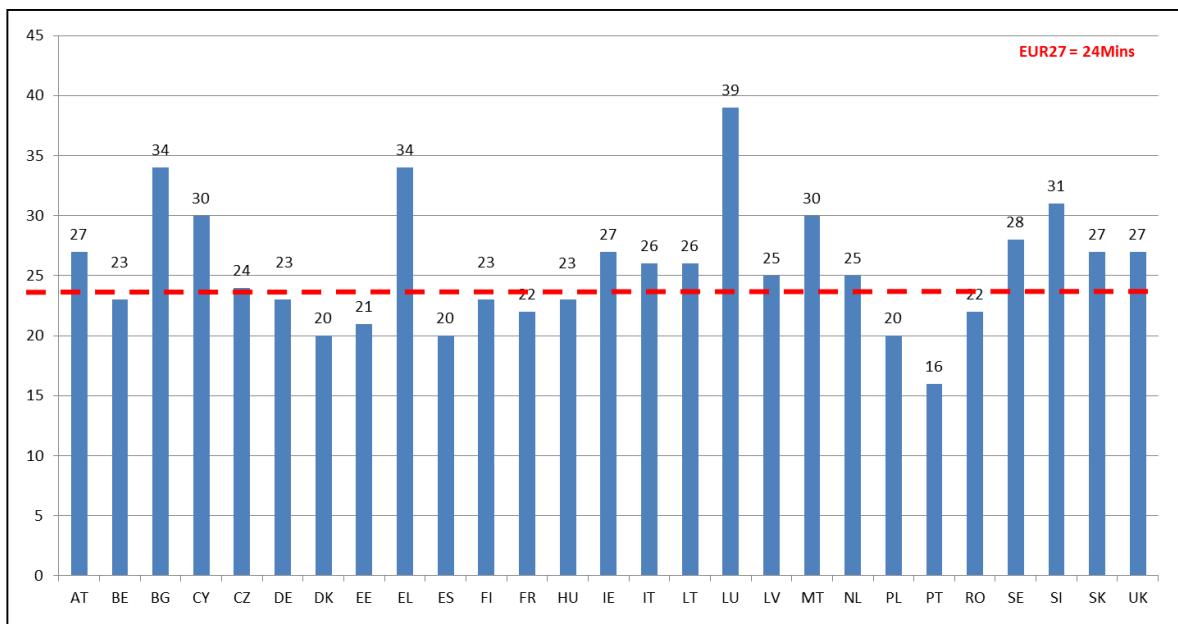
The average time needed to visit each point depends mainly on the land cover and the land use of the point and surroundings and is obviously also strongly related to the closeness of the point to the next road. Surveyors first of all have to reach the point and then they had to walk along a transect of 250 m towards the East. In general points in the forest were the most difficult to reach and indeed the highest average time spend per point is recorded in the countries with large areas of woodland. The average time spent per point varies between 19 min for water and 26 min for woodland (see **Error! Reference source ot found.**).

Graph 3: European average time spent per point by main land cover class compared with minimum and maximum time spend for this class by country (in minutes)
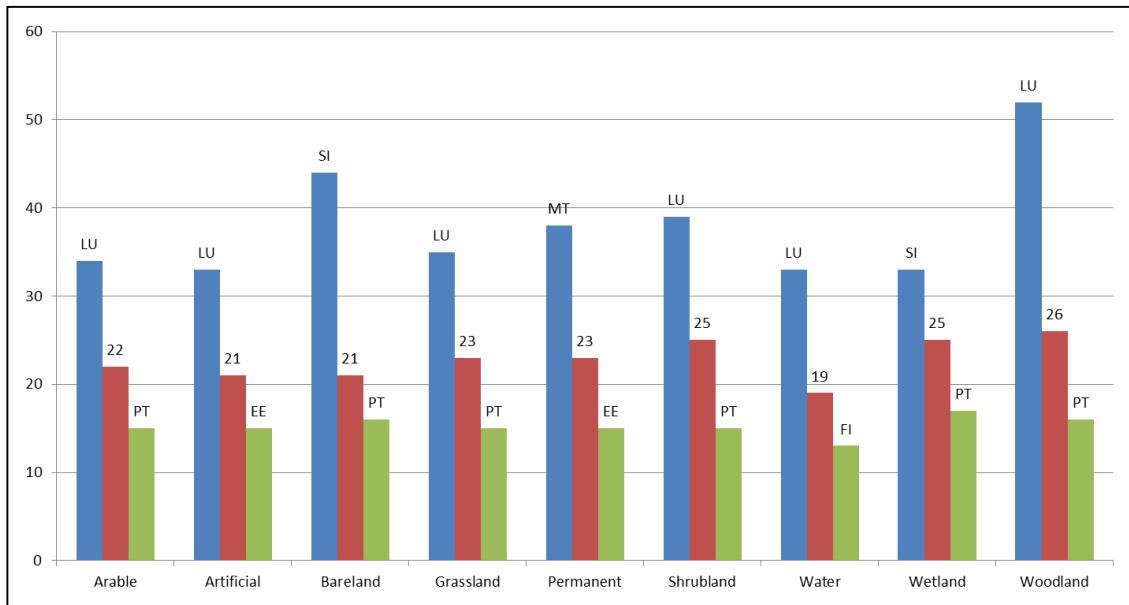
Data collection outcome

In Table 10 is reported the distribution of points by country and the different modalities to get the target information. In addition to the points photo interpreted ex ante, also during the data collection the surveyors could be unable to directly observe the points that are photo interpreted "in field", on the basis of the most recent available pictures.

The percentage of the directly observed points for the total of participating countries is about 75%; the lowest percentages (about 61 %) are reported for Estonia, Greece and Finland, while the highests for Luxemburg, Czech Republic and Slovenia.

Table 10: Number of surveyed points by countries and type of observation

Country	Points			Total	% of observed points
	observed	in field PI[3]	Ex ante PI[4]		
Austria	5801	657	9	6467	89,70
Belgium	2290	156	0	2446	93,62
Bulgaria	6152	490	0	6642	92,62
Cyprus	1251	137	54	1442	86,75
Czech Republic	5449	65	0	5514	98,82
Germany	24229	714	0	24943	97,14
Denmark	3276	168	0	3444	95,12
Estonia	1911	291	0	2202	86,78
Greece	6798	828	202	7828	86,84
Spain	32290	3087	0	35377	91,27
Finland	11350	2132	0	13482	84,19
France	35290	3048	0	38338	92,05
Hungary	4467	170	0	4637	96,33
Ireland	2866	618	0	3484	82,26
Italy	17805	3189	19	21013	84,73
Lithuania	3729	160	0	3889	95,89
Luxembourg	214	1	0	215	99,53
Latvia	3644	776	0	4420	82,44
Malta	74	5	0	79	93,67
Netherlands	2111	118	0	2229	94,71
Poland	20496	1310	0	21806	93,99
Portugal	6835	501	0	7336	93,17
Romania	11131	3147	0	14278	77,96
Sweden	20041	2380	0	22421	89,38
Slovenia	1463	35	123	1621	90,25
Slovak Republic	2205	250	0	2455	89,82
United Kingdom	10423	1829	0	12252	85,07
EU	243591	26262	407	270260	90,13

The number and the percentage of the observed points increases from 2009 and 2012 survey; the points photo-interpreted ex ante are negligible in 2012 while in 2009 they were about 13% of the total surveyed points (table 11).

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[3] Points photo-interpreted in the field by the surveyor, due to unexpected unaccessibility circumstances
[4] Points photo interpreted in the office, by the supervisors, due to dangerous conditions (remote forest, military areas, bear emergency..); the list of points was agreed beforehand by Eurostat

Table 11: Survey 2012 and 2009:percentage of points per type of observation

	Points				Total	% of observed points
	observed	missing	in field PI	Ex ante PI		
LUCAS 2009	174749	179	29875	29742	234545	74,51
LUCAS 2012	243591	-	26262	407	270260	90,13

IT tools and equipment

Various IT tools have been developed during the time to support LUCAS data imputing, editing and storage:
- The Data Entry Tool was developed in MS Access in 2005 with the aim of encoding and checking the information gathered by the surveyors;
- the CAESAR software was provided by the JRC in order to calculate final estimates and precision indicators;
- A specific software aimed at characterising the landscapes in Europe using the photos taken by the surveyors and the orthophotos was developed.

-

In order to store the amount of gathered data and allow easy access to information, the photos, ancillary data, location maps and orthophotos have been stored on three different servers. This infrastructure is operational and ready to be used for additional surveys.

In 2008, a very important IT technological innovation was introduced: the Data Management Tool (DMT). This tool provides support in all the phases of the survey with modules for the data entry, data import/export and reporting. The module for the data importing (Data Entry Tool –DMT) reproduces strictly the field form used by the LUCAS surveyors to register data in the field. It guides the surveyor in the data editing indicating the next field that needs to be filled in, the modalities that are coherent with the ones already inserted and so on. It also includes a list of on-line ranges, consistency checks and other automatic controls. Further development of this IT tool will be considered for future Lucas surveys.

Data processing

The data processing involved two main stages:
- o Data imputation for partial missing data;
- o Estimates production.

Data imputation of detailed land cover classes for PI points in cropland

As shown in Table12, a total of 26,669 points were photo-interpreted either ex-ante or in the field. Most of those points (about 56%) were classified as woodland or grassland (about 15%) but a limited percentage of them were located in cropland (about 9%) . For those points a simplified nomenclature was sometimes used due to the difficulties in properly distinguishing among specific classes in orthophotos (i.e. durum wheat from oats and barley). This issue appeared in 2299 points.

Table 12: Land cover photo-interpreted

	PI points	**PI %**
Artificial land	1087	4,08
cropland	2299	8,62
woodland	14979	56,17
shrub land	2276	8,53
grassland	4122	15,46
bareland	344	1,29
water	847	3,18
wetland	715	2,68
Total	**26669**	**100,00**

In the estimation phase the resulting observations can be considered affected by partial non response phenomenon (some detailed information on land cover is missing).

To avoid losing the points in the estimation phase, an imputation methodology was set up and applied taking into consideration both the need to look at the distribution of the land cover classes among the donor sets and the minimization of an overall indicator of distance between donor and recipient point. At each stage donor sets of increasing size (10, 15, 20, 25, 30 points) were built up in a way that each set was obtained adding more distant points to the previous order donor set. Only points belonging to cropland were included in the datasets.

The main features of the methodology were:
   o   The adoption of the modal value of the distribution of the potential donors;
   o   selection of the donor set that minimizes the cost function:

$$G_s = \left(\left(Maxd_{M_s} \right)^2 * \pi \right) / f_{M_s}$$

   Where:

   M_s modal land cover class of the distribution of the s-*th* set of donors

   f_{M_s} frequency of the modal land cover class of the distribution of the s-*th* set of donors

   d_{M_s} distance of the donors having the modal land cover class from the recipient

$Maxd_{M_s}$ maximum distance of the donors having the modal land cover class in the donor set

Estimates production

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 classes of elevation are taken into account (<300; 300-600, 600-900, more than 900). So the sum of weights of sampled points are forced to equalize the totals of master points in the domains defined by "Nuts2 crossed with the Strata", "Nuts1 crossed with the class of elevation" and "Nuts0 crossed with the strata and the class of elevation". 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

$$\widehat{S}_L = \widehat{Y}_L * S \qquad\qquad (1)$$

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

The estimator for a percentage in double sample is

$$\widehat{Y}_L = \sum_h W_h \, \hat{y}_{hL} \qquad\qquad (2)$$

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

$$\widehat{Y}_L = \sum_h W_h \left(\sum IL_{hk} \; y_{kh} \, / \, n_h \right) \qquad\qquad (3)$$

Where
$$IL_{hk} = \begin{cases} 1 \; if \; y_{kh} = L \\ 0 \; otherwise \end{cases}$$

with h=1 to 7 and k=1 to n_h . Formula (2) can be developed as

$$\widehat{Y}_L = (1\,/N) \sum_h \left[\sum_k IL_{kh} \, y_{kh} \right] * N_h \, / \, n_h \qquad\qquad (4)$$

where $N_h \, / \, n_h$ represent the inverse of inclusion probabilities p_{hk} .

Substituting (4) into (1) we obtain

$$\widehat{S}_L = (S\,/N) \sum_h \left[\sum_k IL_{kh} \, y_{kh} \right] * N_h \, / \, n_h$$

and because $S/N = \overline{S}$ is the average point area in NUTS2 we can write

$$\widehat{S}_L = \sum_h \left[\sum_k IL_{kh} \, y_{kh} \right] * \overline{S} * p_{hk} \qquad\qquad (5)$$

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

$$\widehat{S}_L = \sum_h \left[\sum_k IL_{kh} \, y_{kh} \right] * \overline{S} * w_{hk}$$

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

$$w_{i;v_1,...,v_m}^{t_1} = \frac{N_{v_1,...,v_m}}{n_{v_1,...,v_m}} w_{i;v_1,...,v_m}^{t_0}$$

Quality Report

Where:

- t^1 and t^0 represent two consecutive iterations;
- *i* refers to the i-th point;
- $v_1, \dots, v_m$ refers to the values observed for the *1,…,m* variables;
- $N_{v_1,\dots,v_m}$ are the number of points (derived from the master data set) of the values for the *1,…,m* variables;
- $N_{v_1,\dots,v_m}$ are the totals of the values for the *1,…,m* variables as observed in the sample; $w_{i;v_1,\dots,v_m}^{t^1}$ and $w_{i;v_1,\dots,v_m}^{t^0}$ 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:

$$\text{MV} = \frac{\sum_{i=1}^{n}(w^{t^1} - w^{t^0})^2}{n}$$

When *MV* is less than 0.00001, the IPF procedures is stopped.

According to the above estimator, for all the codes of land cover classification, are reported in the Table 13 the estimated area (in km^2) and in Table 14 the corresponding percentages .

