

LUCAS 2009
(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 2009 Survey took place in the following 23 countries (AT, BE, CZ, DE, DK, EE, EL, ES, FI, FR, HU, IE, IT, LT, LU, LV, NL, PL, PT, SE, SK, SI, UK), covering 91% of total EU area.

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: imageries 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 photo interpreted during 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 shrubland, bare land, artificial land, water (see Table 1).

In double sampling we assume that in every NUTS2 region the strata weights $Wh = (Nh/N)$ with $h=1....7$, estimated from the first phase sample, are correct estimates of the related percentage Wh^* in the population, that is $E(Wh) = Wh^*$.

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 25%. For the 2009 editions survey the priority was focused on general land cover monitoring and the subsampling rates were more balanced than in 2006 among strata, with some geographic variability depending on the target accuracy per administrative unit. While in LUCAS 2006 the same sampling rate was applied in each stratum across the 11 countries covered in that occasion, in 2009 the sampling rate per stratum was tuned separately for each NUTS2 region.

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.

Points above 1000 metres are excluded from the sample to be visited in order to limit the cost of the data collection exercise; they are taken into consideration by the estimation procedure, considering them as “missing” observations.

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 shrubland	Forests, other wooded areas, shrubland (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 survey 2009 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 countries.

Table 2: Number of points of the master sample per country

Code	Country	Points
AT	Austria	20.979
BE	Belgium	7.682
BG	Bulgaria	27.741
CY	Cyprus	2.311
CZ	Czech Republic	19.718
DE	Germany	89.501
DK	Denmark	10.825
EE	Estonia	11.354
EL	Greece	33.045
ES	Spain	124.613
FI	Finland	84.542
FR	France	137.306
HR	Croatia	14.141
HU	Hungary	23.271
IE	Ireland	17.557
IT	Italy	75.335
LT	Lithuania	16.334
LU	Luxembourg	646
LV	Latvia	16.145
MT	Malta	80
NL	Netherlands	8.864
PL	Poland	78.141
PT	Portugal	22.261
RO	Romania	59.610
SE	Sweden	112.494
SI	Slovenia	5.067
SK	Slovak Republic	12.263
UK	United Kingdom	62.008
	Total	1.093.834

Table 3 shows the cross distribution of points by participating countries and strata; so the table summarizes the structure of the master sample as frame for the second phase sample. The 23 participating countries cover the 91% of the total EU area.

Table 3: Master sample: number of points by strata and by participating countries

Country	STRATA							Total
	1	2	3	4	5	6	7	
	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land, low or rare vegetation	Artificial land	Water	
Austria	3178	278	3778	11925	711	818	291	20979
Belgium	2077	50	2508	2117	25	813	92	7682
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

Country	STRATA							Total
	1	2	3	4	5	6	7	
	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land, low or rare vegetation	Artificial land	Water	
Finland	5502	37	5098	60975	2731	1521	8678	84542
France	39954	3139	32298	51880	2243	6310	1482	137306
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
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
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
Total	252119	28226	165132	453454	21268	40030	29722	989951

From the stratified master sample, a sub-sample of points was extracted in order to be classified by field visits according to the full land use/coverage nomenclature; in Table 4 the number of selected points in second phase sample is showed as well as the sampling rates. The overall sampling rate is about 23,7 and it ranges from a minimum of about 23,3 in United Kingdom to the maximum of about 27,1 in Netherland.

Table 4: Number of selected points by country and strata

	1	2	3	4	5	6	7	Total	Sampling rate
	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land, low or rare vegetation	Artificial land	Water		
Austria	909	77	969	2604	19	320	61	4959	23,64
Belgium	487	11	592	498	4	189	23	1804	23,48
Czech Republic	1817	22	638	1945	26	165	50	4663	23,65
Germany	7972	155	3510	7306	105	1800	270	21118	23,60
Denmark	1782	0	177	393	18	144	27	2541	23,47
Estonia	435	2	438	1597	39	26	129	2666	23,48
Greece	1862	695	711	4042	81	269	102	7762	23,49
Spain	9228	3232	3934	11846	578	865	229	29912	24,00
Finland	2629	8	1215	12795	467	717	2065	19896	23,53
France	9435	742	7627	12243	458	1486	338	32329	23,55
Hungary	2823	109	806	1469	26	169	111	5513	23,69
Ireland	219	0	2876	694	164	123	88	4164	23,72
Italy	5598	1886	2067	6650	209	1164	275	17849	23,69
Lithuania	1492	7	799	1338	112	113	0	3861	23,64
Luxembourg	39	1	38	61	1	11	1	152	23,53

	1	2	3	4	5	6	7	Total	Sampling rate
	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land, low or rare vegetation	Artificial land	Water		
Latvia	1042	5	501	1900	297	80	0	3825	23,69
Netherlands	531	16	1022	427	51	260	94	2401	27,09
Poland	8378	59	2581	6487	47	652	298	18502	23,68
Portugal	1116	497	703	2670	140	241	61	5428	24,38
Sweden	1696	3	1208	19878	937	503	2432	26657	23,70
Slovenia	146	30	169	806	2	44	6	1203	23,74
Slovak Republic	876	26	401	1460	25	86	24	2898	23,63
United Kingdom	3379	13	5208	4676	155	828	183	14442	23,29
Total	63891	7596	38190	103785	3961	10255	6867	234545	23,69

The total area and the areas by strata of each participating country, corresponding to the number of points in first phase sample, is reported in Table 5. It is obtained from the master sample summing up the area of each stratum; this quantity is calculated multiplying the corresponding number of points by the average area per point. For some countries the total area does not correspond to the official one because some territories are excluded (see Table 10 pag. 17).

Table 5: Master sample: area and percentage over the total by strata per country

	1		2		3		4		5		6		7		Total Area
	Arable Land		Permanent Crops		Grassland		Wooded Areas		Bare Land		Artificial Land		Water		
	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
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	29,1	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	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
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
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	30,2	441	0,9	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

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	1		2		3		4		5		6		7		Total
	Arable Land		Permanent Crops		Grassland		Wooded Areas		Bare Land		Artificial Land		Water		
	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area	%	Area
EU	1.006.510	25,47	112.822	2,85	658.595	16,66	1.811.046	45,82	84.918	2,15	159.808	4,043	118.666	3,002	3.952.353

In producing master sample, in case of uncertainty in classifying 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 6 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 6: Whole master sample: cross table of the double strata allocation

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

Ground survey

Information collected

For each point belonging to the field sample, the following information was collected (see *LUCAS 2009 - Technical reference document C-2: Field form*):

- Land cover;
- Land use;
- Water management on the field information;
- A set of information on soil and on the soil samples;
- A set of information along a transect 250m long eastwards from the point;
- 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.

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, a full explanation of each item is reported in *LUCAS 2009 - Technical reference document C-1*).

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 photointerpreted 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 orthophoto 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 orthophoto 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		“WGS 84” (if no signal “X” required)
Precision		Indication of average location error as given by GPS receiver (in m)

Items recorded through the ground survey	Item modalities	Description
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 3-50 m 50-100 m >100 m not relevant	Indication of the distance between observation location and 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.
	$0.5 \leq \text{Area} < 1$	The size of the observed plot ranges between 0.5 and 1 ha.
	$1 \leq \text{Area} < 10$	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 maturity	Less than 5 m	Assessment of the height of the trees for specific land covers.
	More/equal 5 m	
Width of feature	Less than 20 m	Assessment the width of the feature for specific land covers.
	More/equal 20 m	
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	The coverage of land cover 1 or 2 is less than 10%.
	$10 \leq \%LC < 25$	The coverage of land cover 1 or 2 ranges between 10% and 25%.
	$25 \leq \%LC < 50$	The coverage of land cover 1 or 2 ranges between 26% and 50%.
	$50 \leq \%LC < 75$	The coverage of land cover 1 or 2 ranges between 51% and 75%.
	%LC ≥ 75	The coverage of land cover 1 or 2 is 76% or more.
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	

Items recorded through the ground survey	Item modalities	Description
Presence of water management	Irrigation	Photo acquisition of the irrigation device
	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 earth fill 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.

Items recorded through the ground survey	Item modalities	Description
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.
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

Items recorded through the ground survey	Item modalities	Description
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

Soil data were collected by taking top soil samples on 10% of total LUCAS points. Soil results for 25¹ countries are available via the JRC Land resource management unit under license agreement. Approximately 20,000 points were selected out of the main LUCAS grid for the collection of soil samples. A standardised sampling procedure was used to collect around 0.5 kg of topsoil (0-20 cm).

Implementation and schedule

LUCAS 2009 was carried out in 23 MS², covering 91% of total EU area. Around 21.000 km² (equivalent to 0.6 %) of EU23 total area were not covered by the survey³.

All the survey has been conceived and designed by Eurostat. The Contractors were responsible for the data collection in the 23 countries (arranged in 5 Lots), the recruitment and management of the surveyors and the data delivery.