Table 13: Estimates of land cover by country – absolute values (km^2)

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland	Total
AT	4405	2312	14295	20316	1572	1636	222	39170	83.928
BE	3748	154	8887	9953	135	438	69	7283	30.668
BG	2007	918	35475	22862	6734	961	100	41922	110.979
CY	598	433	3146	1221	1999	39	16	1795	9.246
CZ	3484	519	27133	16327	582	1040	123	29661	78.870
DE	26285	2719	118539	82476	3728	6383	1832	115802	357.766
DK	3022	472	20989	9245	580	730	441	7584	43.065
EE	964	503	5447	9341	1279	2240	747	24850	45.372
EL	5029	2988	30840	18023	33014	1924	631	39242	131.692
ES	18501	23955	141699	79143	80618	4567	603	149456	498.537
FI	5520	2314	20429	14199	7841	33747	16537	237254	337.839
FR	29874	4832	169654	153693	19008	7731	1043	163236	549.061
HU	3173	1022	43540	19460	2120	1779	1129	20787	93.013
IE	2964	448	4135	44155	2899	1809	4596	8940	69.946

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland	Total
IT	21871	4714	97634	51625	18808	8809	646	96530	300.633
LT	1606	452	17166	19410	763	1694	618	23192	64.899
LU	265	23	539	865	26	19	0	858	2.596
LV	1049	670	8390	15878	966	2421	1422	33790	64.586
MT	103	24	83	35	51	8	0	12	315
NL	4555	537	9122	14085	478	2215	182	4344	35.518
PL	10468	2648	107687	75783	3450	5661	1394	104836	311.928
PT	5108	2883	16103	15072	15089	1239	245	33105	88.843
RO	5056	1397	83516	64278	4019	4737	1707	73682	238.392
SE	8090	2860	19127	27491	23759	38168	22598	307630	449.718
SI	677	278	2205	4470	456	89	66	12035	20.277
SK	1429	249	13758	9855	1599	556	40	21540	49.026
UK	14892	2998	52040	100728	20600	5716	6352	41247	244.574
EU	184964	63353	1072546	901416	252341	136051	63211	1637404	4.311.286

Table 14: Estimates of land cover by country – percentages

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland	Total
AT	5,2	2,8	17,0	24,2	1,9	1,9	0,3	46,7	100,0
BE	12,2	0,5	29,0	32,5	0,4	1,4	0,2	23,7	100,0
BG	1,8	0,8	32,0	20,6	6,1	0,9	0,1	37,8	100,0
CY	6,5	4,7	34,0	13,2	21,6	0,4	0,2	19,4	100,0
CZ	4,4	0,7	34,4	20,7	0,7	1,3	0,2	37,6	100,0
DE	7,3	0,8	33,1	23,1	1,0	1,8	0,5	32,4	100,0
DK	7,0	1,1	48,7	21,5	1,3	1,7	1,0	17,6	100,0
EE	2,1	1,1	12,0	20,6	2,8	4,9	1,6	54,8	100,0
EL	3,8	2,3	23,4	13,7	25,1	1,5	0,5	29,8	100,0
ES	3,7	4,8	28,4	15,9	16,2	0,9	0,1	30,0	100,0
FI	1,6	0,7	6,0	4,2	2,3	10,0	4,9	70,2	100,0
FR	5,4	0,9	30,9	28,0	3,5	1,4	0,2	29,7	100,0
HU	3,4	1,1	46,8	20,9	2,3	1,9	1,2	22,3	100,0
IE	4,2	0,6	5,9	63,1	4,1	2,6	6,6	12,8	100,0
IT	7,3	1,6	32,5	17,2	6,3	2,9	0,2	32,1	100,0
LT	2,5	0,7	26,5	29,9	1,2	2,6	1,0	35,7	100,0
LU	10,2	0,9	20,8	33,3	1,0	0,7	0,0	33,0	100,0
LV	1,6	1,0	13,0	24,6	1,5	3,7	2,2	52,3	100,0
MT	32,5	7,5	26,3	11,3	16,3	2,5	0,0	3,8	100,0
NL	12,8	1,5	25,7	39,7	1,3	6,2	0,5	12,2	100,0
PL	3,4	0,8	34,5	24,3	1,1	1,8	0,4	33,6	100,0
PT	5,7	3,2	18,1	17,0	17,0	1,4	0,3	37,3	100,0
RO	2,1	0,6	35,0	27,0	1,7	2,0	0,7	30,9	100,0
SE	1,8	0,6	4,3	6,1	5,3	8,5	5,0	68,4	100,0
SI	3,3	1,4	10,9	22,0	2,2	0,4	0,3	59,4	100,0
SK	2,9	0,5	28,1	20,1	3,3	1,1	0,1	43,9	100,0
UK	6,1	1,2	21,3	41,2	8,4	2,3	2,6	16,9	100,0
EU	4,3	1,5	24,9	20,9	5,9	3,2	1,5	38,0	100,0

In the same way are calculated the two following tables, related to Land use: in Table 15 is reported the estimated area (in km^2) while in Table 16 the corresponding percentages for all the codes of land use classification.

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Table 15: Estimates of land use by country – absolute values (km^2)

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	Total
AT	31571	198	219	82	159	161	40015	148	462	4603	1158	2739	2374	39	83.928
BE	15890	236	330	90	27	145	6164	163	62	1512	463	3979	1584	24	30.668
BG	54798	118	170	79	83	374	38808	113	152	12716	418	1732	1183	233	110.979
CY	3721	46	39	56	18	0	692	0	34	3971	67	315	260	29	9.246
CZ	39789	206	330	58	71	681	28042	334	208	3920	905	2093	1984	249	78.870
DE	187634	2161	3953	376	751	1449	102915	1438	1846	14958	7166	17044	15352	719	357.766
DK	27194	378	400	63	37	140	5098	138	12	3741	1568	2764	1450	83	43.065
EE	12885	0	20	0	214	1345	25072	40	554	2619	965	1028	630	0	45.372
EL	53016	295	362	204	593	722	26259	154	378	43635	686	2050	2993	344	131.692
ES	236590	499	1441	708	1012	444	99249	489	1346	134859	2353	7184	9921	2443	498.537
FI	26581	250	963	81	1142	10682	233028	166	1953	31375	21693	4480	5372	74	337.839
FR	298887	1208	3684	549	593	2515	133696	813	1137	51557	6797	28063	18877	681	549.061
HU	57665	174	318	20	81	724	20704	263	219	6050	969	3791	1635	401	93.013
IE	48831	79	73	20	59	557	6425	59	1899	6745	1252	2290	1495	163	69.946
IT	145735	1539	935	743	950	1052	74554	1007	743	46848	3809	12627	9807	286	300.633
LT	34505	67	16	17	17	1400	23006	67	149	2959	543	1120	978	56	64.899
LU	1325	18	18	13	0	5	887	0	0	36	24	94	174	0	2.596
LV	20599	45	60	15	116	1333	33221	31	406	5417	1193	1224	897	29	64.586
MT	110	0	4	0	0	0	0	0	0	103	8	63	28	0	315
NL	20210	369	381	225	17	0	1182	213	45	3172	2740	3132	3723	108	35.518
PL	161067	593	1769	446	125	1862	96701	574	774	26286	4074	10802	6376	477	311.928
PT	38525	229	235	210	115	36	28895	153	189	14544	247	2213	3146	107	88.843
RO	143672	119	272	229	119	3595	74595	319	322	8158	324	3988	2541	136	238.392
SE	40227	243	1421	54	1727	19198	286952	441	562	58913	27280	5437	7160	108	449.718
SI	6156	31	70	33	24	44	11032	34	57	1521	318	510	413	33	20.277
SK	20288	20	227	19	152	283	21506	79	69	3870	443	1091	831	148	49.026
UK	148762	1352	2155	188	372	1751	28786	682	1049	31401	8792	12256	6273	756	244.574
EU	1878630	10496	19878	4578	8565	50336	1445045	7927	14638	525550	96104	134291	107515	7735	4.311.286

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Table 16: Estimates of land use by country – percentages

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	Total
AT	37,6	0,2	0,3	0,1	0,2	0,2	47,7	0,2	0,6	5,5	1,4	3,3	2,8	0,0	100,0
BE	51,8	0,8	1,1	0,3	0,1	0,5	20,1	0,5	0,2	4,9	1,5	13,0	5,2	0,1	100,0
BG	49,4	0,1	0,2	0,1	0,1	0,3	35,0	0,1	0,1	11,5	0,4	1,6	1,1	0,2	100,0
CY	40,2	0,5	0,4	0,6	0,2	0,0	7,5	0,0	0,4	42,9	0,7	3,4	2,8	0,3	100,0
CZ	50,4	0,3	0,4	0,1	0,1	0,9	35,6	0,4	0,3	5,0	1,1	2,7	2,5	0,3	100,0
DE	52,4	0,6	1,1	0,1	0,2	0,4	28,8	0,4	0,5	4,2	2,0	4,8	4,3	0,2	100,0
DK	63,1	0,9	0,9	0,1	0,1	0,3	11,8	0,3	0,0	8,7	3,6	6,4	3,4	0,2	100,0
EE	28,4	0,0	0,0	0,0	0,5	3,0	55,3	0,1	1,2	5,8	2,1	2,3	1,4	0,0	100,0
EL	40,3	0,2	0,3	0,2	0,5	0,5	19,9	0,1	0,3	33,1	0,5	1,6	2,3	0,3	100,0
ES	47,5	0,1	0,3	0,1	0,2	0,1	19,9	0,1	0,3	27,1	0,5	1,4	2,0	0,5	100,0
FI	7,9	0,1	0,3	0,0	0,3	3,2	69,0	0,0	0,6	9,3	6,4	1,3	1,6	0,0	100,0
FR	54,4	0,2	0,7	0,1	0,1	0,5	24,4	0,1	0,2	9,4	1,2	5,1	3,4	0,1	100,0
HU	62,0	0,2	0,3	0,0	0,1	0,8	22,3	0,3	0,2	6,5	1,0	4,1	1,8	0,4	100,0
IE	69,8	0,1	0,1	0,0	0,1	0,8	9,2	0,1	2,7	9,6	1,8	3,3	2,1	0,2	100,0
IT	48,5	0,5	0,3	0,2	0,3	0,4	24,8	0,3	0,2	15,6	1,3	4,2	3,3	0,1	100,0
LT	53,2	0,1	0,0	0,0	0,0	2,2	35,4	0,1	0,2	4,6	0,8	1,7	1,5	0,1	100,0
LU	51,1	0,7	0,7	0,5	0,0	0,2	34,2	0,0	0,0	1,4	0,9	3,6	6,7	0,0	100,0
LV	31,9	0,1	0,1	0,0	0,2	2,1	51,4	0,0	0,6	8,4	1,8	1,9	1,4	0,0	100,0
MT	35,0	0,0	1,3	0,0	0,0	0,0	0,0	0,0	0,0	32,5	2,5	20,0	8,8	0,0	100,0
NL	56,9	1,0	1,1	0,6	0,0	0,0	3,3	0,6	0,1	8,9	7,7	8,8	10,5	0,3	100,0
PL	51,6	0,2	0,6	0,1	0,0	0,6	31,0	0,2	0,2	8,4	1,3	3,5	2,0	0,2	100,0
PT	43,4	0,3	0,3	0,2	0,1	0,0	32,5	0,2	0,2	16,4	0,3	2,5	3,5	0,1	100,0
RO	60,3	0,1	0,1	0,1	0,1	1,5	31,3	0,1	0,1	3,4	0,1	1,7	1,1	0,1	100,0
SE	8,9	0,1	0,3	0,0	0,4	4,3	63,8	0,1	0,1	13,1	6,1	1,2	1,6	0,0	100,0
SI	30,4	0,2	0,3	0,2	0,1	0,2	54,4	0,2	0,3	7,5	1,6	2,5	2,0	0,2	100,0
SK	41,4	0,0	0,5	0,0	0,3	0,6	43,9	0,2	0,1	7,9	0,9	2,2	1,7	0,3	100,0
UK	60,8	0,6	0,9	0,1	0,2	0,7	11,8	0,3	0,4	12,8	3,6	5,0	2,6	0,3	100,0
EU	43,6	0,2	0,5	0,1	0,2	1,2	33,5	0,2	0,3	12,2	2,2	3,1	2,5	0,2	100,0

Quality control and data editing

Quality assurance has been a crucial component during all the phases of the survey. In this respect the following actions have been put in place:

- External quality check during the survey
- A common framework
- Field work related quality control
- Eurostat quality control and data processing
- Quality check by external company

External quality check during the survey

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. However a minimum of 20% of the points was checked in every country. The total number and the rate of checked points by country is presented in Table 17: . In the same table 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 first rejection rate varies between 0,08 (LT) and 18,99% (MT) with an average of 6,85%.

Table 17: Rate of checked points by country.

COUNTRY	Total points	Visually Controlled	%	First rejected points	%
Austria	6467	2047	31,7	224	3,5
Belgium	2446	620	25,3	238	9,7
Bulgaria	6642	2857	43,0	840	12,6
Cyprus	1442	494	34,3	60	4,2
Czech Republic	5514	1396	25,3	105	1,9
Germany	24943	6618	26,5	1652	6,6
Denmark	3444	1293	37,5	221	6,4
Estonia	2202	1093	49,6	197	8,9
Greece	7828	3376	43,1	455	5,8
Spain	35377	18144	51,3	3091	8,7
Finland	13482	4601	34,1	543	4,0
France	38338	11717	30,6	2201	5,7
Hungary	4637	1407	30,3	202	4,4
Ireland	3484	1240	35,6	480	13,8
Italy	21013	8249	39,3	1580	7,5
Lithuania	3889	840	21,6	39	1,0
Luxembourg	215	95	44,2	5	2,3
Latvia	4420	1830	41,4	154	3,5
Malta	79	79	100,0	15	19,0
Netherlands	2229	917	41,1	214	9,6
Poland	21806	6021	27,6	1006	4,6
Portugal	7336	3290	44,8	536	7,3
Romania	14278	5668	39,7	1490	10,4
Sweden	22421	7428	33,1	1699	7,6
Slovenia	1621	631	38,9	54	3,3
Slovak Republic	2455	1112	45,3	265	10,8
United Kingdom	12252	4795	39,1	1370	11,2
EU	270260	97858	36,2	18936	7,0

The common framework

Quality assurance is a central component throughout all the phases of the LUCAS survey as to assure the quality and the comparability of results. 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,
- Standardised and automated Data Management Tool (DMT),
- Common training for all the Survey Managers.

A second part of the quality assurance is related to the field work and includes:

- Follow-up visit to each country by a team of experts,
- Internal quality check,
- Independent data quality control
- Eurostat quality control.

As outlined above the common framework included common reference documents (documentation and instructions), as well as a "Frequently asked questions" documents. This last one was regularly updated based on the issues raised during the project. Comparing 2009 campaign, two new documents were edited: a plant identification guide and guidelines for report.

The DMT consists of an Access based tool which provides support both in the controlled data entry and in the data flow.

The supervised data entry module reproduces strictly the field form used by the LUCAS surveyors to register data in the field. It guides the surveyor in the data editing indicating the next field that needs to be filled in, the modalities that are coherent with the ones already inserted and so on. It also includes a list of on-line ranges, consistency checks and other automatic controls. If, editing data, surveyor violates one of these rules, DMT provides a warning message informing about the problem.

The training for the survey managers included 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.

Field work related quality control

The field work related support by an expert team aims 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 & their training, communication and quality control. Based on the results a second round of follow-up visits were organized to propose corrective measures where needed.

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 (around 270.000) in the 27 participating countries.

An independent external data visual quality control of over 1/3 of the points was assured by a separate expert team of 13 LUCAS 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) was analyzed to evaluate the reliability of the results. Point data that clearly required correction or clarification was rejected and send back to the field work contractors. This concerned about 7% of the points checked. After a second control the data was forwarded to Eurostat, where a further quality control took place.