The campaign started in early April in Lithuania and Poland and was completed by end of October in Sweden. In 2009 round more than 500 surveyors were recruited for a total of 234,561 points to be visited in the ground (Table 8). In the same table is also reported the number of points photo interpreted ex-ante by the central staff because it was impossible to access them.

Table 8: Organization of the work.

COUNTRY	No. Surveyors	Surveyed Points	Ex-ante PI	Survey Time	
				Start	End
Austria	9	4959	695	04-mag	24-set
Belgium	7	1804	180	15-mag	03-ott
Czech Republic	10	4663	96	24-apr	23-lug
Germany	32	21118	2114	06-apr	01-set
Denmark	4	2541	238	11-mag	02-ago
Estonia	6	2666	266	09-mag	07-ott
Greece	60	7762	864	20-apr	22-ott
Spain	27	29912	2991	07-apr	30-set
Finland	64	19896	4986	01-apr	28-set

¹ Cyprus and Malta, excluded from the field survey took part to the soil module, on voluntary base.

² LUCAS survey was carried out in Romania and Bulgaria in 2008 in the frame work of Phare project.

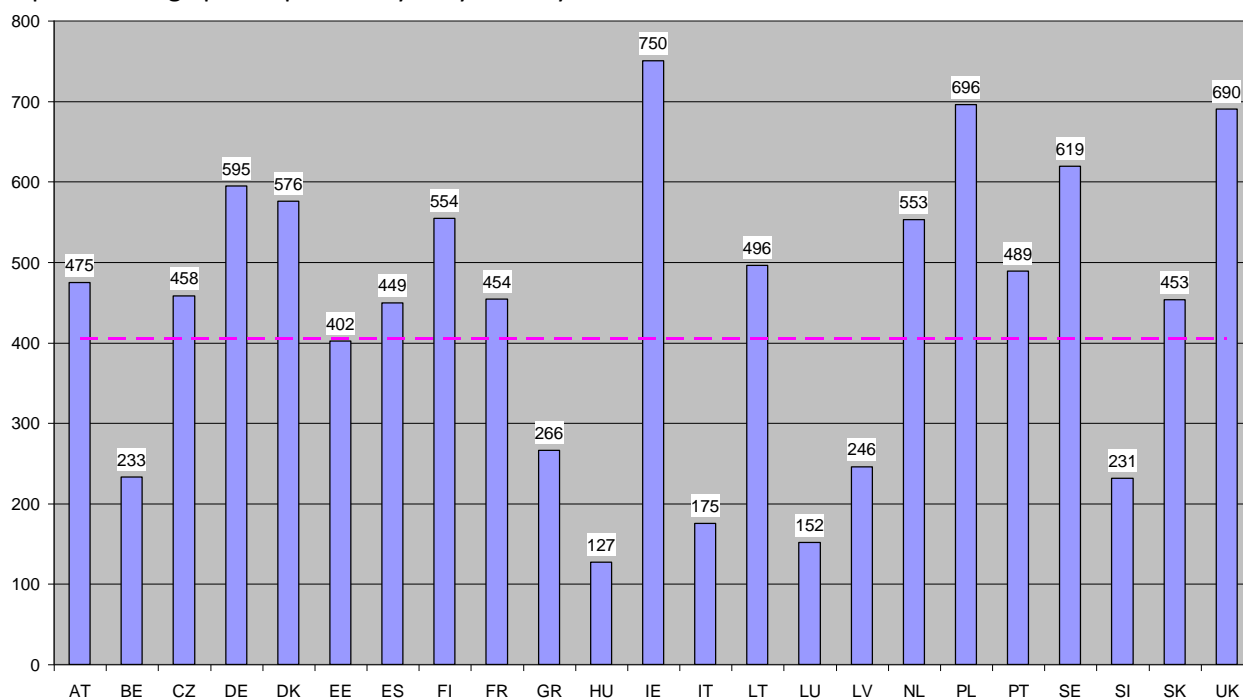
³ This area belongs to the following regions: Canaries, Balearics, Ceuta and Melilla (ES), Norieo, Notio Aigaio and Ionia Nisia (GR), Azores and Madeira (PT), Western + Orkney + Shetland (UK), Land (FI).

COUNTRY	No. Surveyors	Surveyed Points	Ex-ante PI	Survey Time	
				Start	End
France	26	32329	3251	09-apr	14-ott
Hungary	42	5513	180	07-apr	28-set
Ireland	5	4164	416	14-apr	28-ott
Italy	92	17849	1787	13-apr	29-set
Lithuania	7	3861	386	03-apr	07-ott
Luxembourg	1	152	0	12-mag	11-giu
Latvia	14	3825	383	01-mag	07-ott
Netherlands	4	2401	199	08-mag	01-set
Poland	24	18502	1824	06-apr	25-ott
Portugal	10	5428	541	27-apr	28-set
Sweden	32	26657	6856	04-mag	22-ott
Slovenia	5	1203	47	14-mag	23-set
Slovak Republic	6	2898	180	27-apr	16-set
United Kingdom	19	14442	1351	14-apr	03-ott
EU	506	234545	29831	03-apr	25-ott

Survey performance

In the 23 countries the average number of points per surveyor was 405, but a great variability was observed: the work load ranges from 127 (Hungary) to 750 (Ireland) points per surveyor (Graph 1).

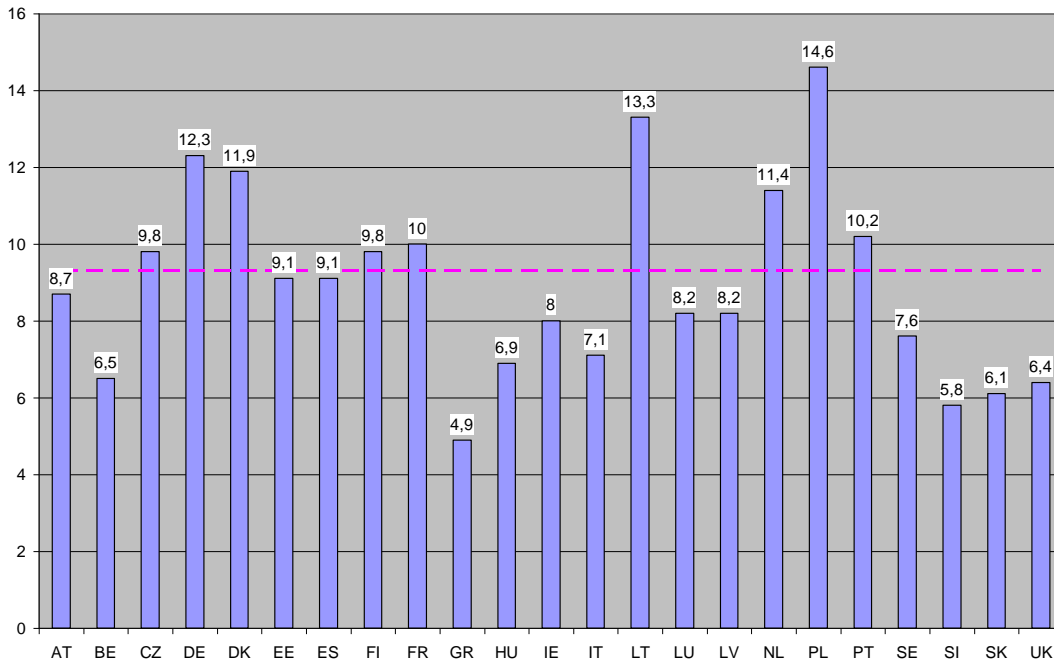
Graph 1: Average points per surveyor by country.



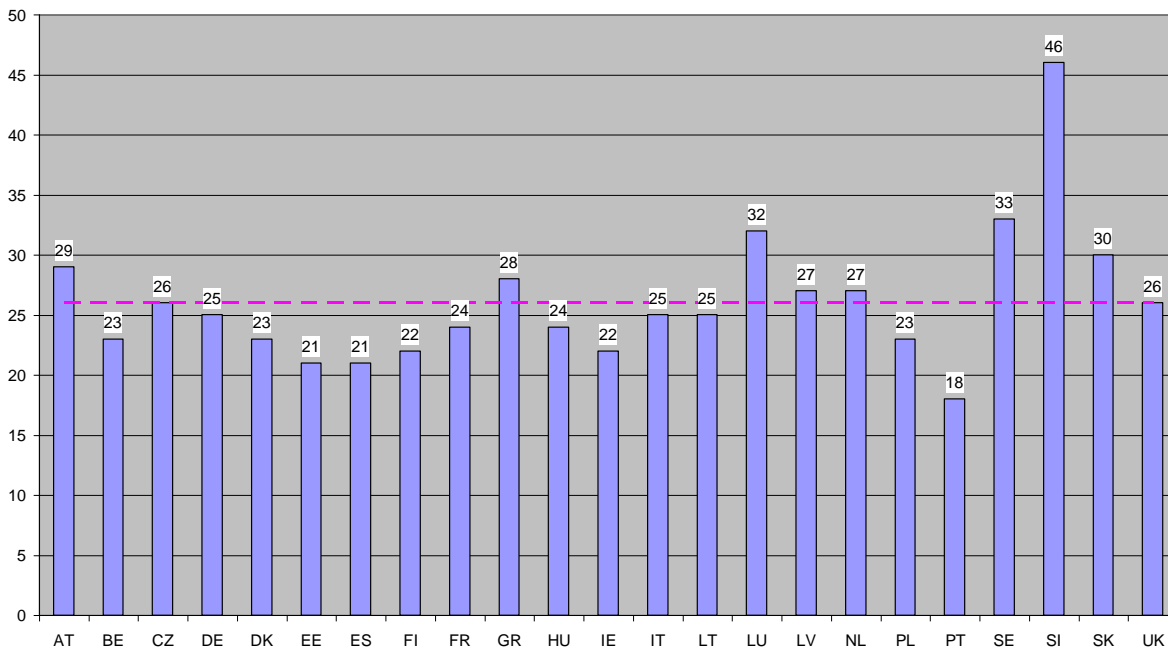
Quality Report

Graphs 2 and 3 give an overview about the performance of the surveyors in each country regarding the number of points surveyed per day and the time spent per surveyed point in average⁴. The average number of points per day was 9.3. DE, DK, LT, NL, PL and PT recorded more than 10 points per day, with the maximum being reached in PL where a surveyor had an average of 24 points per day.

Graph 2: Average surveyed points per day by country.



Graph 3: Average time spent per point by country (in minutes).



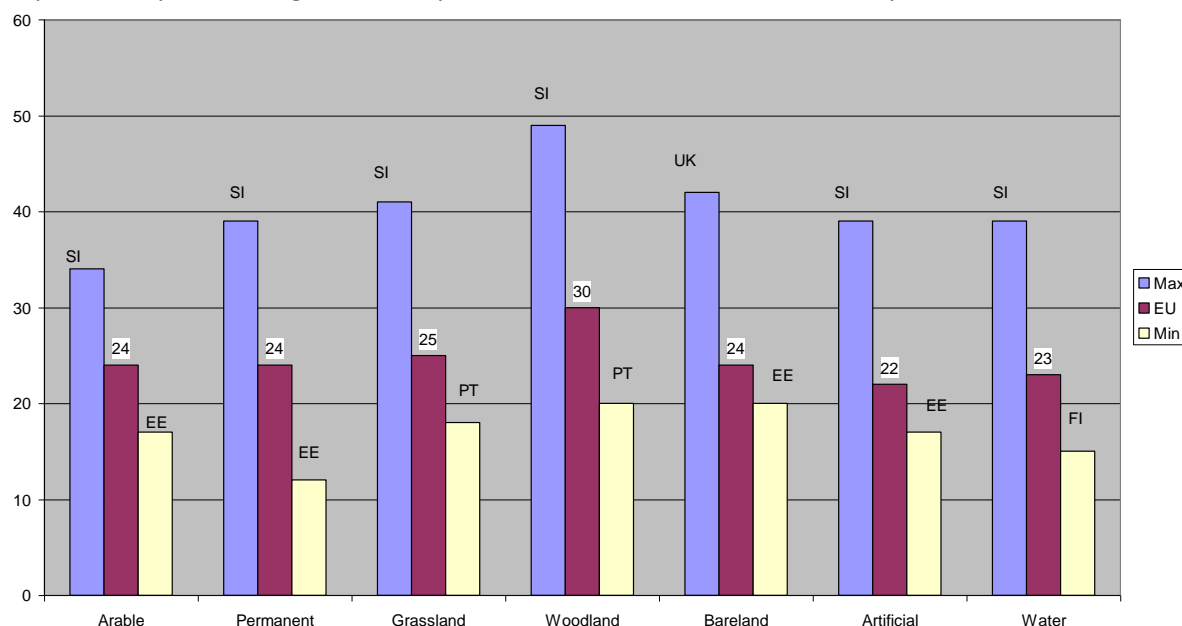
The average time needed to visit each point depends on the land cover and landscape met and it is obviously related to the closeness of the points to the roads and the environment surrounding the point (the surveyors had to walk a transect of 250m to the East direction). It can be read as an indicator of the

⁴ The trip time has not been taken into consideration, but only the time spent on the spot for surveying the point.

Quality Report

measurement accuracy too, since points surveyed too quickly could be inaccurate. In general points in forestry were the most difficultly reachable and the longest time per point is recorded in the countries with large areas of woodland.

Graph 4: European average time compared with minimum and maximum by main Land Cover classes.



Data collection outcome

In Table 9 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 highest for Luxemburg, Czech Republic and Slovenia.

Table 9: Number of surveyed points by type of observation

Country	Points				Total	% of observed points
	observed	missing	in field PI ⁵	Ex ante PI ⁶		
Austria	3959	0	305	695	4959	79,83
Belgium	1261	0	363	180	1804	69,90
Czech Republic	4506	0	61	96	4663	96,63
Germany	18397	0	606	2115	21118	87,12
Denmark	2105	0	182	254	2541	82,84
Estonia	1628	0	772	266	2666	61,07
Greece	4771	0	0	2991	7762	61,47
Spain	23006	0	1920	4986	29912	76,91
Finland	12278	0	4367	3251	19896	61,71
France	26032	0	5407	890	32329	80,52

⁵ Points photo-interpreted in the field by the surveyor, due to unexpected unaccessibility circumstances

⁶ 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.

Country	Points				Total	% of observed points
	observed	missing	in field PI ⁵	Ex ante PI ⁶		
Hungary	4692	0	641	180	5513	85,11
Ireland	2487	0	1261	416	4164	59,73
Italy	12196	0	3866	1787	17849	68,33
Lithuania	2960	0	513	388	3861	76,66
Luxembourg	148	0	4	0	152	97,37
Latvia	2776	0	666	383	3825	72,58
Netherlands	2071	0	86	244	2401	86,26
Poland	15919	0	759	1824	18502	86,04
Portugal	4343	0	544	541	5428	80,01
Sweden	16058	0	3743	6856	26657	60,24
Slovenia	1088	0	68	47	1203	90,44
Slovak Republic	2375	0	343	180	2898	81,95
United Kingdom	9693	179	3398	1172	14442	67,12
EU	174749	179	29875	29742	234545	74,51

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 characterizing the landscapes in Europe using the photos taken by the surveyors and the orthophotos was developed

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.

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.

Data processing

The data processing involved two main stages:

- Data imputation for partial missing data;
- Estimates production.

Data imputation for photo-interpreted points in cropland

As shown in Table 9, a total of 59,617 points were photo-interpreted either ex-ante or in the field. Most of those points were classified as woodland or water but a limited percentage of them were located in cropland. For those points a simplified nomenclature was sometimes used due to the difficulties in properly distinguishing among specific classes in ortho-photos (i.e. durum wheat from oats and barley). This issue appeared in 2.130 points.

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 of 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:

- The adoption of the modal value of the distribution of the potential donors;
- selection of the donor set that minimizes the cost function:

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

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

Points above 1000 metres are excluded from the sample to be visited in order to limit the cost of the data collection exercise; they are taken into consideration by the estimation procedure, considering them as “missing” observations.

The following territories/islands presented in the table 10 were not included in the field survey; they are excluded from the reference population and hence also their 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 10: Territories/islands not included in the field survey

EL22 (Ionia Nisia)	
EL41 (Voreio Aigaio)	52% of EL4 (NISIA AIGAIO, KRITI)
EL42 (Notio Aigaio)	
ES53 (Illes Balears)	8% of ES5 (ESTE)
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)	
FI20 (Åland)	100% of FI2 (Åland)

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

$$\hat{S}_L = \hat{Y}_L * S \quad (1)$$

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

The estimator for a percentage in double sample is

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

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

$$\hat{Y}_L = \sum_h W_h \left(\sum_k I_{hk} y_{kh} / n_h \right) \quad (3)$$

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

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

$$\hat{Y}_L = (1/N) \sum_h [\sum_k IL_{kh} y_{kh}] * N_h / n_h \quad (4)$$

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

Substituting (4) into (1) we obtain

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

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

$$\hat{S}_L = \sum_h [\sum_k IL_{kh} y_{kh}] * \bar{S} * p_{hk} \quad (5)$$

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

$$\hat{S}_L = \sum_h [\sum_k IL_{kh} y_{kh}] * \bar{S} * w_{hk}$$

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

$$w_{i;v_1,\dots,v_m}^{t^1} = \frac{N_{v_1,\dots,v_m}}{n_{v_1,\dots,v_m}} w_{i;v_1,\dots,v_m}^{t^0}$$

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 $1, \dots, m$ variables;
- N_{v_1,\dots,v_m} are the number of points (derived from the master data set) of the values for the $1, \dots, m$ variables;
- N_{v_1,\dots,v_m} are the totals of the values for the $1, \dots, m$ 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:

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

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

According to the above estimator, in the following Table 11 and Table 12 are reported the estimated area (in km^2) and the related percentages over the total area of each country.