Eurostat quality control and data processing

In Eurostat the quality control first included the consolidation of the "raw" data set (duplicates, completeness, internal matches, and photo anonymisation); the further step of the data production process concerned imputation of photo interpreted land cover and computation of weighted estimates for land cover and land use. Preliminary estimates were compared with 2009 data following a macro-editing approach to identify "influent"errors.

At this stage the Eurostat quality control requires a deeper evaluation of changes compared to the LUCAS 2009 campaign; it is performed both at macro-level (from national to NUTS2 level) and at micro-level (analyzing the panel of 184000 points common to the two surveys); in particular the analysis of the land cover transition matrix identifies the changes that seem to be doubtful or rare, especially if their occurrence is rather important.

Quality check by external company

At the end of 2013, when results from 2012 LUCAS survey were available, a further external quality check was performed by an external company on 12728 points belonging to the 2009 and 2012 LUCAS campaigns. The following tables report the number of points checked by country.

Table 18: Checked points by country relative to the 2009 and 2012 LUCAS campaigns.

Country	Total points	Worked points	% worked points
AT	205	205	100%
BE	153	153	100%
BG	705	705	100%
CY	251	251	100%
CZ	111	111	100%
DE	904	904	100%
DK	111	111	100%
EE	165	165	100%
EL	393	393	100%
ES	1196	1196	100%
FI	477	477	100%
FR	1539	1539	100%
HU	266	266	100%
IE	304	304	100%
IT	1305	1305	100%
LT	109	109	100%
LU	6	6	100%
LV	165	165	100%
MT	1	1	100%
NL	245	245	100%
PL	742	742	100%
PT	326	326	100%
RO	1060	1060	100%
SE	815	815	100%
SI	23	23	100%
SK	115	115	100%
UK	1036	1036	100%
Total	12.728	12.728	100%

The outcome of checking step was a set of corrections depending on different types of errors: 24% of the checked points were corrected for positional errors and 51% for classification errors. Among this last group, 5% were corrected for both type of errors. Positional errors were mainly attributed to the use of different ortho-photos in 2009 and 2012. For both 2009 and 2012 data the main corrections on the classifications regards the following land cover classes:

- artificial land;
- woodland;
- grassland;
- shrub land.

The results concerning the 2012 survey are reported in Table 19 and Graph 4.

Table 19: Number of points by type of correction performed.

LC Class 2012	New LC Class 2012								Total points
	A	B	C	D	E	F	G	H	
A	385	48	106	13	315	52	10	1	930
B	50	13	68	3	27	4	2	1	168
C	76	72	7	121	372	19	11	50	728
D	16	8	80	12	26	4	3	34	183
E	116	8	51	10	87	18	20	42	352
F	45	4	9	6	31	8	22	10	135
G	4	4	39	8	24	7	12	29	127
H	1	5	30	11	36	4	15	4	106
Total points	693	162	390	184	918	116	95	171	2.729
Difference New LC2012 - LC2012	-237	-6	-338	1	566	-19	-32	65	

Graph 4: Classification correction performed on land cover in 2012
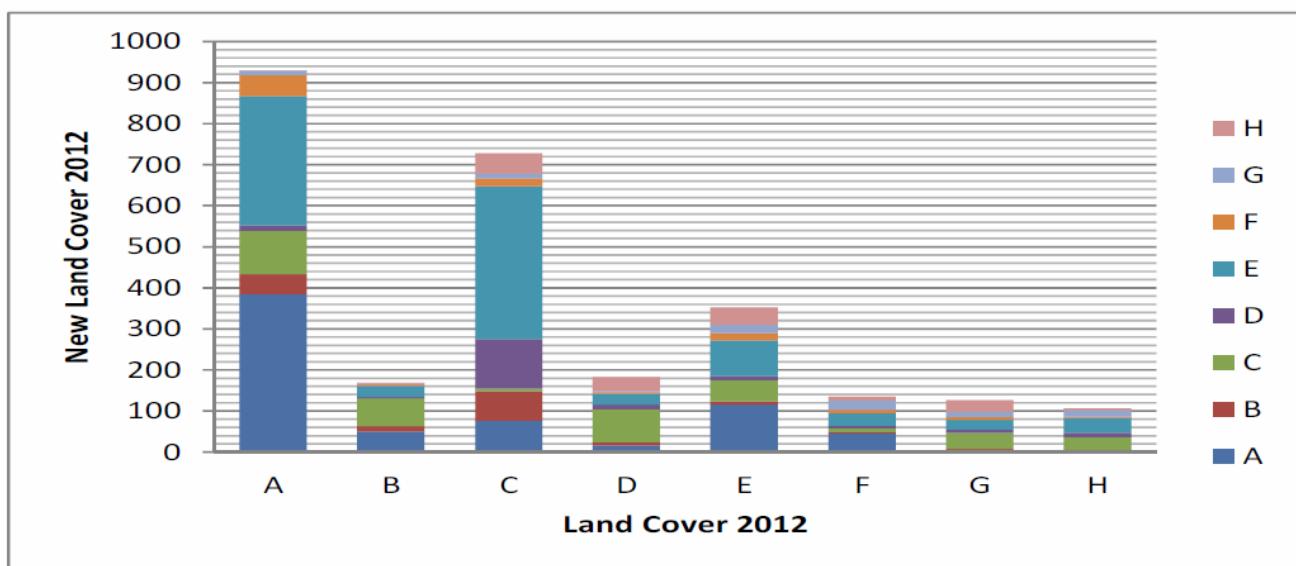
Accuracy and reliability

Stratification and photo-interpretation

The stratification of the master sample was done in 2005 and it is one of the characteristic of the estimation procedure. To evaluate the goodness of the stratification, we can use the information on land cover collected in the current survey and conveniently reclassified. Combining the recoded and strata variables we obtain a "transition matrix" that is the resulting of two phenomena: from one side the actual changes from 2005 to 2012 in land cover and on the other side the difference between the ground observation (land cover variable) and the photo-interpretation (strata).

In Table 20 is reported an un-weighted matrix, that is what is found in field work. In order to measure the "agreement" between the two classifications it has been calculated the percentage of points that are classified in the same group (the data related to the principal diagonal); the value is 74%. In relative term, the bare land (with an "agreement" equal to 13,5%) is the most unstable typology followed by artificial land (61%) and grassland (65%).

The agreement can be also measured through the kappa index, that measures the improvement compared with the agreement of a random attribution (Bishop et al., 1975):

$$K = \frac{\sum_i p_{ii} - \sum_i p_{i+} p_{+i}}{1 - \sum_i p_{i+} p_{+i}}$$

where $p_{ij} = \frac{n_{ij}}{N}$ are the proportions of each cell of the table and p_{i+} and p_{+j} are the proportions of rows and columns.

The value of Kappa index is 0,6418 (with a 95% confidence interval 0.6396 - 0.6440) that is considered "substantial agreement" or "good agreement" by the two most frequently used benchmark scales (Landis & Koch, Fleiss).

Table 20: Un-weighted transition matrix - strata by recoded land cover

Strata (2005)	Land cover reclassified (2009)							
	Arable land	Permanent crops	Grassland	Wooded areas and shrub land	Bare land	Artificial land	Water	Total
Arable land	56262	2208	16383	3118	2103	1355	281	81710
Permanent crops	657	7046	656	615	123	179	11	9287
Grassland	5269	717	28346	6651	458	1392	1047	43880
Wooded areas and shrub land	1681	1415	9492	95123	692	2035	1989	112427
Bare land	127	81	720	1410	561	363	882	4144
Artificial land	499	291	2536	1269	146	7521	97	12359
Water	39	1	208	481	51	49	5624	6453
Total	64534	11759	58341	108667	4134	12894	9931	270260

In Table 21 the corresponding weighted matrix, containing the estimates, it is reported; this matrix is useful to understand if and how the changes can influence the estimation process. The matrix produces substantially the same indicators as the unweighted one: the percentage of agreement in classifications assumes the value 75%. And, as in the previous survey, also in this case, the bare land (with an "agreement" equal to 15%) is the most unstable typology followed by artificial land (60%) and grassland (64%). The value of Kappa index is 0,6455 (with a 95% confidence interval 0.6444 - 0.6466) and so, also in this case, the agreement can be considered "substantial agreement" or "good agreement".

Table 21: Weighted transition matrix - strata by recoded land cover

| Strata (2005) | Land cover reclassified (2009) | | | | | | | |
	Arable land	Permanent crops	Grassland	Wooded areas and shrub land	Bare land	Artificial land	Water	Total
Arable land	199931	7571	59092	11006	6694	4701	1006	290001
Permanent crops	2111	22075	2101	1966	368	560	35	29216
Grassland	19457	2484	112046	28186	1971	5171	5907	175224
Wooded areas and shrub land	5996	4882	38531	416397	2959	7756	9962	486483
Bare land	454	237	3370	7992	3060	1194	4741	21048
Artificial land	1754	1018	9270	4588	512	26680	352	44174
Water	204	654	980	2375	277	186	27819	32495
Total	229906	38921	225390	472511	15841	46248	49823	1078640

The information on land cover can be collected, in addition to the principal variable, also by a secondary land cover; the first is normally used in production of estimates because it is reported for all the points while the secondary depends on the "nature" of the point. The main variable represents only partially the actual state of the surveyed point (e.g. in the case of mixed or overlapping crops) and it could generate some biases in the data when we summarize all the information only by the main land cover. In Table 22 the number of selected points according to the double classification is reported; the points classified by only the principal land cover are about 94% of the total. The remaining 6% are classified in the other cells of the table that contain the "changes" operated by the double classification. The remaining 7% are classified in the other cells of the table that contain the "changes" operated by the double classification. Because in the table the 1st classification level is used, the values of the principal diagonal cells are changes among the 2nd level classification. The double codes are concentrated in the combination of the main "cropland" with secondary "grassland" (about 41% of the total of points double classified) and "bareland" (23%) and principal "woodland" with secondary grassland (about 20%).

Table 22: Distribution of principal and secondary land cover

Principal land cover	Secondary land cover						
	Artificial land	Cropland	Woodland	Shrub land	Grassland	Bare land	Total
Artificial land	0	48	0	0	0	0	48
Cropland	4	1059	0	200	6740	3719	11722
Woodland	0	112	0	840	3336	91	4379
Shrub land	0	3	1	0	0	165	169
Grassland	0	34	2	0	0	73	109
Bare land	0	0	0	6	25	0	31
Water areas	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0
Total	4	1256	3	1046	10101	4048	16458

For the double classified points, the surveyors are requested to give an estimate of the area covered by the two crops; the results are shown in Table 23. Beyond some mistake, it is likely that the cells representing two combinations of modalities that sum up to a value greater than 100% represent overlapping crops, while the combinations of modalities that do not sum up to 100% suggest more than two crops present on the point.

Table 23: Percentage of principal and secondary land cover

Principal land cover	Secondary land cover						
	<5%	5%-10%	10% -25%	25% - 50 %	50% - 75%	>75%	Total
<5%	34	11	14	16	28	135	238
5% -10%	12	30	52	58	122	468	742
10% - 25%	38	49	248	370	680	1677	3062
25% - 50%	45	70	377	943	1419	2390	5244
50% - 75%	32	91	334	1108	1271	1840	4676
> 75%	88	161	355	377	416	1134	2531
Total	249	412	1380	2872	3936	7644	16493

Measurement accuracy

For the directly observed points[5], in Table 24 is reported the distribution and some indicators (average, median and percentage of points included in the upper class) of the distance of the surveyor from the point during the data collection step.

All the results in 2012 show a consistent decrease in observation distance with respect to the 2009 survey. The average distance for all the countries is about 26 meters; among countries, the lowest average values are those of Luxemburg (4,2 meters), Lithuania (7,2 meters) and Czech Republic (7,7 meters) while the biggest ones are found for Finland (67,7 meters), and Greece (50,7 meters), followed by United Kingdom, Italy and Ireland with an average observation distance higher than 40 meters.

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[5] The totals of Tables 21 and 22 do not coincide with the corresponding totals of other tables because all the points photo-interpreted are excluded as well as the points in which the distance is missing.

The EU median is 2 meters; Malta (10 meters), Ireland and Italy (7 meters), show the highest medians while the remaining countries have the parameter equal or lower than 4 meters.

For EU the percentage of points with a distance over 100 meters is about 6% of the directly observed points; excluding Luxemburg, for which the indicator is equal to zero, the lowest values, below 2%, are found in Malta, Lithuania, Czech republic and Austria while in four countries (Netherlands, United Kingdom, Ireland and Greece) percentages over 10% are reported.

Table 24: Distance of observation of the points by country

Country	Class of distance (meters)					Average distance	Median distance	% of points with distance >100
	0 -3	apr-50	51 - 100	>100	Total	(meters)	(meters)	%
Austria	4083	1436	180	102	5801	11,0	2	1,76
Belgium	1385	772	74	59	2290	12,7	2	2,58
Bulgaria	4407	876	298	571	6152	30,0	1	9,28
Cyprus	926	247	35	43	1251	12,9	2	3,44
Czech Republic	4457	799	91	102	5449	7,7	1	1,87
Germany	14698	6775	1364	1392	24229	23,6	2	5,75
Denmark	1821	886	266	303	3276	30,6	2	9,25
Estonia	1277	460	67	107	1911	23,4	2	5,60
Greece	4065	1449	467	817	6798	50,7	2	12,02
Spain	26155	3577	990	1568	32290	19,8	1	4,86
Finland	7871	1924	421	1134	11350	67,7	2	9,99
France	24265	8773	1277	975	35290	12,9	2	2,76
Hungary	3603	550	139	175	4467	16,0	1	3,92
Ireland	1121	1122	259	364	2866	42,3	7	12,70
Italy	5912	8529	1431	1933	17805	43,6	7	10,86
Lithuania	3308	306	57	58	3729	7,2	1	1,56
Luxembourg	155	57	2	0	214	4,6	2	0,00
Latvia	2841	590	89	124	3644	14,9	2	3,40
Malta	6	65	2	1	74	14,1	10	1,35
Netherlands	1264	468	166	213	2111	29,4	0	10,09
Poland	12686	5472	994	1344	20496	25,4	2	6,56
Portugal	4857	1167	221	205	6450	12,7	1	3,18
Romania	9366	1291	221	253	11131	10,0	1	2,27
Sweden	11263	6744	552	1482	20041	30,3	3	7,39
Slovenia	914	514	21	14	1463	6,6	3	0,96
Slovak Republic	1874	245	33	53	2205	10,3	1	2,40
United Kingdom	4770	3717	744	1192	10423	47,4	4	11,44
EU	159350	58811	10461	14584	243206	25,8	2	6,00

The distance of observation depends mainly on the accessibility of the point and so on the nature of the environment in which the surveyor operates (roads, forest, slope, the accessibility of private ownership…). In Table 25 land cover is used as a proxy of the "environment" to analyse the above cited relationship. The points located in "water areas" show the highest values for the three indicators considered, followed by the points of "wetland" and, far-between, "shrub land", that is land cover modalities that reveal "difficult" environment.