Table 11: Area by country and 1st level land cover classification - absolute values (km²)

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
Austria	3.360	2.996	13.448	21.158	2.165	1.384	231	39.184	83.928
Belgium	3.334	324	8.267	10.281	259	396	132	7.674	30.668
Czech Republic	3.340	524	27.861	16.040	527	1.039	186	29.353	78.870
Germany	24.510	2.128	117.814	82.794	2.814	6.427	2.011	119.269	357.766
Denmark	2.791	392	20.832	9.586	737	676	497	7.553	43.065
Estonia	710	355	5.241	9.092	1.066	2.363	2.388	24.157	45.372
Greece	4.451	3.332	30.184	18.332	34.556	1.831	790	38.217	131.692
Spain	16.551	25.226	150.109	76.027	84.951	4.736	748	140.188	498.537
Finland	5.372	4.223	20.237	11.250	21.622	34.189	19.392	221.555	337.839
France	27.124	6.369	165.432	146.654	23.555	7.742	1.098	171.087	549.061
Hungary	3.014	465	44.190	19.412	1.870	1.860	1.228	20.965	93.013
Ireland	2.623	539	3.560	44.709	4.225	1.931	4.232	8.128	69.946
Italy	19.932	6.343	95.752	53.302	21.916	5.231	752	97.405	300.633
Lithuania	1.538	415	15.731	21.183	1.006	2.005	363	22.663	64.899
Luxembourg	209	33	566	864	18	16	0	890	2.596
Latvia	1.085	536	7.841	17.161	2.344	1.860	1.473	32.287	64.586
Netherlands	4.259	384	8.872	14.221	657	2.234	352	4.536	35.518
Poland	9.202	1.684	112.544	76.890	3.057	5.864	1.435	101.221	311.928
Portugal	4.380	3.518	16.516	13.682	16.294	1.244	373	32.828	88.843
Sweden	6.791	12.862	20.057	23.160	39.485	41.284	26.398	279.680	449.718
Slovenia	592	418	1.951	4.147	550	124	57	12.442	20.277
Slovak Republic	1.182	181	13.894	9.286	1.706	534	49	22.189	49.026
United Kingdom	14.577	3.693	48.768	105.656	24.506	5.552	5.552	36.270	244.574
total	161.651	76.676	955.284	809.837	288.127	128.847	68.376	1.463.952	3.952.355

Table 12: Area by country and 1st level land cover classification - percentages

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
Austria	4,00	3,57	16,02	25,21	2,58	1,65	0,28	46,69	100
Belgium	10,87	1,06	26,96	33,53	0,84	1,29	0,43	25,02	100
Czech Republic	4,23	0,66	35,33	20,34	0,67	1,32	0,24	37,22	100
Germany	6,85	0,59	32,93	23,14	0,79	1,80	0,56	33,34	100
Denmark	6,48	0,91	48,37	22,26	1,71	1,57	1,15	17,54	100
Estonia	1,57	0,78	11,55	20,04	2,35	5,21	5,26	53,24	100
Greece	3,38	2,53	22,92	13,92	26,24	1,39	0,60	29,02	100
Spain	3,32	5,06	30,11	15,25	17,04	0,95	0,15	28,12	100
Finland	1,59	1,25	5,99	3,33	6,40	10,12	5,74	65,58	100
France	4,94	1,16	30,13	26,71	4,29	1,41	0,20	31,16	100
Hungary	3,24	0,50	47,51	20,87	2,01	2,00	1,32	22,54	100
Ireland	3,75	0,77	5,09	63,92	6,04	2,76	6,05	11,62	100
Italy	6,63	2,11	31,85	17,73	7,29	1,74	0,25	32,40	100
Lithuania	2,37	0,64	24,24	32,64	1,55	3,09	0,56	34,92	100

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	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
Luxembourg	8,04	1,26	21,82	33,27	0,69	0,62	-	34,30	100
Latvia	1,68	0,83	12,14	26,57	3,63	2,88	2,28	49,99	100
Netherlands	11,99	1,08	24,98	40,04	1,85	6,29	0,99	12,77	100
Poland	2,95	0,54	36,08	24,65	0,98	1,88	0,46	32,45	100
Portugal	4,93	3,96	18,59	15,40	18,34	1,40	0,42	36,95	100
Sweden	1,51	2,86	4,46	5,15	8,78	9,18	5,87	62,19	100
Slovenia	2,92	2,06	9,62	20,45	2,71	0,61	0,28	61,36	100
Slovak Republic	2,41	0,37	28,34	18,94	3,48	1,09	0,1	45,26	100
United Kingdom	5,96	1,51	19,94	43,2	10,02	2,27	2,27	14,83	100
total	4,09	1,94	24,17	20,49	7,29	3,26	1,73	37,04	100

In the following Table 13 and Table 14 the estimated areas (in km²) for land use of each country, absolute values and percentages, by countries are reported.

Table 13: Area by country and 1st level land cover classification - absolute values (km²)

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment	Total
AT	31318	128	248	105	71	242	39867	52	117	5737	1581	2230	2172	58	83928
BE	16237	123	482	70	0	49	6161	171	68	1306	713	3554	1667	67	30668
CZ	40093	140	1648	39	50	612	27113	268	181	3532	883	2003	1894	413	78870
DE	186364	1699	4325	358	504	1710	107874	1360	2021	12672	7155	16421	14647	644	357766
DK	27942	323	349	102	17	294	5665	84	34	2604	1866	2431	1302	50	43065
EE	12495	0	17	34	127	283	23951	17	539	4416	2276	652	565	0	45372
EL	51021	254	269	133	504	791	36556	176	313	36177	760	1861	2577	298	131692
ES	271967	289	1540	703	618	1236	87299	628	1366	111966	2154	6336	9382	3051	498537
FI	25818	139	902	44	443	11507	212514	142	1574	57020	18395	3882	5409	54	337839
FR	298887	1461	3607	571	467	2399	146654	648	939	42036	7594	26015	17092	697	549061
HU	58511	50	288	101	69	549	21158	304	281	4670	1348	3389	1805	489	93013
IE	51082	34	182	85	29	321	6488	34	2688	4414	1468	1805	1282	34	69946
IT	151871	1413	1178	713	469	1290	58774	1127	794	59357	3160	10961	9214	316	300633
LT	34757	67	90	17	63	593	22891	118	109	2475	1286	1279	1092	63	64899
LU	1371	23	0	0	0	0	894	0	0	54	50	61	125	18	2596
LV	21135	36	71	0	72	1009	33074	54	421	5828	1057	862	882	83	64586
NL	20916	228	446	73	0	291	1771	287	47	2621	2370	2651	3739	76	35518
PL	167234	683	1691	203	115	2467	93422	490	758	25644	4049	8887	5914	371	311928
PT	34068	180	211	191	124	169	34726	114	243	13862	432	2092	2294	138	88843
SE	38258	202	994	49	2366	10353	254608	495	567	112569	18295	4834	6049	76	449718
SI	5908	15	14	59	0	14	11544	46	30	1434	366	421	411	14	20277
SK	20898	50	627	32	86	264	20898	95	88	3564	565	1013	752	96	49026
UK	161382	1189	3444	247	210	1756	24022	783	1152	23533	8303	11989	5400	1164	244574
EU	1729531	8728	22624	3928	6406	38199	1277922	7493	14332	537492	86126	115631	95667	8270	3952353

Table 14: Area by country and 1st level land cover classification - percentages

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	communication networks, stora	Water and waste treatment	Total
AT	37,3	0,2	0,3	0,1	0,1	0,3	47,5	0,1	0,1	6,8	1,9	2,7	2,6	0,1	100,0
BE	52,9	0,4	1,6	0,2	0,0	0,2	20,1	0,6	0,2	4,3	2,3	11,6	5,4	0,2	100,0
CZ	50,8	0,2	2,1	0,0	0,1	0,8	34,4	0,3	0,2	4,5	1,1	2,5	2,4	0,5	100,0
DE	52,1	0,5	1,2	0,1	0,1	0,5	30,2	0,4	0,6	3,5	2,0	4,6	4,1	0,2	100,0
DK	64,9	0,8	0,8	0,2	0,0	0,7	13,2	0,2	0,1	6,0	4,3	5,6	3,0	0,1	100,0
EE	27,5	0,0	0,0	0,1	0,3	0,6	52,8	0,0	1,2	9,7	5,0	1,4	1,2	0,0	100,0
EL	38,7	0,2	0,2	0,1	0,4	0,6	27,8	0,1	0,2	27,5	0,6	1,4	2,0	0,2	100,0
ES	54,6	0,1	0,3	0,1	0,1	0,2	17,5	0,1	0,3	22,5	0,4	1,3	1,9	0,6	100,0
FI	7,6	0,0	0,3	0,0	0,1	3,4	62,9	0,0	0,5	16,9	5,4	1,1	1,6	0,0	100,0
FR	54,4	0,3	0,7	0,1	0,1	0,4	26,7	0,1	0,2	7,7	1,4	4,7	3,1	0,1	100,0
HU	62,9	0,1	0,3	0,1	0,1	0,6	22,7	0,3	0,3	5,0	1,4	3,6	1,9	0,5	100,0
IE	73,0	0,0	0,3	0,1	0,0	0,5	9,3	0,0	3,8	6,3	2,1	2,6	1,8	0,0	100,0
IT	50,5	0,5	0,4	0,2	0,2	0,4	19,6	0,4	0,3	19,7	1,1	3,6	3,1	0,1	100,0
LT	53,6	0,1	0,1	0,0	0,1	0,9	35,3	0,2	0,2	3,8	2,0	2,0	1,7	0,1	100,0
LU	52,8	0,9	0,0	0,0	0,0	0,0	34,4	0,0	0,0	2,1	1,9	2,4	4,8	0,7	100,0
LV	32,7	0,1	0,1	0,0	0,1	1,6	51,2	0,1	0,7	9,0	1,6	1,3	1,4	0,1	100,0
NL	58,9	0,6	1,3	0,2	0,0	0,8	5,0	0,8	0,1	7,4	6,7	7,5	10,5	0,2	100,0
PL	53,6	0,2	0,5	0,1	0,0	0,8	30,0	0,2	0,2	8,2	1,3	2,8	1,9	0,1	100,0
PT	38,3	0,2	0,2	0,2	0,1	0,2	39,1	0,1	0,3	15,6	0,5	2,4	2,6	0,2	100,0
SE	8,5	0,0	0,2	0,0	0,5	2,3	56,6	0,1	0,1	25,0	4,1	1,1	1,3	0,0	100,0
SI	29,1	0,1	0,1	0,3	0,0	0,1	56,9	0,2	0,1	7,1	1,8	2,1	2,0	0,1	100,0
SK	42,6	0,1	1,3	0,1	0,2	0,5	42,6	0,2	0,2	7,3	1,2	2,1	1,5	0,2	100,0
UK	66,0	0,5	1,4	0,1	0,1	0,7	9,8	0,3	0,5	9,6	3,4	4,9	2,2	0,5	100,0
EU	43,8	0,2	0,6	0,1	0,2	1,0	32,3	0,2	0,4	13,6	2,2	2,9	2,4	0,2	100,0

Quality controls and data editing

The monitoring and control of the 2009 survey was split into three phases:

- Follow-up missions in 10 countries to check the technical and administrative capacities of the contractors and verify the field work;
- A double-blind survey on a limited number of points in each country to verify the field observation.
- Control in ESTAT premises: (a) automatic control of logical errors (like LC-LU combination not possible, wrong location; (b) manual point-by-point control by comparison of crop and landscape photos with LC/LU information.

Quality assurance has been a crucial component during all the phases of the survey. In this respect the following actions⁷ have been put in place:

- Different actors/level of controls;
- Standardization and computerization of the main phases of the data management;
- Continuous monitoring of the work;
- Various training steps;
- Independent data quality check carried out by different contractor other than the field work ones.

External data quality check during the survey

A data quality check was performed by an external company on around 36% 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 are presented in table 15.

Table 15: Rate of checked points by country.

Country	Total points in sample	Checked points	Control Rate (%)
FR	19946	12113	60.7
AT	4969	2128	42.8
BE	1808	644	35.6
CZ	4674	3307	70.8
DE	21157	10799	51.0
DK	2554	1628	63.7
EE	2680	848	31.6
ES	29917	10860	36.3
FI	32417	8269	25.5
GR	7819	2838	36.3
HU	5513	1650	29.9
IE	4165	922	22.1
IT	17851	6302	35.3
LT	3827	1768	46.2
LU	152	152	100.0
LV	3864	1175	30.4
NL	2461	974	39.6
PL	18530	5543	29.9
PT	5426	2099	38.7
SE	26665	5580	20.9
SI	1201	615	51.2

⁷Details have been presented in doc. CPSA/LCU/3 in October 2009.

Country	Total points in sample	Checked points	Control Rate (%)
SK	2895	1229	42.5
UK	14508	2888	19.9
EU	234999	84331	35.9

Both automatic and manual controls were applied.

The main manual controls are:

- LUCAS instructions and rules compliance;
- Formal errors checking;
- Obvious content errors checking;
- 2009 data versus 2006 data comparison (where available);
- Transect checking;
- GPS tracks checking to verify whether surveyors actually reached the correct location of the points;
- Photos quality checking.

Points affected by serious mistakes were returned back to the field work contractors for revision or repetition of the field work (in case of impossibility to correct the points in the office).

All those points were then checked for a second time and either refused again or accepted. Table 16 and Table 17 outline the result of the quality check by country and provide an indication of the quality of the data in terms of measurement errors.

Table 16: Results of the quality check by country⁸.

Country	Total	Accepted	Uncorrectable	Refused in first control step	Still refused after second control step	Rate of rejected points in the first control round (%)
FR	12155	11336		777	42	6.40
AT	2131	2057	10	61	3	2.90
BE	647	621		23	3	3.60
CZ	3327	3177	3	127	20	3.80
DE	10822	10371	95	333	23	3.10
DK	1633	1534	19	75	5	4.60
EE	852	823		25	4	2.90
ES	10870	10341		519	10	4.80
FI	8282	7943	9	317	13	3.80
GR	2841	2735		103	3	3.60
HU	1651	1593	3	54	1	3.30
IE	924	854		68	2	7.40
IT	6338	5935		367	36	5.80
LT	1768	1760		8		0.50
LU	153	143		9	1	5.90
LV	1177	1119		56	2	4.80
NL	983	864	1	109	9	11.20
PL	5546	5446		97	3	1.70
PT	2109	1878		221	10	10.50
SE	5583	5461		119	3	2.10
SI	616	599		16	1	2.60

⁸ The total in this table includes 246 points twice. Those are the points rejected a first time and still considered mistaken after the second check. Therefore the total number of points in this table is 84,577 instead of 84,331.

Country	Total	Accepted	Uncorrectable	Refused in first control step	Still refused after second control step	Rate of rejected points in the first control round (%)
SK	1229	1214		15		1.20
UK	2940	2567		321	52	11.10
EU	84577	80371	140	3820	246	4.50

Table 17: Main issues highlighted by the quality check.

Issue	Percentage
Observation	15.0%
Land Use / Land Cover	22.7%
Irrigation	0.3%
Transect	44.0%
Photos	18.0%
Total (out of the mistaken points)	100%

The main conclusions of the external quality check (summarized in Table 16 and Table 17 above) were that:

- the overall quality of the data is very good since only 4.5% of the points were returned back to the field work contractors after the first round;
- the main sources of error were the mistaken application of instructions in the transect and the wrong attribution of land cover and land use;
- photos were not always taken in a proper way.

As stated by both field work and quality check contractors in their final reports, the good quality of the data depended largely on:

- the good quality of the training;
- the controlled data entry;
- the data flow guaranteed by the tool provided by Eurostat to the contractors to manage the various stages of the data collection process (Data Management Tool - DMT). The DMT 2009 release included a lot of pre-checks on the data (as much as possible illogic data entries were not allowed by the DMT).

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 and the corrections performed 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 checking points were followed by a set of corrections applied to different types of errors. In particular, 24% of the checked points were corrected for positional errors and 51% for classification errors, among them 5% were corrected for both type of errors. Positional errors were mainly attributed to the use of different orthophotos in 2009 and 2012.