Table 25: Distance of observation of the points by land cover

Land cover	Class of distance (meters)					Average distance	Median distance	% of points with distance >100
	0 -3	apr-50	51 - 100	>100	Total	(meters)	(meters)	%
Artificial land	5635	5505	429	194	11763	13,7	4	1,65
Cropland	50885	13889	4188	4969	73931	22,3	1	6,72
Woodland	50433	23583	2172	2425	78613	14,5	2	3,08
Shrub land	8029	2895	625	1084	12633	35,6	2	8,58
Grassland	40022	10080	1836	2179	54117	15,6	1	4,03
Bare land	3101	435	88	161	3785	17,1	1	4,25
Water areas	286	1788	928	3262	6264	287,8	111	52,08
Wetland	959	636	195	310	2100	50,4	4.5	14,76
Total	159350	58811	10461	14584	243206	25,8	2	6,00

Points rejected

An indirect indication of the quality of the results is given by the rejection rate during the external quality control done by the contractor (Table 26). The overall first rejection rate is 7.0 % and it varies between a value of about 1% in Lithuania to the 19 % of Malta: in five countries (Bulgaria, Ireland, Romania, Slovak Republic) the indicator assumes values over 10 %.

Table 26: Number of total points, points checked and first rejection rates by country

COUNTRY	POINTS	Visually Controlled	%	First rejected points	%
Austria	6467	2047	31,7	224	3,5
Belgium	2446	620	25,3	238	9,7
Bulgaria	6642	2857	43,0	840	12,6
Cyprus	1442	494	34,3	60	4,2
Czech Republic	5514	1396	25,3	105	1,9
Germany	24943	6618	26,5	1652	6,6
Denmark	3444	1293	37,5	221	6,4
Estonia	2202	1093	49,6	197	8,9
Greece	7828	3376	43,1	455	5,8
Spain	35377	18144	51,3	3091	8,7
Finland	13482	4601	34,1	543	4,0
France	38338	11717	30,6	2201	5,7
Hungary	4637	1407	30,3	202	4,4
Ireland	3484	1240	35,6	480	13,8
Italy	21013	8249	39,3	1580	7,5
Lithuania	3889	840	21,6	39	1,0
Luxembourg	215	95	44,2	5	2,3
Latvia	4420	1830	41,4	154	3,5
Malta	79	79	100,0	15	19,0
Netherlands	2229	917	41,1	214	9,6
Poland	21806	6021	27,6	1006	4,6
Portugal	7336	3290	44,8	536	7,3
Romania	14278	5668	39,7	1490	10,4
Sweden	22421	7428	33,1	1699	7,6
Slovenia	1621	631	38,9	54	3,3
Slovak Republic	2455	1112	45,3	265	10,8
United Kingdom	12252	4795	39,1	1370	11,2
EU	**270260**	**97858**	36,2	**18936**	7,0

Sampling errors

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

Grouping variable	Observed value of the variable of interest	Strata (from master)		Weight of the record
…	…	…	…	…
…	…	…		…

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

Nuts0	Land cover	Strata (from master)		Weight from IPF
…	…	…	…	…
…	…	…		…

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,..i…,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):

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

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 the article "A Three-Phase Sampling Strategy for Large-Scale Multisource Forest Inventories**" by Lorenzo FATTORINI, Marzia MARCHESELLI, and Caterina PISANI, published on the *Journal of Agricultural, Biological, and Environmental Statistics, Volume 11, Number 3, Pages 1–21 - American Statistical Association and the International Biometric Society* (2006).

Before to develop such expression, we will have to consider 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^h 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).

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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:

$$V\left(\widehat{x^k(g)}\right) = \frac{1}{N_g - 1}\left[\frac{1}{N_g}\sum_{h=1}^{7}\frac{N_g^h\left(N_g^h - 1\right)}{n_g^h - 1}x^k(g)\left(1 - x^k(g)\right) + \frac{1}{N_g}\sum_{h=1}^{7}N_g^h\left(x^k(g)\right)^2 - \left(\frac{1}{N_g}\sum_{h=1}^{7}N_g^h x^k(g)\right)^2\right]$$

Once the variance was evaluated, it will be possible to derive the *standard deviation* and the coefficient of variation considering:

$$CV^k(g) = 100 * \frac{\sqrt{V\left(\widehat{x^k(g)}\right)}}{x^k(g)}$$

According to the above methodology, in Table 27 CV for estimatesof land cover by country are given.

Table 27: Land cover CV (%) by countries

Country	Land cover							
	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
AT	4,86	11,76	2,11	2,13	12,95	6,73	23,56	1,18
BE	4,28	28,6	2,51	2,6	30,24	12,7	40,55	2,74
BG	7,55	13,35	1,19	2,18	5	12,67	44,83	1,2
CY	8,12	9,51	2,9	5,41	4,31	33,36	55,49	4,64
CZ	4,86	16,32	1,4	2,33	15,58	8,27	34,16	1,19
DE	2,04	7,15	0,74	1,07	6,16	3,92	8,71	0,69
DK	5,75	15,7	1,56	3,2	14,47	11,36	17,16	3,27
EE	12,04	19,62	4,83	3,65	12,29	5,81	17,07	1,32
EL	5,08	7,46	1,58	2,72	1,9	7,64	16,66	1,58
ES	2,3	2,22	0,65	1,16	1,23	4,54	15,57	0,73
FI	5,83	10,89	2,19	3,9	5,83	1,4	3,79	0,45
FR	1,73	5,54	0,58	0,71	2,7	3,25	11,91	0,59
HU	6,46	13,92	1,14	2,56	9,51	7,24	13,15	2,05
IE	7,06	20,75	6,13	1,14	8,07	6,43	6,22	3,76
IT	2,03	6,6	0,77	1,45	2,8	3,99	15,34	0,81
LT	8,43	20,05	2,3	2,23	14,87	8,51	17,28	1,46
LU	15,62	72,84	10,86	7,77	68,26	49,48		7,15
LV	10,18	14,66	3,46	2,33	12,2	6,5	9,43	1,04
MT	16,21	39,51	18,86	31,6	25,54	.		57
NL	4,31	16,7	3	2,3	17,18	5,72	29,26	4,45
PL	3,47	7,27	0,79	1,12	6,4	3,84	10,11	0,72
PT	4,25	6,35	2,23	2,46	2,52	8,31	22,87	1,39
RO	4,89	10,95	0,89	1,24	6,75	5,34	10,69	0,93
SE	4,74	8,43	2,51	2,53	2,83	1,39	2,89	0,39
SI	13,14	16,11	6,8	4,6	16,25	35,92	42,81	1,96
SK	9,23	28,62	2,23	3,45	10,95	13,04	70,91	1,48
UK	2,83	8,11	1,32	0,93	2,82	4,43	5,46	1,77
EU	0,78	1,58	0,25	0,34	0,79	0,80	1,64	0,20

In order to evaluate the efficiency of the sample design for the estimates of land cover, in Table 28 the ratios between the above coefficients of variation and the same indicators calculated under the hypothesis of simple random sample (SRS) are reported. A value of the indicator equal or higher to 1, means that no efficiency is found while values lower than 1 indicate a gain of the actual sample design with respect to a SRS of the same size. Generally, the gain or the loss due to the stratification are moderate; only few indicators show a significant values but without a defined schema.

Table 28: Efficiency indicator of sample design by country – land cover

| Country | Land cover | | | | | | | |
	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
AT	4,86	11,76	2,11	2,13	12,95	6,73	23,56	1,18
BE	4,28	28,6	2,51	2,6	30,24	12,7	40,55	2,74
BG	7,55	13,35	1,19	2,18	5	12,67	44,83	1,2
CY	8,12	9,51	2,9	5,41	4,31	33,36	55,49	4,64
CZ	4,86	16,32	1,4	2,33	15,58	8,27	34,16	1,19
DE	2,04	7,15	0,74	1,07	6,16	3,92	8,71	0,69
DK	5,75	15,7	1,56	3,2	14,47	11,36	17,16	3,27
EE	12,04	19,62	4,83	3,65	12,29	5,81	17,07	1,32
EL	5,08	7,46	1,58	2,72	1,9	7,64	16,66	1,58
ES	2,3	2,22	0,65	1,16	1,23	4,54	15,57	0,73
FI	5,83	10,89	2,19	3,9	5,83	1,4	3,79	0,45
FR	1,73	5,54	0,58	0,71	2,7	3,25	11,91	0,59
HU	6,46	13,92	1,14	2,56	9,51	7,24	13,15	2,05
IE	7,06	20,75	6,13	1,14	8,07	6,43	6,22	3,76
IT	2,03	6,6	0,77	1,45	2,8	3,99	15,34	0,81
LT	8,43	20,05	2,3	2,23	14,87	8,51	17,28	1,46
LU	15,62	72,84	10,86	7,77	68,26	49,48		7,15
LV	10,18	14,66	3,46	2,33	12,2	6,5	9,43	1,04
MT	16,21	39,51	18,86	31,6	25,54	.		57
NL	4,31	16,7	3	2,3	17,18	5,72	29,26	4,45
PL	3,47	7,27	0,79	1,12	6,4	3,84	10,11	0,72
PT	4,25	6,35	2,23	2,46	2,52	8,31	22,87	1,39
RO	4,89	10,95	0,89	1,24	6,75	5,34	10,69	0,93
SE	4,74	8,43	2,51	2,53	2,83	1,39	2,89	0,39
SI	13,14	16,11	6,8	4,6	16,25	35,92	42,81	1,96
SK	9,23	28,62	2,23	3,45	10,95	13,04	70,91	1,48
UK	2,83	8,11	1,32	0,93	2,82	4,43	5,46	1,77
EU	0,78	1,58	0,25	0,34	0,79	0,80	1,64	0,20

The same parameters are given for land use in Table 29 and Table 30; generally the CVs are higher than those reported for land cover and the gain or losses due to sample design are much remarkable.

Table 29: Land use CV (%) by countries

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	1,39	26,83	22,59	34,12	28,09	28,38	1,13	27,31	36,68	7,00	9,67	5,91	6,91	55,52
BE	1,52	23,01	19,51	37,56	69,20	27,71	3,20	27,59	40,36	8,80	16,09	5,04	8,00	60,96
BG	0,93	34,21	28,41	41,65	48,59	23,10	1,33	34,84	33,93	3,49	21,80	8,38	11,17	29,63
CY	2,61	35,78	37,53	29,85	53,37	8,24	38,47	2,56	28,70	12,65	14,10	40,76		
CZ	0,93	26,27	20,68	49,84	45,17	11,58	1,28	20,46	24,56	5,83	12,49	7,78	7,80	23,57
DE	0,46	8,04	5,97	19,60	13,78	9,60	0,74	9,83	8,15	3,02	4,31	2,61	2,93	14,08
DK	1,11	17,53	17,54	43,82	57,12	34,18	4,08	29,34	106,63	5,47	8,75	6,11	8,96	42,39
EE	2,21		100,00	.	35,94	13,39	1,31	70,69	18,80	8,85	18,33	13,39	16,27	
EL	1,19	23,45	21,79	28,83	17,39	14,26	2,16	33,02	21,81	1,56	15,97	8,69	7,07	23,24
ES	0,45	16,42	10,10	14,09	11,65	18,26	1,04	16,82	10,98	0,85	7,98	4,21	3,50	7,14
FI	1,94	29,31	15,97	55,56	15,37	4,24	0,47	34,57	12,27	2,72	2,59	7,23	6,09	59,05
FR	0,35	10,83	6,21	16,20	15,61	7,20	0,74	13,28	12,14	1,55	4,58	2,13	2,51	14,67
HU	0,84	33,77	25,07	102,40	49,91	14,93	2,10	27,60	30,08	5,47	13,76	6,59	10,54	22,21
IE	0,98	50,46	52,24	101,17	58,41	18,53	4,85	58,22	9,82	5,09	12,72	8,91	11,15	37,75
IT	0,57	9,16	12,39	13,52	12,03	10,99	1,05	11,62	16,91	1,62	6,92	3,11	3,56	23,87
LT	1,01	49,49	100,00	100,00	100,00	10,07	1,46	49,49	37,69	7,42	18,65	11,47	12,25	58,54
LU	4,61	81,56	81,56	96,90		106,73	6,80			58,36	60,83	35,12	23,59	
LV	1,60	57,60	49,91	100,00	35,16	9,45	1,04	70,43	18,55	4,86	10,63	10,47	12,25	70,71
MT	15,33		100,00							.	70,26	22,50	36,33	
NL	1,41	20,76	20,39	26,48	95,52	.	10,85	27,40	58,62	6,62	7,09	6,49	5,86	38,56
PL	0,53	15,46	8,94	17,92	33,76	8,25	0,76	15,74	13,32	2,22	5,39	3,44	4,65	17,29
PT	1,21	23,05	22,95	24,14	32,99	59,71	1,58	28,18	25,88	2,59	22,29	6,97	5,94	34,64
RO	0,51	34,33	26,51	28,00	43,48	6,58	0,92	21,20	25,05	4,58	22,93	5,65	7,87	39,30
SE	1,69	28,37	12,35	59,31	10,79	2,68	0,44	21,17	20,08	1,70	2,46	5,95	5,17	43,08
SI	3,66	60,79	41,59	59,73	68,05	52,22	2,18	57,10	45,35	9,35	24,50	15,15	17,11	61,76
SK	1,56	102,55	29,83	104,36	35,46	22,02	1,50	50,46	56,12	6,77	21,18	12,77	14,49	36,06
UK	0,60	12,05	9,60	32,79	23,25	10,61	2,24	17,07	13,69	2,26	4,69	3,64	5,38	16,94
EU	0,17	3,72	2,84	5,79	4,51	1,74	0,23	4,34	3,52	0,52	1,27	1,01	1,15	4,76