For both 2009 and 2012 the main corrections on the classifications regards the following land cover classes:

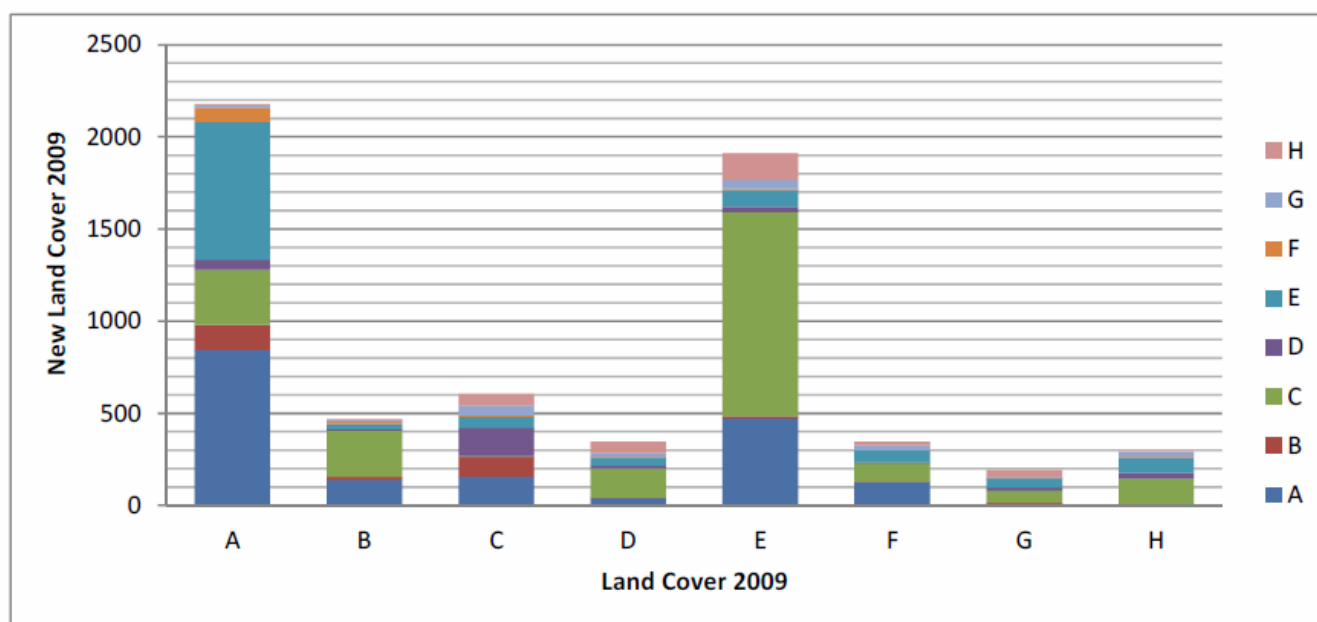
- artificial land;
- woodland;
- grassland;
- shrubland.

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

Classification errors	Point position errors								Total N° of points	N° of points with classification errors		
	Shift				Other point position errors							
	National cartography more reliable than Google	One orthophoto has a very bad resolution	Only the orthophotos in 2012 shows the objects	Equal quality of orthophotos select 2012	Wrong field position compared to orthophotos	The point evaluated from less distance is more reliable	Other	No point position difference				
Class definition changed between campaign				1	1				135	137	6.461	51%
Application of class definition changed between campaign									2	2		
Class definition are not applied correctly	46	25	7	85	71	2	3	4.113	4.352			
Border rule not applied correctly	33	27		128	70			989	1.247			
Linear rule not applied correctly	13	4	2	55	48			463	585			
Use of wrong window size		1			1			8	10			
Other	3			1	3			121	128			
No classification errors	397	256	38	849	797	16	9	3.905	6.263			
Total N° of points	492	313	47	1119	991	18	12	9.733	12.728			
N° of points with point position errors	2.992											
	24%											

Graph 5: Classification correction performed on land cover in 2009.



Eurostat Quality Control

As a further step of quality assurance, an additional quality check was conducted by Eurostat on a sample drawn up with a specific methodology aimed at selecting the points with the highest probability of being mistaken. For this reason the rate of rejection is not meaningful at this stage.

Eurostat sample included both the points already checked by the external company and those delivered directly by subcontractors with a total sampling rate of 1% (i.e. 2335 points out of the 234,561 total points).

The main source of rejection at Eurostat level came from remote observation (> 100 m) and Photo Interpretation (PI) in the field, due to questionable difficulties to reach the point.

These amounts of field PI points might be linked to an attempt of earning time and increasing the number of points per day by walking the smallest distance possible.

The potential impact of field PI or remote observation can be:

- low for LC/LU in homogenous landscape (e.g.: grass fields in Ireland, forests in Finland), but higher in mixed landscape;
- significant for transect since linear elements can be missed or misinterpreted from distance;
- relevant for the landscape photos since they do not necessary provide a picture of the landscape in the point.

Accuracy and reliability

Stratification and photointerpretation

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 2009 in land cover and on the other side the difference between the ground observation (land cover variable) and the photointerpretation (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 75,6%. In relative term, the bare land (with an “agreement” equal to 15%) is the most unstable typology followed by artificial land (61%) and grassland (64%).

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 0,6576 (with a 95% confidence interval 0.6552 - 0.6599) 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)							Total
	Arable land	Permanent crops	Grassland	Wooded areas and shrubland	Bare land	Artificial land	Water	
Arable land	45069	1428	12544	2370	1226	1031	223	63891
Permanent crops	377	6067	459	501	78	108	6	7596
Grassland	4266	507	24448	5942	684	1049	1294	38190
Wooded areas and shrubland	1276	794	7710	88558	1285	1318	2844	103785
Bare land	95	68	548	1332	586	260	1072	3961
Artificial land	366	157	2009	1154	136	6337	96	10255
Water	17	0	103	458	39	23	6227	6867
Total	51466	9021	47821	100315	4034	10126	11762	234545

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 un-weighted one: the percentage of agreement in classifications assumes the value 75,8%. And also in this case, the bare land (with an “agreement” equal to 22%) is the most unstable typology followed by artificial land (62%) and grassland (64%).

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

Strata	Land cover reclassified							Total
	Arable land	Permanen t crops	Grassland	Wooded areas and shrubland	Bare land	Artificial land	Water	
Arable land	177482	5578,28	50427,8	9320,16	4336,34	4088,59	878897	252112
Permanent crops	1406,69	22440,5	1726,55	1928,16	282437	405618	23006	28213
Grassland	17665,8	2011,31	105302	27080	3211,91	4389,08	5471,88	165132
Wooded areas and shrubland	5206,27	3230,35	32758,4	388706	6076,87	5407,81	12065,5	453451
Bare land	353965	220382	3054,13	7246,81	4664,67	1000,22	4657,82	21198
Artificial land	1461,15	649789	8027,04	4080,28	518625	24923,6	354514	40015
Water	665871	0	465392	1927,77	164458	102697	26829,1	29556
Total	203642	34130,6	201761	440289	19255,3	40317,6	50280,7	989677

The information on land cover can be collected not only by one variable, the principal, but also by a secondary land cover; the first is mostly used in production of estimates. 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 introduce 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 93% of the total. 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 35% of the total of points double classified) and “bareland” (30%) and principal “woodland” with secondary grassland (about 17%) and “shrubland” (8%)

Table 22: Distribution of principal and secondary land cover

Principal land cover	Secondary land cover						
	Artificial land	Cropland	Woodland	Shrubland	Grassland	Bare land	Total
Artificial land	0	26	0	0	0	0	26
Cropland	1	655	1	92	4118	3487	8354
Woodland	1	78	0	958	2003	172	3212
Shrubland	0	10	0	0	0	0	10
Grassland	0	26	0	0	0	0	26
Bare land	0	0	0	0	0	0	0
Water areas	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0
Total	2	795	1	1050	6121	3659	11628

In the 11628 cases of double classification, 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 concerning the two combinations of modalities (“25% - 50 %” and “50% - 75%” or “50% - 75%” and “50%

- 75%”) 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 2 crops present on the point.

Table 23: Percentage of principal and secondary land cover

Principal land cover	Secondary land cover						Total
	<5%	5%-10%	10% -25%	25% - 50 %	50% - 75%	N.R.	
<5%	55	36	53	114	418	4	680
5% -10%	59	128	175	608	1277	12	2259
10% - 25%	44	115	811	1413	1534	34	3951
25% - 50%	56	282	781	826	1362	25	3332
50% - 75%	139	309	160	249	624	104	1585
Total	353	870	1980	3210	5215	179	11807

Measurement accuracy

For the directly observed points⁹, 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.

The average distance is about 35 meters while the median is 2 meters; the lowest values (below 10 meters) are the distances in Latvia, Czech Republic, Slovenia and Portugal while the biggest one is reported for United Kingdom (about 130 meters) followed by Finland (about 79 meters) and Ireland (about 51 meters).

United Kingdom (10 meters), Ireland and Netherlands (8 meters), Italy (5 meters) show the highest medians while the remaining countries have the parameter lower than 3 meters.

The percentage of points with a distance over 100 meters is lowest in Sweden (6 %), Estonia (13%) and Spain (14%); the highest values are reported for Slovenia (42%) and Netherlands (41%)-

Table 24: Distance of observation of the points by country

Country	Distance (meters)				Total	Average	Median	% of points with distance >100
	0 -3	3-50	50 - 100	>100				
Austria	2613	1068	167	111	3959	15,9	2	27,0
Belgium	710	360	81	65	1216	19,9	2	29,6
Czech Republic	3417	877	111	101	4506	9,8	2	19,5
Germany	11701	4469	970	1257	18397	26,9	2	24,3
Denmark	1150	550	163	242	2105	34,3	3	26,1
Estonia	1269	212	48	98	1627	19,4	1	13,0
Greece	3137	1100	306	505	5048	43,8	2	21,8
Spain	17375	3296	775	1559	23005	29,6	1	14,3
Finland	7836	2548	523	1371	12278	79,3	2	20,8
France	16830	6779	1209	1196	26014	21,4	2	26,1
Hungary	3227	1005	153	307	4692	27,0	2	21,4
Ireland	889	945	215	418	2467	50,9	8	38,3
Italy	5368	4701	948	1148	12165	41,3	5	38,6
Lithuania	2382	452	52	74	2960	10,4	1	15,3
Luxembourg	90	47	9	2	148	11,6	2	31,8
Latvia	2199	472	55	49	2775	8,1	1	17,0
Netherlands	739	851	214	266	2070	40,5	8	41,1

⁹ The totals of Table 24 do not coincide with the corresponding totals (column “observed” of Table 9) because for some points the distance is missing.

Country	Distance (meters)				Total	Average	Median	% of points with distance >100
	0 - 3	3-50	50 - 100	>100				
Poland	11449	2698	712	1060	15919	26,6	1	16,9
Portugal	3391	716	154	82	4343	9,5	1	16,5
Sweden	13694	1036	337	989	16056	24,8	0	6,5
Slovenia	591	458	22	17	1088	9,2	3	42,1
Slovak Republic	1840	409	36	90	2375	16,6	1	17,2
United Kingdom	3324	2746	784	2207	9061	129,6	10	30,3
EU	115221	37795	8044	13214	174274	35,3	2	21,7

The relationships between distance of observation and land cover classification is reported in Table 25; the highest values for average distance and percentage of points observed from a distance more than 100 meters, are related to “water areas”, “wetland” and “shrubland” while only for water areas the median is an outlier in comparison with the other classification modalities.

Table 25: Distance of observation by land cover

Land cover	Distance (meters)				Total	Average	Median	% of points with distance >100
	0 - 3	3-50	50 - 100	>100				
Artificial land	4240	4126	337	182	8885	15,2	4	2,0
Cropland	37623	11100	3653	4885	57261	27,8	2	8,5
Woodland	37200	11594	1303	1896	51993	18,3	2	3,6
Shrubland	4410	1795	395	1057	7657	84,4	2	13,8
Grassland	28780	7352	1581	2279	39992	24,3	1	5,7
Bare land	2023	351	53	126	2553	26,6	1	4,9
Water areas	177	1107	573	2517	4374	380,9	145	57,5
Wetland	768	370	149	272	1559	72,4	4	17,4
Total	115221	37795	8044	13214	174274	35,3	2	7,6

Graph 6 describes the type of observation in each country; this parameter is split into 4 categories:

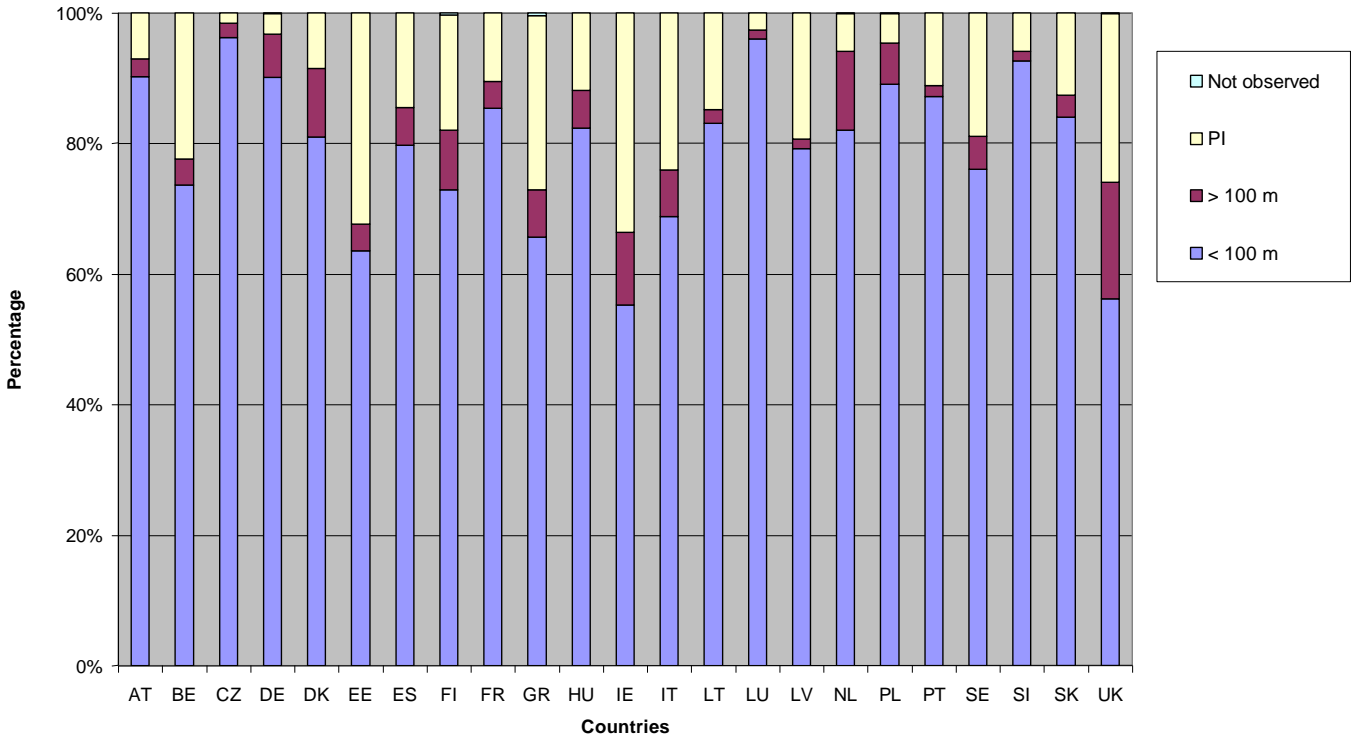
- Field survey, point visible, distance 0-100 m;
- Field survey, point visible, distance >100 m;
- Photo-interpretation, point not visible;
- Point not observed.

The chart point out that between 56% (IE) and 96% (CZ) of the points in all countries were surveyed from a distance less than 100m. In total in the 23 countries 79% of the points in all countries were surveyed from a distance less than 100m. This figure can be read as an indicator of the measurement accuracy too, since points were surveyed from very close distance. In most of the countries less than 10 % of the points were observed from a distance more than 100m. The percentage of points observed by photo interpretation is around 14%. Most of the points which were not reachable are not visible as they are located in woodlands area where the view is limited due to the density of forests.

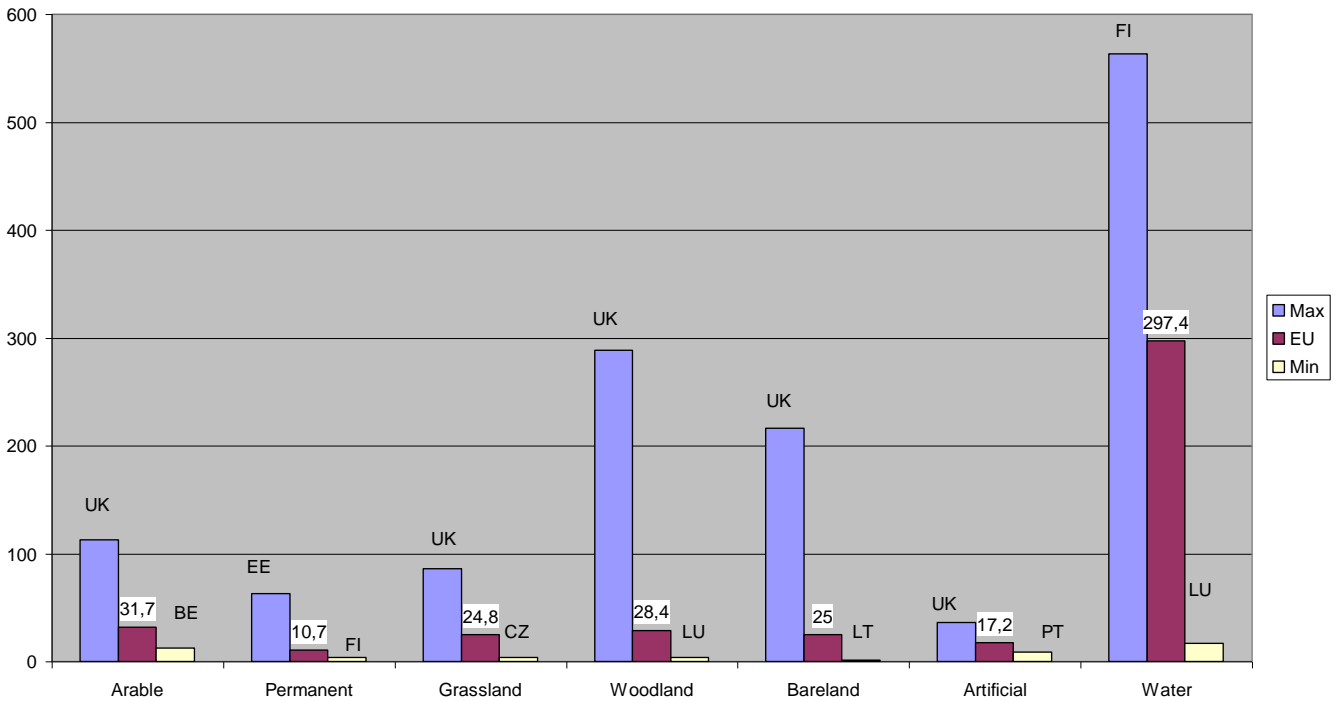
More detailed analysis of the observation distance is offered by Graph 7, where the average distance to the point is compared with minimum and maximum in the main land cover classes; excluding water and wetlands where the average distance to the point is 297m, in all the other land cover the distance (calculated with GPS tracks) is less than 32 meters, pointing out a level of good measurement accuracy.