Table 30: Efficiency indicator of sample design by country – land use

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	1,03	0,86	1,06	0,76	1,18	1,20	0,95	0,99	1,05	0,98	0,94	1,01	0,91	1,21
BE	1,00	1,00	0,97	1,00	1,00	0,99	1,00	0,99	0,79	1,00	1,01	1,00	1,00	1,00
BG	1,00	1,00	1,00	1,01	1,02	1,02	0,92	1,00	0,96	1,04	0,97	1,01	1,01	0,98
CY	0,99	0,96	0,99	0,99	0,93	1,05	1,02	1,00	1,04	0,98	1,00	1,02	.	.
CZ	1,00	1,01	1,01	1,00	1,02	1,06	0,98	1,00	1,01	1,01	1,02	1,00	1,01	1,01
DE	1,00	1,00	1,01	1,00	1,00	1,02	0,99	0,94	1,01	1,01	1,00	1,00	1,00	1,00
DK	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
EE	1,00	.	1,00	.	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	.
EL	1,01	1,04	1,06	1,06	0,97	1,01	0,94	1,06	0,94	1,02	1,08	1,04	1,02	1,05
ES	1,00	1,03	1,03	1,04	0,99	1,02	1,01	1,04	0,99	0,98	1,05	1,03	1,01	1,00
FI	1,00	1,01	1,01	1,02	1,02	0,99	1,03	1,00	1,04	0,97	1,00	1,00	1,01	1,02
FR	0,99	1,01	1,01	1,02	1,01	1,02	0,97	1,05	1,15	1,01	1,00	1,03	1,01	1,04
HU	1,00	1,00	1,01	1,03	1,00	1,00	0,99	1,00	1,01	1,01	1,00	1,00	1,00	1,01
IE	1,02	1,01	1,03	1,01	1,01	1,00	0,92	1,01	1,02	0,99	1,00	1,02	1,01	1,00
IT	0,99	1,04	1,05	1,04	0,79	1,05	0,95	1,04	1,20	0,97	1,05	1,04	1,02	1,11
LT	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
LU	1,00	0,82	0,82	0,97	.	1,07	0,98	.	.	1,02	0,95	0,96	1,08	.
LV	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
MT	1,00	.	1,00	.	.	.	.	.	.	.	1,00	1,00	1,00	.
NL	1,00	1,00	1,00	1,00	1,00	.	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
PL	1,00	1,00	1,02	1,00	1,03	1,01	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,01
PT	1,00	1,01	1,03	1,04	1,03	0,99	1,01	1,02	1,02	0,97	1,02	1,02	1,01	1,00
RO	1,00	1,03	1,06	1,00	1,05	1,02	0,91	1,01	1,02	1,07	0,91	1,00	1,00	1,01
SE	0,99	1,00	0,98	1,03	1,02	0,99	1,13	1,00	1,14	0,85	0,95	1,03	1,02	1,02
SI	1,01	1,04	1,02	1,14	0,99	1,03	0,96	1,02	1,00	1,03	0,87	1,02	1,00	1,06
SK	0,99	1,00	1,00	1,04	1,04	1,02	0,94	1,01	1,23	1,05	1,00	1,04	1,04	1,01
UK	1,00	1,01	1,02	1,04	0,98	1,02	1,04	1,03	1,04	0,98	1,00	1,01	1,02	1,02
EU	1,00	1,01	1,02	1,03	1,00	1,01	1,00	1,01	1,06	0,98	0,99	1,02	1,01	1,02

Relevance, assessment of user needs and perceptions

Even though the initial focus of the survey was agriculture, during the implementation of the project it became clear that data gathered on the ground by surveyors were important and a unique source for the monitoring of the (agri)-environment. The landscape photos taken by the surveyors are to this end, a good representative snapshot of the state of the landscape in Europe.

LUCAS provides information on agricultural areas but also on the other land cover and uses like urban data or forest in a consistent manner on the whole territory of the Union. The land management information systems, such as LUCAS combined by other sources of information like CORINE, could therefore turn out to be the backbone of the future European Spatial Data Infrastructures (ESDI).

User needs

The LUCAS in-situ survey provides information on land cover, land use as well as on environmental parameters associated to the single surveyed points. A point and landscape photo archive is also part of the information disseminated.

Data from the LUCAS surveys can contribute to some of the major EU policy areas (see Table 31:):

- the integration of environmental concerns into the Common Agricultural Policy (CAP);
- preventing dangerous climate change;
- soil protection;
- holding the loss of biodiversity;
- the efficient use of resources, which is important to achieve sustainable growth;
- land monitoring.

Table 31: User needs – example of data use

Most Needed Parameters	Policy Domain	Currently Used Datasets
Land Cover/Land Use	Agri-Environment, CAP support post 2013, Spatial Data Policy (INSPIRE), GMES in-situ requirement, Europe 2020 Strategy - Resource Efficient Europe.	Common Agricultural Policy Regionalised Impact model (CAPRI), CLC, LUCAS, FSS, OECD Questionnaire, National Data, Copernicus high resolution layers.
Crop Area	CAP Support.	Remote Sensing, Modelling, FSS, CLC, LUCAS
Erosion	Soil Thematic Strategy.	PESERA, EROSSAT, EROSRILL, LUCAS ad hoc survey.
Landscape elements	Rural Development Programs (CMEF), EU Biodiversity strategy to 2020.	National Data, LUCAS.
Biomass/Carbon Pool	European Climate change Programme, Climate Change Convention, Kyoto Protocol.	CLC, National Data.
Farm Saved Seeds	Community Plant Variety rights.	Eurostat.

Specifically the LUCAS data are currently used for different application [6]and, in general, the information available are potentially useful different contexts, such as the following.

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[6] A comprehensive description of a selected use cases based on LUCAS data are available at:
http://ec.europa.eu/eurostat/web/lucas/publications/use-cases

- Agricultural and environmental data gathering.
    - It could provide crop area estimates independent from farm declarations, which could be of importance for the CAP market management when it would be fully validated and operational and when the other crop statistics are not fully developed yet or nor fully reliable.
    - It can be used as a sampling base for more specific surveys linked to agricultural and environmental issues.
    - It is one of the very few identified contributors to the agri-environmental indicators on landscape and on land cover changes. A major lack of information that LUCAS can overcome is about the presence of linear features and landscape diversity all over Europe.

It can be considered as a unique source of basic information for modeling erosion risk, for surveying irrigation use and map landscape elements, as well for other environment variables. Concerning the soil, Soil organic matter (AEI 26: Soil quality – CMEF Impact and Context indicator) and the Soil erosion (AEI 21: Soil erosion – CMEF Impact and Context indicator) are the indicators to be included in implementing acts, once the basic regulations have been adopted, within the Common Monitoring and Evaluation Framework post 2013. Both indicators depend on data obtained from the LUCAS soil survey.

    - It is useful for the Soil Thematic Strategy. From the viewpoint of European policy-making, LUCAS has three very important characteristics that makes it a good tool for achieving the objectives of the Soil Thematic Strategy: 1) It is based on a uniform methodology applied consistently across the EU, 2) It has sufficient flexibility to allow the Commission services to determine which parameters to consider in the different survey campaigns, and 3) It can provide a first set of harmonized and comparable soil monitoring data within two-three years.

- Providing data for landscape analysis
    - The historical archive of landscape elements, environment information and photos is a valuable source of baseline information for future trend analysis. LUCAS provides data for the long-term monitoring of agricultural and environmental issues on a European scale.
    - Another added-value is the possibility to compare precisely the observations done in successive surveys in order to detect differences and extract land cover and land use evolutions.
    - Associated with orthophotos and remote sensing data, it provides an insight into the spatial organisation of agriculture and the balance of agriculture/nature conservation/ cultural heritage/green space areas. It provides an understanding of size, location, distribution, connectivity and fragmentation of habitats, and supports therefore conservation and management of landscapes.

LUCAS micro data on crop types are useful for computing the agri-environmental indicator n. 28 "landscape state and diversity". LUCAS transect data can be used for analyzing the linear elements of the landscape, which are related to a number of ecosystem services. Both the mentioned indicators are used for policy purposes and analysis related to the Common Agricultural Policy (CAP).

- Linking its data with earth observation initiatives
    - It is expected to be a main "in situ" data provider needed for the GMES (Global monitoring of environment by satellite). Pursuant to the program, the European Environment Agency and will produce 5 high resolution geographic datasets (HRL) describing the main land cover types: artificial surfaces, forest areas, agricultural areas, wetlands, and water bodies. LUCAS 2012 (Land use / land cover micro data, field photographs) dataset is listed in the guidelines to the contract among the in-situ data sources for the verification of all the 5 HRL layers.
    - LUCAS data plays a crucial role be it in the production process of the CORINE land use and land cover information as LUCAS data is the only information that is available for a European wide validation which fulfils the criteria of validation data: being of high geometric accuracy and

having a mostly coincident acquisition window. The support to the production process is through the LUCAS land use and land cover point information as well as through the photos taken at each point.

o   LUCAS provides harmonised information on land cover and land use in a consistent manner on the whole territory of the Union. Such land management information systems, combined by other sources of information like CORINE, could therefore turn out to be the backbone of the future European Spatial Data Infrastructures (ESDI).

Timeliness and punctuality

Data collection takes place between spring and autumn on the year of the survey (t), and the statistics are published according to the schedule in early October of t+1.

The punctuality is 100%.

Coherence

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, 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.

1. 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.

2. FAO forest definitions:

In LUCAS, 'Woodland' has been defined in a way that allows to provide 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.

The heading "Total woodland" in LUCAS statistical classification (LUCAS ST LC) includes: 'Forest' and 'other wooded area' as defined according to FAO standards and other areas covered by trees not respecting FAO definition.

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.

Comparability

- Assessed by comparing the main features of 2009 and 2012 surveys, by checking if some f the following has changed:
  - sample design;
  - sample size;
  - countries involved;
  - sampling unit;
  - data collection method;
- Comparison of the information collected with the 2006, 2009 and 2012 (comparison of the variables reported in the field forms);
- Comparison of the definition of the variables collected with the 2006, 2009 and 2012 (information reported in the metadata and/or in the Technical Reference Documents).

Comparability: the LC/LU classification is comparable with others LC/LU systems (e. FAO, CLC). 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 (LUCAS ST LC) includes: 'Forest' and 'other wooded area' as defined according to FAO standards and other areas covered by trees not respecting FAO definition.

The 2012 LUCAS survey was extended to cover 27 Member States; the main features are reported in the following table 32.

Table 32: Main features of the LUCAS survey 2009 and 2012.

Item	2009	2012
Reference population	EU 23	EU 27
Sampling unit	Point	Point
Sampling scheme	Two-phase design with stratification	Two-phase design with stratification
Sample size (No. of photointerpreted points)	989,951	1,097,607
Sample size (No. of points surveyed)	234,545	270,260
Number of MSs involved	23	27
Main information collected	Land cover/use	land use data; land cover details (i.e. height of trees, width of feature, plant species and degree of coverage (percentage); soil data; water

Item	2009	2012
		management information and transect data.
Information collected walking a transect	YES	Yes
Stratification	YES	Yes
Estimator		H-T for two phase stratified design

Comparability - geographical

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

Comparability - over time

The 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 and to revise the series related to the 2009 and 2012 surveys.

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).

LUCAS survey classification comparison 2009 - 2012

The LUCAS 2012 Survey classification is not fundamentally different from the 2009 survey classification. Main changes are the following:

- The following B43 fresh vegetables in "roots-bulbs-tubers" were moved to B23 (other root crops)
    - carrots (Daucus carota)
    - garlic (Allium sativum)
    - onions (Allium cepa)
    - radishes (Raphanus sativus)
    - red beet (Beta vulgaris, var. conditiva)
    - shallots (Allium ascalonicum)
    - turnips (Brassica rapa var. rapifera);
- Description of B77j changed from "abandoned citrus orchards" to "citrus orchards";
- Energy crops (e.g. Miscanthus) are assigned to B84 (permanent industrial crops);
- EUNIS Forest types are assigned under the condition that the woodland exceeds 0.5ha in size and 20m in width;
- Forest codes for inclusion of forest types (Y) now have 4 digits CXXY instead of 3 (CXY);
- New land cover classes were included under land cover C00 (woodland):
    - C21 (spruce dominated coniferous woodland)
    - C22 (pine dominated coniferous woodland)
    - C23 (other coniferous woodland)
    - C31 (spruce dominated mixed woodland)
    - C32 (pine dominated mixed woodland)
    - C33 (other mixed woodland);
- More restrictive definition of Bareland (from a coverage of 50% to 90%);
- New land cover classes were included under land cover F00 (bare soil and lychens):
    - F10 (rocks)
    - F20 (sand)
    - F30 (lichens)
    - F40 (other bare soil);
- Mire and swamp forests are excluded from land cover H12 (peatbogs): if the tree canopy covers more than 10%, the point is assigned to CXX (woodland);
- Description of U112 changed from "Fallow and abandoned land" to "Fallow land";
- Description of U130 changed from "Fishing" to "Aquaculture and fishing" (aquaculture was already included in this class in 2009);
- Classes were suppressed under land use:
    - U150 (hunting) is collected as a special remark in the field form
    - U364 (nature reserve) is collected as a special status in the field form
- New land use classes were included under land use U400 (unused and abandoned areas):
    - U410 (abandoned areas)
    - U420 (semi-natural and natural areas not in use)

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Addendum to 2012 QUALITY REPORT

In this addendum an important topic, not included in 2012 Quality Report, is reported: the impact of the procedure of "projection" of points between 2009 and 2012 surveys, set up in the context of a wider study launched by Eurostat to improve the comparability of the two LUCAS surveys results.

The impact of the projection procedure

The sample selection in 2012 survey did not follow the random rules established for the previous occasions because of the pressure from the users of the LUCAS point data to select "accessible points" ; so some biases are found in the estimates when comparing and analysing the changes. To deal with this problem, after the survey taking in 2012, it was studied the solution to impute, into the 2012 sample, the units randomly collected in 2009 but not present in 2012, hypothesizing a sort of "enlargement" of the longitudinal structure and a further way to help in reducing biases, in combination with the weight system. Because of the lapse of time it has been required to take into account the changes at micro level because it was chosen "to impute" points. In doing so two methodological problems had to be faced with:

1) How to identify the units to be changed
2) How to change the selected units.

The most appropriate method in answering to the above questions, seemed to model the "change" probability of the points according to specific characteristics. The model parameters have been estimated from the actual changes from 2009 to 2012 of the points in common to the two surveys; then the model was applied to the 2009 data not present in 2012, obtaining the estimated status of a specific point in 2012. The change probability was modelled for "land cover" because its importance in the context of LUCAS project; by a logistic regression model, was estimated the probability to find one of the eight modalities of the 2012 variable depending on "2009 land cover", "country"," land use" and "altitude". The independent variables were selected from a wider set of variables after some trials. For the four countries that participated to the 2012 round but not to the 2009 one (in 2009 participated to the survey 23 countries against 27 in 2012), there are no 2009 data to be imputed; so the merged 2012 data is lacking of the corresponding projected points.

The model can be write:

- $LC^{t^1} = f\left(LC^{t^0}, LU^{t^0}, Elevation, Country\right)$, where
  - t^1 represents the "imputation" year, in this case 2012;
  - t^0 represents the "base" year, in this case 2009;
- LC^{t^1} land cover estimated for "imputation" year, in this case 2012;
- *f* identifies a linear logistic function, in this case 2009;
- $LC^{t^0}, LU^{t^0}, Elevation, Country$ refer, respectively, to the land cover, land use, elevation and Country for the point as observed in the base year;
- For what concerns the *Elevation*, the following values are considered: *<300 mt*; *between 301mt and 600 mt*, *between 601mt* and *900 mt*; *more than 901 mt*.
- For *land cover* it is intended the *first letter* of the variable *LC1* (so the different values given when considering: Artificial land, Cropland, Woodland, Shrubland, Grassland, Bare land, Water areas, Wetland;
- For *land use* are intended the first *three letters* of the variable *LU1* (*Agriculture, Forestry, Fishing, Mining and quarrying, Hunting, Energy production, Industry and manufacturing, Transport, communication networks, storage, protective works, Water and waste treatment, Construction, Commerce, finance, business, Community services, Recreation, leisure, sports, Residential, Not used and abandoned*)

After having estimated the model, it is applied to all the points belonging to the 2012 but not to the 2009 data, substituting the values of independent variable and so obtaining, for each of the eight modalities of land cover, the probability to be the "true" one in 2012. The modality with the highest probability, or, in other words, the most probably *land cover* for the 2012, is chosen. Then, each point to be projected in the current year can be in one of the two following situations:

- *The value of the estimated land cover is the same as observed in the base year*: in this case the point is attributed in the current year maintaining all the information surveyed in the base year;
- *The value of the estimated land cover changes in respect to the one observed in the base year*: in this case, the point is substituted with the information of the most *near* point that has the same value of the *estimated land cover*. This operation is needed to realign all the other variables to the new code of land cover and so avoiding inconsistencies in the data.

To identify the nearest point, it was chosen the following approach:

- The data observed in the current year and those to be imputed are sorted by the land cover (real or estimated), the Country, the class of elevation, the latitude and the longitude; then it is chosen as donor the observed point ranked just before the unit to be imputed; into this one all the variables of the donor are copied;
- If some points still remain not imputed, then the procedure is repeated but considering, as sorting characteristics, latitude, class of elevation and longitude.

The following Table 1 reports the results of the imputation strategy; it contains the number of records that remained unchanged (in the principal diagonal) and those that where imputed with the most similar. About 50000 points were imputed and 510 of them (1%) were changed with the above described methodology; the great part of changes is due to the transition from bareland to cropland and grassland.

Table 1: Points from 2012 projected in 2009

		To 2009								
		Artificial land	Cropland	Woodland	Shrub land	Grass land	Bare land	Water areas	Wetland	Total
From 2012	Artificial land	628	0	0	0	0	0	0	0	628
	Cropland	0	3006	0	0	0	0	0	0	3006
	Woodland	0	0	26886	0	0	0	0	0	26886
	Shrub land	0	0	44	7048	0	0	0	0	7092
	Grassland	0	0	0	0	5509	0	0	0	5509
	Bare land	0	314	27	0	125	903	0	0	1369
	Water	0	0	0	0	0	0	3061	0	3061
	Wetland	0	0	0	0	0	0	0	2353	2353
	Total	628	3320	26957	7048	5634	903	3061	2353	49904

In Table 2 the number of imputed, original and the ratio between imputed and original points by country is given. In average, the imputed points are about the 18% of the original ones but there is a great variability among the countries; the ratios range from about 70% for Finland and 44% for Sweden to about 1% for Luxemburg and 2% for Czech Republic. In the table are also reported the four countries with were not present in 2009 round for which the imputation rate is equal to zero.

Table 2: Projected points from 2012 in 2009, original points and their ratios

Country	Original points	Imputed points	Ratio imputed/original
AT	6467	821	12,70
BE	2446	312	12,76
BG	*6642*	*0*	*0,00*
CY	*1442*	*0*	*0,00*
CZ	5514	127	2,30
DE	24943	2366	9,49
DK	3444	339	9,84
EE	2202	769	34,92
EL	7828	1954	24,96
ES	35377	4897	13,84
FI	13482	9427	69,92
FR	38338	4657	12,15
HU	4637	981	21,16
IE	3484	978	28,07
IT	21013	3229	15,37
LT	3889	729	18,75
LU	215	3	1,40
LV	4420	769	17,40
MT	*79*	*0*	*0,00*
NL	2229	351	15,75
PL	21806	2154	9,88
PT	7336	816	11,12
RO	*14278*	*0*	*0,00*
SE	22421	9820	43,80
SI	1621	70	4,32
SK	2455	581	23,67
UK	12252	3754	30,64
EU	270260	49904	18,47

The impact on Land Cover

Putting together the imputed and original points in "2009 merged data", the weight system is recalculated by the same methodology described for the original data as well as the estimated area and sampling errors. In Table 3 the estimated land cover area for the participating countries in 2009 is reported and in Table 4 the corresponding percentages are given.

Table 3: Land cover areas (km^2) by countries - projected data

Country	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
AT	4113	1779	14807	20235	1658	1543	258	39533	83928
BE	3731	139	8899	9827	125	410	65	7473	30668
BG	2007	917	35476	22863	6734	961	100	41922	110979
CY	598	433	3146	1220	1999	39	16	1795	9246
CZ	3472	529	27058	16435	610	1092	124	29550	78870
DE	25638	2909	117792	82090	3625	6348	1844	117520	357766
DK	2958	420	20943	9495	510	672	438	7630	43065
EE	819	476	5126	8857	1249	2342	2239	24264	45372
EL	4566	2972	30414	17839	33620	1828	707	39745	131692
ES	17668	26490	140066	78466	82898	4582	709	147658	498537
FI	5462	2500	21226	12655	19098	33817	19821	223260	337839
FR	28815	3909	169457	149229	19991	7572	1120	168968	549061
HU	3092	892	43394	19446	1991	1814	1232	21150	93013
IE	2721	357	4115	44489	3981	1897	4202	8183	69946
IT	21149	3884	98472	50190	19652	7546	700	99040	300633
LT	1541	390	17092	19229	744	1802	545	23556	64899
LU	263	23	539	866	26	19	0	861	2596
LV	1022	671	8234	15892	1144	2104	1520	33999	64586
MT	102	24	83	35	51	8	0	12	315
NL	4415	481	9077	13890	600	2242	311	4502	35518
PL	10213	2586	107731	75683	3403	5780	1463	105070	311928
PT	4870	3353	15803	14376	15677	1398	279	33087	88843
RO	5056	1399	83516	64278	4019	4737	1707	73682	238392
SE	7052	11428	19326	25446	39424	40616	24024	282402	449718
SI	659	275	2181	4336	433	147	73	12172	20277
SK	1364	209	13719	9620	1437	530	51	22096	49026
UK	14736	2125	51630	105724	21491	5723	6281	36865	244574
EU	178103	71569	1069319	892713	286189	137569	69829	1605994	4311286

Table 4: Land cover areas (percentages) by countries - projected data

Country	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
AT	4,90	2,12	17,64	24,11	1,98	1,84	0,31	47,10	100,00
BE	12,17	0,45	29,02	32,04	0,41	1,34	0,21	24,37	100,00
BG	1,81	0,83	31,97	20,60	6,07	0,87	0,09	37,77	100,00
CY	6,47	4,68	34,02	13,20	21,62	0,42	0,17	19,41	100,00
CZ	4,40	0,67	34,31	20,84	0,77	1,38	0,16	37,47	100,00
DE	7,17	0,81	32,92	22,95	1,01	1,77	0,52	32,85	100,00
DK	6,87	0,98	48,63	22,05	1,18	1,56	1,02	17,72	100,00
EE	1,81	1,05	11,30	19,52	2,75	5,16	4,94	53,48	100,00
EL	3,47	2,26	23,10	13,55	25,53	1,39	0,54	30,18	100,00
ES	3,54	5,31	28,10	15,74	16,63	0,92	0,14	29,62	100,00

Country	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
FI	1,62	0,74	6,28	3,75	5,65	10,01	5,87	66,09	100,00
FR	5,25	0,71	30,86	27,18	3,64	1,38	0,20	30,77	100,00
HU	3,33	0,96	46,65	20,91	2,14	1,95	1,33	22,74	100,00
IE	3,89	0,51	5,88	63,61	5,69	2,71	6,01	11,70	100,00
IT	7,04	1,29	32,76	16,70	6,54	2,51	0,23	32,94	100,00
LT	2,38	0,60	26,34	29,63	1,15	2,78	0,84	36,30	100,00
LU	10,14	0,88	20,75	33,35	0,99	0,72	.	33,18	100,00
LV	1,58	1,04	12,75	24,61	1,77	3,26	2,35	52,64	100,00
MT	32,50	7,50	26,25	11,25	16,25	2,50	.	3,75	100,00
NL	12,43	1,35	25,56	39,11	1,69	6,31	0,88	12,68	100,00
PL	3,27	0,83	34,54	24,26	1,09	1,85	0,47	33,68	100,00
PT	5,48	3,77	17,79	16,18	17,65	1,57	0,31	37,24	100,00
RO	2,12	0,59	35,03	26,96	1,69	1,99	0,72	30,91	100,00
SE	1,57	2,54	4,30	5,66	8,77	9,03	5,34	62,80	100,00
SI	3,25	1,36	10,76	21,39	2,13	0,73	0,36	60,03	100,00
SK	2,78	0,43	27,98	19,62	2,93	1,08	0,10	45,07	100,00
UK	6,03	0,87	21,11	43,23	8,79	2,34	2,57	15,07	100,00
EU	4,13	1,66	24,80	20,71	6,64	3,19	1,62	37,25	100,00

In order to evaluate the impact of the "projection" methodology over the original data, in Table 5 are reported the same percentages calculated for the 2012 original data.

Table 5: Estimated land cover areas (percentages) by countries - original data

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland	Total
AT	5,25	2,75	17,03	24,21	1,87	1,95	0,26	46,67	100,00
BE	12,22	0,50	28,98	32,45	0,44	1,43	0,22	23,75	100,00
BG	1,81	0,83	31,97	20,60	6,07	0,87	0,09	37,77	100,00
CY	6,47	4,68	34,03	13,21	21,62	0,42	0,17	19,41	100,00
CZ	4,42	0,66	34,40	20,70	0,74	1,32	0,16	37,61	100,00
DE	7,35	0,76	33,13	23,05	1,04	1,78	0,51	32,37	100,00
DK	7,02	1,10	48,74	21,47	1,35	1,70	1,02	17,61	100,00
EE	2,12	1,11	12,01	20,59	2,82	4,94	1,65	54,77	100,00
EL	3,82	2,27	23,42	13,69	25,07	1,46	0,48	29,80	100,00
ES	3,71	4,81	28,42	15,88	16,17	0,92	0,12	29,98	100,00
FI	1,63	0,68	6,05	4,20	2,32	9,99	4,89	70,23	100,00
FR	5,44	0,88	30,90	27,99	3,46	1,41	0,19	29,73	100,00
HU	3,41	1,10	46,81	20,92	2,28	1,91	1,21	22,35	100,00
IE	4,24	0,64	5,91	63,13	4,14	2,59	6,57	12,78	100,00
IT	7,27	1,57	32,48	17,17	6,26	2,93	0,21	32,11	100,00
LT	2,47	0,70	26,45	29,91	1,18	2,61	0,95	35,74	100,00
LU	10,21	0,89	20,76	33,32	1,00	0,73	.	33,05	100,00
LV	1,62	1,04	12,99	24,58	1,50	3,75	2,20	52,32	100,00

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland	Total
MT	32,70	7,62	26,35	11,11	16,19	2,54	.	3,81	100,00
NL	12,82	1,51	25,68	39,66	1,35	6,24	0,51	12,23	100,00
PL	3,36	0,85	34,52	24,30	1,11	1,81	0,45	33,61	100,00
PT	5,75	3,25	18,13	16,96	16,98	1,39	0,28	37,26	100,00
RO	2,12	0,59	35,03	26,96	1,69	1,99	0,72	30,91	100,00
SE	1,80	0,64	4,25	6,11	5,28	8,49	5,02	68,41	100,00
SI	3,34	1,37	10,87	22,04	2,25	0,44	0,33	59,35	100,00
SK	2,91	0,51	28,06	20,10	3,26	1,13	0,08	43,94	100,00
UK	6,09	1,23	21,28	41,19	8,42	2,34	2,60	16,86	100,00
EU	4,29	1,47	24,88	20,91	5,85	3,16	1,47	37,98	100,00

In Table 6 the percentage ratios between projected and original land cover are given. For the total of the participating countries, the imputation procedure increases significantly bareland, shrubland and wetland, where increases higher of 10% occur. Water areas, cropland and grassland remain substantially stable (with small increase/decreases); artificial land (-4%) and woodland (-2%) decrease their amounts of respectively -4% and 2%. Of the three most relevant areas cropland and grassland remain substantially unchanged while woodland shows a small decrease of 2%.

The procedure produces an increase in estimation (ratios greater than 100) in the most of countries for wetland (14 countries) followed by shrubland and woodland (13 countries) while for the remaining typologies the number of countries with ratios lower than 100 are the majority.

Regarding the "intensity" of changes operated by the procedure, it can be pointed out the increases greater than 5% in 11 countries for wetland and 6 countries for shrubland and the decreases lower than 5% for bareland (10 countries) and water areas (5 countries).

Table 6: Percentages ratios between projected and original land cover by countries

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
AT	93,38	76,96	103,58	99,60	105,44	94,34	116,44	100,93
BE	99,54	90,01	100,13	98,74	92,46	93,68	93,78	102,60
BG	99,99	99,87	100,00	100,00	100,01	100,02	100,00	100,00
CY	100,04	100,02	100,00	99,96	99,99	100,52	97,66	99,98
CZ	99,65	101,97	99,72	100,66	104,89	104,96	100,67	99,63
DE	97,54	107,00	99,37	99,53	97,23	99,45	100,64	101,48
DK	97,87	88,96	99,78	102,70	87,91	92,03	99,31	100,60
EE	84,95	94,62	94,10	94,82	97,66	104,56	299,75	97,64
EL	90,79	99,48	98,62	98,98	101,84	95,01	112,08	101,28
ES	95,50	110,58	98,85	99,14	102,83	100,33	117,52	98,80
FI	98,95	108,04	103,90	89,13	243,57	100,21	119,86	94,10
FR	96,45	80,90	99,88	97,10	105,17	97,94	107,39	103,51
HU	97,46	87,27	99,66	99,93	93,93	101,99	109,16	101,75
IE	91,81	79,62	99,53	100,76	137,33	104,86	91,43	91,53
IT	96,70	82,39	100,86	97,22	104,49	85,66	108,36	102,60
LT	95,98	86,33	99,57	99,07	97,48	106,35	88,22	101,57
LU	99,36	99,33	99,93	100,07	98,45	98,65		100,38

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
LV	97,40	100,15	98,14	100,09	118,41	86,91	106,91	100,62
MT	99,39	98,44	99,62	101,25	100,37	98,44		98,44
NL	96,93	89,49	99,50	98,62	125,43	101,21	171,15	103,64
PL	97,56	97,65	100,04	99,87	98,64	102,10	104,95	100,22
PT	95,35	116,30	98,13	95,38	103,90	112,86	113,86	99,95
RO	100,00	100,14	100,00	100,00	100,00	99,99	99,97	100,00
SE	87,17	399,58	101,04	92,56	165,93	106,41	106,31	91,80
SI	97,28	98,98	98,91	97,01	94,89	165,63	110,91	101,14
SK	95,48	83,88	99,72	97,61	89,87	95,32	127,47	102,58
UK	98,95	70,89	99,21	104,96	104,32	100,12	98,88	89,38
EU	96,29	112,97	99,70	99,03	113,41	101,12	110,47	98,08

In Table 7 the percent coefficients of variations (CVs) of the projected data are given; in Table 8 are reported the ratios between CVs calculated for "projected" and "original" land use. Except for few outliers, for which the ratio is equal or even greater than 1 , in the most of the cases the CVs for projected data are lower than the original ones because of the increase in sample sizes.

Table 7: Coefficient of variations (%) for land cover estimates by country – projected data

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
AT	4,85	14,29	2,34	2,03	11,39	6,50	22,19	1,06
BE	4,11	28,80	2,44	2,49	29,57	12,43	39,08	2,49
BG	7,55	13,35	1,19	2,18	5,00	12,67	44,82	1,20
CY	8,12	9,51	2,90	5,41	4,31	33,36	55,49	4,64
CZ	4,83	15,84	1,40	2,31	15,02	7,79	33,35	1,18
DE	2,02	6,67	0,73	1,04	5,99	3,73	8,25	0,65
DK	5,62	16,10	1,53	3,02	14,00	11,49	15,68	3,07
EE	11,40	17,90	4,57	3,39	10,81	4,39	7,88	1,26
EL	4,93	6,69	1,50	2,51	1,65	6,99	13,99	1,37
ES	2,22	2,05	0,63	1,10	1,09	4,17	13,11	0,67
FI	4,54	7,81	1,79	3,16	2,77	1,31	2,61	0,41
FR	1,68	5,89	0,57	0,70	2,39	3,09	10,96	0,53
HU	5,95	13,57	1,06	2,33	8,88	6,47	11,34	1,84
IE	6,46	19,91	5,58	1,02	5,98	5,51	5,80	3,47
IT	1,97	6,78	0,76	1,40	2,48	3,90	13,93	0,72
LT	8,30	19,53	2,23	2,14	13,45	6,83	15,61	1,35
LU	15,53	72,62	10,84	7,73	68,53	49,48	.	7,05
LV	10,07	13,66	3,44	2,25	10,06	6,07	7,55	0,98
MT	16,21	39,51	18,86	31,60	25,54	0,00	.	57,00
NL	4,08	16,45	2,86	2,19	14,26	5,24	20,81	4,02
PL	3,45	7,23	0,78	1,09	6,22	3,67	9,40	0,68
PT	4,19	5,53	2,18	2,43	2,32	7,31	19,00	1,32
RO	4,89	10,95	0,89	1,24	6,75	5,34	10,69	0,93
SE	4,41	3,44	2,28	2,26	1,79	1,20	2,32	0,38
SI	13,05	15,94	6,73	4,60	16,33	27,42	39,37	1,90

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
SK	8,63	28,37	2,09	3,17	10,37	12,07	57,32	1,31
UK	2,56	8,43	1,22	0,81	2,35	3,90	4,66	1,64
EU	0,74	1,37	0,25	0,32	0,65	0,72	1,38	0,18

Table 8: Land cover – percentage ratios (projected/original) of coefficients of variations (%) by country

Country	Artificial land	Bare land	Cropland	Grassland	Shrub land	Water areas	Wetland	Woodland
AT	99,81	121,53	111,01	95,18	87,96	96,64	94,18	89,76
BE	96,04	100,71	97,25	95,95	97,80	97,86	96,37	90,96
BG	100,05	99,97	100,20	100,15	100,03	100,00	99,98	99,91
CY	99,98	100,01	99,96	99,91	100,09	100,01	99,99	100,01
CZ	99,35	97,09	99,99	98,97	96,39	94,19	97,63	99,33
DE	99,20	93,34	98,91	97,53	97,25	95,25	94,77	93,87
DK	97,79	102,53	97,91	94,48	96,77	101,16	91,40	93,85
EE	94,66	91,26	94,58	92,87	87,94	75,48	46,19	95,39
EL	97,12	89,73	94,75	92,12	86,97	91,47	83,95	86,86
ES	96,57	92,54	97,20	95,10	88,98	91,95	84,22	92,07
FI	77,93	71,69	81,88	80,93	47,48	93,57	68,78	90,20
FR	97,32	106,39	98,47	98,30	88,68	95,03	92,01	89,93
HU	92,17	97,47	93,35	91,20	93,32	89,36	86,22	89,55
IE	91,57	95,97	91,10	89,50	74,12	85,66	93,22	92,35
IT	96,93	102,70	98,18	96,30	88,51	97,66	90,81	88,41
LT	98,40	97,40	96,94	96,04	90,46	80,23	90,35	92,30
LU	99,45	99,70	99,85	99,50	100,40	100,01		98,66
LV	98,93	93,15	99,46	96,42	82,50	93,39	80,06	94,59
MT	100,03	100,00	99,99	100,00	100,01			100,00
NL	94,73	98,49	95,19	95,20	83,00	91,62	71,14	90,37
PL	99,33	99,40	98,78	97,51	97,12	95,69	92,93	95,11
PT	98,49	87,14	97,95	98,90	91,88	87,94	83,06	95,14
RO	100,05	100,00	100,13	100,35	99,99	99,99	100,02	99,59
SE	93,13	40,78	90,90	89,49	63,11	86,15	80,28	97,64
SI	99,29	98,95	99,02	99,96	100,52	76,33	91,97	96,70
SK	93,55	99,12	93,93	91,88	94,67	92,58	80,83	88,35
UK	90,39	103,95	92,80	87,10	83,19	87,98	85,30	92,62
EU	95,48	86,38	97,02	94,46	83,10	89,88	84,04	93,10

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The impact on Land Use

In Table 9 the estimated land use area for the participating countries in 2012 is reported and in Table 10 the corresponding percentages are given.

Table 9: Land use areas (km^2) by countries - projected data

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	Total
AT	31914	177	217	84	160	165	40055	132	276	4691	1147	2600	2272	39	83928
BE	15886	225	385	82	24	128	6235	196	57	1527	441	3827	1637	21	30668
BG	54799	118	170	79	83	374	38807	113	152	12716	418	1732	1183	233	110979
CY	3720	46	39	56	18	0	692	0	34	3970	67	315	260	29	9246
CZ	39556	205	1424	57	68	616	27164	331	223	3955	886	2066	1942	376	78870
DE	186181	2125	4386	365	712	1603	105208	1363	1968	14493	6876	16854	14894	737	357766
DK	27481	367	395	59	33	161	5317	132	12	3526	1423	2681	1417	60	43065
EE	12279	0	15	0	141	502	24045	29	601	4475	1872	838	575	0	45372
EL	49017	270	333	168	475	678	30124	145	353	44480	768	1877	2681	323	131692
ES	238844	469	1591	664	873	469	98935	499	1336	133439	2284	6680	9532	2922	498537
FI	27247	203	956	51	791	9564	212785	162	1639	54632	20538	4020	5207	44	337839
FR	295977	1213	3602	489	566	2388	142404	796	1016	48284	6594	26597	18426	708	549061
HU	57463	144	343	16	65	641	21079	283	232	6110	1082	3497	1676	382	93013
IE	49992	64	111	16	58	372	6171	48	2057	6243	1307	2101	1312	96	69946
IT	144358	1500	992	722	920	1182	65075	1040	767	58996	3484	12034	9293	268	300633
LT	34329	66	42	17	45	927	23246	81	146	2927	910	1064	1029	70	64899
LU	1326	18	18	13	0	5	877	0	0	36	37	93	172	0	2596
LV	20408	38	55	12	97	1056	33266	30	417	5993	1087	1167	919	42	64586
MT	110	0	4	0	0	0	0	0	0	102	8	63	28	0	315
NL	20184	354	417	227	15	114	1717	216	47	3121	2473	2908	3617	107	35518
PL	160864	590	1784	427	128	2028	96526	558	789	27147	3933	10521	6151	483	311928
PT	36778	234	240	193	147	105	29381	159	190	16008	257	2133	2890	128	88843
RO	143672	120	272	229	120	3595	74595	320	322	8156	324	3988	2542	137	238392
SE	37646	234	1070	45	1417	14094	259919	418	598	104514	18780	4929	5972	81	449718
SI	6015	31	67	34	24	43	11195	33	56	1491	367	494	396	31	20277
SK	20221	33	529	16	127	277	20853	98	55	4361	489	1055	768	142	49026
UK	155485	1340	2497	164	296	1536	25047	714	1235	29547	8294	11974	5743	702	244574
EU	1871755	10183	21954	4284	7402	42623	1400719	7898	14578	604940	86146	128108	102533	8162	4311286

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Table 10: Land use areas (percentages) by countries - projected data

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	Total
AT	38,03	0,21	0,26	0,10	0,19	0,20	47,73	0,16	0,33	5,59	1,37	3,10	2,71	0,05	100,00
BE	51,80	0,73	1,25	0,27	0,08	0,42	20,33	0,64	0,19	4,98	1,44	12,48	5,34	0,07	100,00
BG	49,38	0,11	0,15	0,07	0,08	0,34	34,97	0,10	0,14	11,46	0,38	1,56	1,07	0,21	100,00
CY	40,24	0,50	0,42	0,60	0,19	.	7,48	.	0,36	42,94	0,73	3,41	2,81	0,31	100,00
CZ	50,15	0,26	1,81	0,07	0,09	0,78	34,44	0,42	0,28	5,02	1,12	2,62	2,46	0,48	100,00
DE	52,04	0,59	1,23	0,10	0,20	0,45	29,41	0,38	0,55	4,05	1,92	4,71	4,16	0,21	100,00
DK	63,81	0,85	0,92	0,14	0,08	0,37	12,35	0,31	0,03	8,19	3,31	6,23	3,29	0,14	100,00
EE	27,06	.	0,03	.	0,31	1,11	53,00	0,07	1,32	9,86	4,13	1,85	1,27	.	100,00
EL	37,22	0,21	0,25	0,13	0,36	0,52	22,88	0,11	0,27	33,78	0,58	1,43	2,04	0,25	100,00
ES	47,91	0,09	0,32	0,13	0,18	0,09	19,85	0,10	0,27	26,77	0,46	1,34	1,91	0,59	100,00
FI	8,07	0,06	0,28	0,02	0,23	2,83	62,98	0,05	0,49	16,17	6,08	1,19	1,54	0,01	100,00
FR	53,91	0,22	0,66	0,09	0,10	0,44	25,94	0,15	0,19	8,79	1,20	4,84	3,36	0,13	100,00
HU	61,78	0,16	0,37	0,02	0,07	0,69	22,66	0,30	0,25	6,57	1,16	3,76	1,80	0,41	100,00
IE	71,47	0,09	0,16	0,02	0,08	0,53	8,82	0,07	2,94	8,93	1,87	3,00	1,88	0,14	100,00
IT	48,02	0,50	0,33	0,24	0,31	0,39	21,65	0,35	0,26	19,62	1,16	4,00	3,09	0,09	100,00
LT	52,90	0,10	0,06	0,03	0,07	1,43	35,82	0,13	0,23	4,51	1,40	1,64	1,59	0,11	100,00
LU	51,08	0,71	0,71	0,51	.	0,21	33,78	.	.	1,37	1,42	3,59	6,63	.	100,00
LV	31,60	0,06	0,09	0,02	0,15	1,64	51,51	0,05	0,65	9,28	1,68	1,81	1,42	0,07	100,00
MT	35,00	.	1,25	.	.	.	.	.	.	32,50	2,50	20,00	8,75	.	100,00
NL	56,83	1,00	1,17	0,64	0,04	0,32	4,84	0,61	0,13	8,79	6,96	8,19	10,18	0,30	100,00
PL	51,57	0,19	0,57	0,14	0,04	0,65	30,95	0,18	0,25	8,70	1,26	3,37	1,97	0,16	100,00
PT	41,40	0,26	0,27	0,22	0,17	0,12	33,07	0,18	0,21	18,02	0,29	2,40	3,25	0,14	100,00
RO	60,27	0,05	0,11	0,10	0,05	1,51	31,29	0,13	0,14	3,42	0,14	1,67	1,07	0,06	100,00
SE	8,37	0,05	0,24	0,01	0,32	3,13	57,80	0,09	0,13	23,24	4,18	1,10	1,33	0,02	100,00
SI	29,67	0,15	0,33	0,17	0,12	0,21	55,21	0,16	0,28	7,35	1,81	2,43	1,95	0,16	100,00
SK	41,25	0,07	1,08	0,03	0,26	0,57	42,54	0,20	0,11	8,90	1,00	2,15	1,57	0,29	100,00
UK	63,57	0,55	1,02	0,07	0,12	0,63	10,24	0,29	0,51	12,08	3,39	4,90	2,35	0,29	100,00
EU	43,42	0,24	0,51	0,10	0,17	0,99	32,49	0,18	0,34	14,03	2,00	2,97	2,38	0,19	100,00

In order to evaluate the impact of the "projection" methodology over the original data, in Table 11 are reported the same percentages calculated for the 2012 original data.

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Table 11: Land use areas (percentages) by countries - original data

country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	total
AT	37,62	0,24	0,26	0,10	0,19	0,19	47,68	0,18	0,55	5,49	1,38	3,26	2,83	0,05	100,00
BE	51,82	0,77	1,08	0,29	0,09	0,47	20,10	0,53	0,20	4,93	1,51	12,98	5,16	0,08	100,00
BG	49,38	0,11	0,15	0,07	0,08	0,34	34,97	0,10	0,14	11,46	0,38	1,56	1,07	0,21	100,00
CY	40,24	0,50	0,42	0,60	0,19		7,48		0,36	42,94	0,73	3,41	2,81	0,31	100,02
CZ	50,45	0,26	0,42	0,07	0,09	0,86	35,56	0,42	0,26	4,97	1,15	2,65	2,52	0,32	100,00
DE	52,45	0,60	1,11	0,11	0,21	0,41	28,77	0,40	0,52	4,18	2,00	4,76	4,29	0,20	100,00
DK	63,15	0,88	0,93	0,15	0,09	0,33	11,84	0,32	0,03	8,69	3,64	6,42	3,37	0,19	100,00
EE	28,40		0,04		0,47	2,97	55,26	0,09	1,22	5,77	2,13	2,27	1,39		100,00
EL	40,26	0,22	0,28	0,16	0,45	0,55	19,94	0,12	0,29	33,13	0,52	1,56	2,27	0,26	100,00
ES	47,46	0,10	0,29	0,14	0,20	0,09	19,91	0,10	0,27	27,05	0,47	1,44	1,99	0,49	100,00
FI	7,87	0,07	0,29	0,02	0,34	3,16	68,98	0,05	0,58	9,29	6,42	1,33	1,59	0,02	100,00
FR	54,44	0,22	0,67	0,10	0,11	0,46	24,35	0,15	0,21	9,39	1,24	5,11	3,44	0,12	100,00
HU	62,00	0,19	0,34	0,02	0,09	0,78	22,26	0,28	0,24	6,51	1,04	4,08	1,76	0,43	100,00
IE	69,81	0,11	0,10	0,03	0,08	0,80	9,19	0,09	2,72	9,64	1,79	3,27	2,14	0,23	100,00
IT	48,48	0,51	0,31	0,25	0,32	0,35	24,80	0,34	0,25	15,58	1,27	4,20	3,26	0,10	100,00
LT	53,17	0,10	0,03	0,03	0,03	2,16	35,45	0,10	0,23	4,56	0,84	1,73	1,51	0,09	100,00
LU	51,06	0,71	0,71	0,51		0,21	34,18			1,40	0,92	3,61	6,69		99,92
LV	31,89	0,07	0,09	0,02	0,18	2,06	51,44	0,05	0,63	8,39	1,85	1,90	1,39	0,05	100,00
MT	35,00		1,25							32,50	2,50	20,00	8,75		100,32
NL	56,90	1,04	1,07	0,63	0,05		3,33	0,60	0,13	8,93	7,72	8,82	10,48	0,30	100,00
PL	51,64	0,19	0,57	0,14	0,04	0,60	31,00	0,18	0,25	8,43	1,31	3,46	2,04	0,15	100,00
PT	43,36	0,26	0,26	0,24	0,13	0,04	32,52	0,17	0,21	16,37	0,28	2,49	3,54	0,12	100,00
RO	60,27	0,05	0,11	0,10	0,05	1,51	31,29	0,13	0,14	3,42	0,14	1,67	1,07	0,06	100,00
SE	8,95	0,05	0,32	0,01	0,38	4,27	63,81	0,10	0,13	13,10	6,07	1,21	1,59	0,02	100,00
SI	30,36	0,16	0,35	0,16	0,12	0,22	54,41	0,17	0,28	7,50	1,57	2,51	2,04	0,16	100,00
SK	41,38	0,04	0,46	0,04	0,31	0,58	43,87	0,16	0,14	7,89	0,90	2,23	1,70	0,30	100,00
UK	60,83	0,55	0,88	0,08	0,15	0,72	11,77	0,28	0,43	12,84	3,60	5,01	2,57	0,31	100,00
EU	43,57	0,24	0,46	0,11	0,20	1,17	33,52	0,18	0,34	12,19	2,23	3,11	2,49	0,18	100,00

In Table 12 the percentage ratios between projected and original land use are given. The redistribution operated by the procedure for land use is heavier than for land cover. For the total of the 23 participating countries the imputation procedure increases the areas of "community services", "not used", and "water and waste treatment"; in particular the areas of "not used" and "community services" are enlarged for about 15% and 10%. The procedure decreases the areas of the remaining types of land use where the higher decreases are related to "fishing", about 15%, and "energy production", about 14%, that however represent small percentages of land use. Of the bigger areas "agriculture" remain substantially unchanged but "unused" and "forestry" present respectively an increase of about 15% and a decrease of about 3%.

The procedure produces an increase in estimation (ratios greater than 100) in the most of countries for "community services" (13 countries) and "mining" (12 countries); for "forestry" and "not used" the number of countries with an increase equals the number of those with a decrease (11 countries) while for the remaining typologies the number of ratios lower than 100 are the majority (it ranges from 1 to 10).

Regarding the "intensity" of changes operated by the procedure, it can be pointed out that the number of increases greater than 5%, is lower than the number of decreases lower than 5%; these last ones are present in almost all the typologies while in "agriculture", "commerce", "construction" and "residential" there is any increase greater than 5%.

Table 12: Percentages ratios between projected and original land use by countries

country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	101,1	89,4	98,9	102,0	101,1	102,6	100,1	89,2	59,8	101,9	99,1	94,9	95,7	102,2
BE	100,0	95,1	116,7	91,1	88,6	88,3	101,1	120,2	92,0	101,0	95,2	96,2	103,3	89,6
BG	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
CY	100,0	100,0	100,0	100,0	100,0		100,0		100,0	100,0	100,0	100,0	100,0	100,0
CZ	99,4	99,6	432,1	98,6	95,6	90,4	96,9	99,3	107,2	100,9	98,0	98,7	97,9	150,9
DE	99,2	98,3	111,0	97,1	94,8	110,6	102,2	94,8	106,6	96,9	96,0	98,9	97,0	102,5
DK	101,1	97,1	98,8	93,2	88,5	115,1	104,3	95,6	100,0	94,3	90,8	97,0	97,7	72,9
EE	95,3		75,0		65,7	37,3	95,9	73,9	108,3	170,9	194,1	81,6	91,2	
EL	92,5	91,5	92,0	82,6	80,2	94,0	114,7	94,0	93,4	101,9	111,9	91,5	89,6	93,9
ES	101,0	94,0	110,4	93,7	86,2	105,6	99,7	102,0	99,3	98,9	97,0	93,0	96,1	119,6
FI	102,5	81,1	99,3	62,5	69,2	89,5	91,3	98,0	83,9	174,1	94,7	89,7	96,9	59,1
FR	99,0	100,5	97,8	89,0	95,4	95,0	106,5	98,0	89,4	93,7	97,0	94,8	97,6	104,0
HU	99,6	82,9	107,9	81,0	80,5	88,6	101,8	107,4	106,4	101,0	111,6	92,2	102,5	95,4
IE	102,4	81,4	151,9	82,1	98,8	66,7	96,0	81,2	108,3	92,6	104,4	91,7	87,7	58,8
IT	99,1	97,5	106,1	97,2	96,8	112,3	87,3	103,3	103,2	125,9	91,5	95,3	94,8	93,7
LT	99,5	99,0	256,0	100,0	269,2	66,2	101,0	121,4	98,3	98,9	167,7	95,0	105,2	124,1
LU	100,0	100,0	100,0	100,0		100,0	98,8			97,6	153,5	99,6	99,1	
LV	99,1	84,3	91,4	82,6	83,8	79,2	100,1	97,9	102,7	110,6	91,1	95,4	102,4	144,4
MT	100,0		100,0							100,0	100,0	100,0	100,0	
NL	99,9	96,0	109,2	101,1	89,6		145,3	101,7	103,9	98,4	90,3	92,8	97,1	99,3
PL	99,9	99,5	100,9	95,8	102,5	108,9	99,8	97,3	102,0	103,3	96,6	97,4	96,5	101,3
PT	95,5	101,9	102,3	91,9	127,7	287,8	101,7	104,1	100,5	110,1	104,0	96,4	91,9	120,0
RO	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0
SE	93,6	96,3	75,3	83,3	82,0	73,4	90,6	94,9	106,4	177,4	68,8	90,7	83,4	75,0
SI	97,7	97,4	96,2	103,7	100,0	98,6	101,5	97,0	97,2	98,0	115,3	96,8	95,8	95,7
SK	99,7	167,5	233,3	82,1	83,3	97,9	97,0	124,2	80,1	112,7	110,5	96,6	92,4	96,3
UK	104,5	99,1	115,9	87,0	79,6	87,7	87,0	104,7	117,7	94,1	94,3	97,7	91,5	92,9
EU	99,6	97,0	110,4	93,6	86,4	84,7	96,9	99,6	99,6	115,1	89,6	95,4	95,4	105,5

In Table 13 the percent coefficients of variations (CVs) of the projected data are given.

Table 13: Coefficient of variations (%) for land use estimates by country – projected data

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	1,38	24,40	21,73	37,52	26,39	26,04	1,03	27,42	41,21	6,54	9,07	5,85	6,84	51,62
BE	1,46	22,94	16,97	38,15	71,58	27,42	2,92	24,52	40,24	8,05	15,51	4,89	7,58	62,01
BG	0,93	34,21	28,41	41,64	48,59	23,10	1,33	34,84	33,93	3,49	21,80	8,38	11,17	29,63
CY	2,61	35,78	37,53	29,85	53,37	.	8,24	.	38,47	2,56	28,70	12,65	14,10	40,76
CZ	0,93	26,12	9,73	49,98	44,76	12,12	1,33	20,42	22,77	5,72	12,42	7,76	7,80	17,85
DE	0,46	8,01	5,38	19,59	13,79	8,45	0,68	9,96	7,53	2,93	4,20	2,57	2,89	13,31
DK	1,06	17,33	15,97	44,59	57,84	28,68	3,64	29,51	91,11	5,29	8,51	5,95	8,77	44,89
EE	2,13	.	100,00	.	33,40	15,48	1,30	70,69	15,07	5,47	6,51	13,31	15,00	.
EL	1,12	22,97	20,61	28,83	16,54	12,38	1,70	31,47	19,97	1,36	13,36	8,39	6,85	20,96
ES	0,43	16,32	8,91	13,80	11,53	16,05	0,94	15,97	10,13	0,79	7,48	4,13	3,40	5,69
FI	1,60	24,21	12,30	51,08	13,94	3,61	0,45	25,65	9,81	1,51	2,21	5,76	4,79	59,37
FR	0,34	10,63	5,97	16,52	15,03	6,93	0,64	13,03	11,97	1,48	4,36	2,08	2,45	13,75
HU	0,78	33,63	21,79	100,03	50,46	14,11	1,88	24,04	25,79	4,92	11,17	6,22	9,37	20,20
IE	0,84	49,90	38,19	99,87	51,68	17,31	4,30	57,53	8,37	4,54	10,45	8,30	10,52	38,08
IT	0,54	8,97	11,61	13,44	11,48	9,61	1,06	11,21	15,84	1,26	6,14	3,02	3,46	22,74
LT	0,98	49,49	57,92	100,00	57,80	11,13	1,37	44,39	31,29	6,66	11,77	11,28	11,39	44,70
LU	4,58	81,56	81,56	96,90	.	106,73	6,87	.	.	58,40	51,91	34,99	23,54	.
LV	1,57	59,68	50,16	100,00	31,07	8,82	1,00	70,43	14,81	4,18	9,56	10,33	11,40	51,77
MT	15,33	0,00	100,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	70,26	22,50	36,33	0,00
NL	1,34	19,96	17,66	24,79	95,42	31,85	8,00	25,60	51,11	6,14	6,86	6,33	5,46	35,38
PL	0,52	15,43	8,44	17,91	31,77	7,44	0,72	15,70	12,92	2,10	5,29	3,43	4,62	16,78
PT	1,19	21,84	21,56	24,04	26,53	31,33	1,47	26,80	23,83	2,28	20,64	6,90	5,91	28,59
RO	0,51	34,33	26,51	28,00	43,48	6,58	0,92	21,20	25,05	4,58	22,93	5,65	7,87	39,30
SE	1,50	26,53	11,62	58,22	9,90	2,71	0,43	19,74	15,66	0,99	2,47	5,43	4,85	40,09
SI	3,65	60,34	41,54	57,27	67,93	51,81	2,10	57,08	44,86	9,30	21,92	15,10	17,09	61,58
SK	1,46	71,64	17,18	103,70	35,36	20,03	1,49	41,02	57,21	5,71	18,02	11,77	13,77	32,98
UK	0,51	10,88	7,87	31,37	22,78	10,12	2,07	14,89	10,88	2,00	4,21	3,25	5,03	15,44
EU	0,157	3,605	2,468	5,635	4,269	1,645	0,212	4,113	3,095	0,428	1,182	0,963	1,093	4,076

In Table 14 are reported the ratios between CVs calculated for "projected" and "original" land use. Except for few outliers, for which the ratio is equal or even greater than 1 , in the most of the cases the CVs for projected data are lower than the original ones because of the increase in sample sizes.

Table 14: Land use – percentage ratios (projected/original) of coefficients of variations (%) by country

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manifacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	99,1	90,9	96,2	110,0	94,0	91,8	91,4	100,4	112,3	93,4	93,8	99,0	98,9	93,0
BE	96,3	99,7	87,0	101,6	103,4	98,9	91,1	88,9	99,7	91,5	96,4	97,0	94,8	101,7
BG	100,1	100,0	100,0	100,0	100,0	100,0	100,2	100,0	100,0	99,9	100,0	100,0	100,0	100,0
CY	100,0	100,0	100,0	100,0	100,0	0,0	21,4	0,0	134,0	20,3	203,6	31,0		
CZ	99,6	99,4	47,1	100,3	99,1	104,7	103,8	99,8	92,7	98,0	99,4	99,8	100,0	75,7
DE	98,9	99,6	90,2	100,0	100,0	88,0	92,0	101,3	92,4	97,1	97,5	98,4	98,7	94,5
DK	95,8	98,9	91,0	101,8	101,3	83,9	89,3	100,6	85,4	96,8	97,3	97,4	97,9	105,9
EE	96,4		100,0		92,9	115,6	99,5	100,0	80,1	61,8	35,5	99,4	92,2	
EL	94,4	97,9	94,6	100,0	95,1	86,8	78,8	95,3	91,6	87,1	83,6	96,6	96,9	90,2
ES	94,9	99,4	88,2	98,0	99,0	87,9	90,2	95,0	92,3	92,6	93,8	98,1	97,1	79,6
FI	82,4	82,6	77,0	91,9	90,7	85,2	94,7	74,2	80,0	55,6	85,3	79,6	78,6	100,5
FR	96,0	98,1	96,1	102,0	96,3	96,3	85,9	98,1	98,6	95,5	95,2	97,6	97,7	93,7
HU	92,3	99,6	86,9	97,7	101,1	94,5	89,3	87,1	85,7	89,9	81,1	94,4	88,9	91,0
IE	86,1	98,9	73,1	98,7	88,5	93,4	88,6	98,8	85,2	89,2	82,2	93,2	94,4	100,9
IT	95,4	97,9	93,7	99,4	95,4	87,5	100,6	96,5	93,7	77,8	88,8	97,1	97,2	95,3
LT	97,1	100,0	57,9	100,0	57,8	110,5	93,8	89,7	83,0	89,8	63,1	98,3	93,0	76,4
LU	99,4	100,0	100,0	100,0		100,0	101,0			100,1	85,3	99,6	99,8	
LV	98,1	103,6	100,5	100,0	88,4	93,4	96,4	100,0	79,9	86,1	89,9	98,7	93,1	73,2
MT	100,0		100,0							100.0	100,0	100,0	100,0	
NL	95,1	96,1	86,6	93,6	99,9		73,7	93,4	87,2	92,8	96,7	97,5	93,2	91,8
PL	97,2	99,8	94,4	99,9	94,1	90,2	94,7	99,8	97,0	94,5	98,2	99,6	99,3	97,0
PT	98,6	94,8	94,0	99,6	80,4	52,5	93,3	95,1	92,1	88,1	92,6	98,9	99,6	82,5
RO	100,4	100,0	100,0	100,0	100,0	100,1	99,6	100,0	100,0	100,0	100,0	100,1	100,1	100,0
SE	88,9	93,5	94,1	98,2	91,8	101,2	97,5	93,2	78,0	57,9	100,4	91,2	93,8	93,1
SI	99,7	99,3	99,9	95,9	99,8	99,2	96,2	100,0	98,9	99,4	89,5	99,7	99,9	99,7
SK	93,5	69,9	57,6	99,4	99,7	90,9	99,0	81,3	101,9	84,4	85,1	92,2	95,0	91,5
UK	85,3	90,3	82,0	95,7	98,0	95,4	92,3	87,2	79,5	88,7	89,8	89,4	93,5	91,2
EU														