Quality Report

Graph 6: Type of observation by country.



Graph 7: European average distance to the point (in meters) compared with minimum and maximum by main land cover classes.



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 $1, \dots, G$ different values of the *Grouping variables* (in the example $1, \dots, G$ different Nuts0);
- To have $1, \dots, n$ records, and for each of these it is known its weight: w_i
- To have $x^1, \dots, x^j, \dots, x^J$ different values of the variable of interest (in the example $x^1, \dots, x^j, \dots, x^J$ 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): $1, \dots, h, \dots, 7$ (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 $k \in x^1, \dots, x^j, \dots, x^J$ 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).

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:

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

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

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

In the following Table 26, the coefficient of variations (in percentage) for all the typologies of land cover are reported while in Table 27 the same indicators for the categories of land use are given.

Table 26: Coefficient of variations (%) by countries and land cover modalities

	Land cover							
	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland
Austria	6,25	9,02	2,37	2,32	8,94	7,47	26,86	1,18
Belgium	4,79	22,77	3,00	2,83	25,46	14,38	34,24	2,82
Czech Republic	5,24	17,69	1,42	2,50	17,84	8,22	30,10	1,25
Germany	2,27	8,58	0,78	1,14	7,73	4,12	9,09	0,69
Denmark	6,62	19,25	1,79	3,63	15,01	13,07	18,66	3,71
Estonia	12,59	22,02	4,55	3,40	12,43	4,41	8,04	1,30
Greece	5,45	7,29	1,57	2,79	1,88	7,57	15,11	1,61
Spain	2,54	2,46	0,63	1,29	1,29	4,71	15,34	0,83
Finland	4,88	6,59	1,81	3,61	2,83	1,36	2,91	0,44
France	1,88	4,83	0,62	0,78	2,60	3,36	12,59	0,59
Hungary	6,10	18,90	1,04	2,35	9,34	6,44	11,56	1,83
Ireland	6,77	17,10	6,10	1,03	6,02	5,63	5,95	3,67
Italy	2,24	5,96	0,82	1,54	2,84	4,76	15,89	0,84
Lithuania	8,53	20,48	2,45	2,06	13,08	7,03	22,95	1,43
Luxembourg	17,67	71,90		8,96	97,02			7,12
Latvia	10,87	17,22	3,89	2,32	8,19	7,82	9,18	1,14
Netherlands	4,20	19,41	2,94	2,18	14,38	5,24	20,19	4,08
Poland	4,01	9,85	0,82	1,19	7,40	3,99	10,78	0,79
Portugal	5,13	6,66	2,47	3,00	2,78	9,18	21,11	1,60
Sweden	4,74	3,59	2,27	2,54	1,97	1,25	2,44	0,42
Slovenia	16,40	17,16	8,45	5,60	17,24	35,91	53,48	2,18
Slovak Republic	9,07	31,23	2,04	3,24	9,74	12,29	57,32	1,32
United Kingdom	2,65	6,82	1,28	0,85	2,38	4,33	5,50	1,82

Table 27: Coefficient of variations (%) by countries and land use

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment
AT	1,47	33,99	23,15	32,83	48,58	26,92	1,14	51,72	90,49	5,31	8,72	7,09	8,42	49,44
BE	1,62	37,01	18,59	53,13	.	58,60	3,56	31,23	49,54	11,06	15,04	6,16	8,83	49,72
CZ	0,96	35,10	9,99	67,70	58,28	14,07	1,42	25,21	29,33	6,68	13,77	8,75	8,64	19,08
DE	0,49	9,86	6,19	21,73	18,29	9,47	0,73	11,11	8,34	3,58	4,68	2,86	3,26	16,20
DK	1,22	22,02	21,73	40,15	96,53	24,14	4,26	43,62	70,05	7,80	9,16	7,43	10,90	61,60
EE	2,15	.	100,00	70,71	37,77	24,10	1,36	100,00	17,51	5,84	6,02	15,86	16,17	.
EL	1,23	26,60	25,88	34,84	18,68	12,72	1,67	32,12	24,18	1,83	15,46	9,33	7,56	25,49
ES	0,45	23,02	10,63	15,32	16,70	12,08	1,23	16,17	11,87	1,06	9,11	4,83	3,89	6,13
FI	1,67	29,42	13,67	60,35	19,89	3,38	0,48	27,63	11,25	1,60	2,53	6,30	5,03	53,27
FR	0,36	10,68	6,81	17,34	19,17	7,91	0,72	16,16	13,79	1,88	4,64	2,40	2,86	15,63
HU	0,75	57,68	24,10	40,74	49,71	16,38	1,85	23,36	24,40	5,76	10,12	6,40	9,13	18,48
IE	0,84	70,30	30,12	43,93	73,79	23,89	4,40	70,69	7,56	5,75	10,66	9,16	11,07	70,26
IT	0,57	10,40	12,31	16,82	21,47	11,18	1,37	11,53	19,20	1,47	7,56	3,61	3,95	25,58
LT	1,00	49,48	45,17	100,00	58,18	17,94	1,45	37,23	44,59	8,19	11,10	10,71	11,94	58,18
LU	.	84,37	7,07	.	.	55,59	.	49,96	31,67	97,02
LV	1,63	70,36	49,88	.	45,41	11,16	1,11	57,16	17,89	4,90	11,71	13,63	13,26	41,29
NL	1,28	25,16	17,82	44,87	.	24,89	8,10	22,98	62,59	7,05	7,61	6,81	5,66	43,97
PL	0,54	15,60	9,95	28,85	38,17	7,32	0,84	18,42	14,59	2,44	6,05	4,13	5,23	21,31
PT	1,45	30,18	27,67	29,39	37,15	32,16	1,52	37,81	26,39	3,08	19,59	8,28	7,99	35,54
SE	1,59	28,45	12,99	57,69	8,40	3,68	0,48	18,27	17,62	1,03	2,79	5,78	5,14	46,99
SI	4,34	103,95	110,85	51,18	.	110,85	2,38	57,00	72,83	10,07	20,87	19,27	19,85	107,92
SK	1,41	58,11	16,34	72,12	44,12	21,83	1,52	43,35	46,09	6,56	17,23	12,02	14,00	41,67
UK	0,52	11,67	7,03	26,93	30,06	11,07	2,35	14,79	12,92	2,51	4,55	3,36	5,38	13,84
EU	0,18	4,26	2,69	6,52	5,12	1,92	0,25	4,63	3,45	0,51	1,31	1,11	1,24	4,48

In order to evaluate the efficiency of the sample design for the estimates of land cover, in Table 28 and Table 29, the ratios between the above coefficients of variation and the same indicators calculated under the hypothesis of simple random sample (SRS) are reported. A values 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.

For the variable land cover (Table 28), generally, the gain or the loss due to the stratification are moderate; only few indicators show a significant values.

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

	Land cover							
	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland
Austria	0,92	0,68	1,01	0,99	0,73	0,91	0,92	0,97
Belgium	0,99	1,00	1,00	1,00	1,00	1,01	0,83	1,00
Czech Republic	1,00	1,01	1,00	1,00	1,01	1,00	1,00	1,00
Germany	1,00	0,99	1,00	1,00	1,00	1,00	1,00	1,00
Denmark	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Estonia	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Greece	1,01	0,92	1,01	0,98	0,99	1,00	1,01	1,01
Spain	1,00	1,00	1,00	1,02	1,00	0,99	1,08	0,98
Finland	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
France	1,01	0,83	1,00	1,00	0,99	0,99	1,19	0,99
Hungary	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Ireland	0,99	0,99	1,00	1,00	1,00	1,00	1,00	1,00
Italy	1,00	0,94	1,00	0,96	0,98	1,05	0,97	0,97
Lithuania	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Luxembourg	0,96	1,02		0,99	0,97			0,99
Latvia	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Netherlands	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Poland	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Portugal	1,01	0,99	1,00	1,00	0,98	1,00	1,01	1,01
Sweden	1,00	0,87	1,00	1,00	0,96	1,00	1,04	1,02
Slovenia	1,04	0,38	0,92	1,03	1,05	1,03	1,06	0,95
Slovak Republic	1,01	1,04	1,00	1,00	1,03	1,02	0,99	0,98
United Kingdom	0,99	1,01	1,00	1,00	1,01	1,00	1,00	0,99

For the variable land use (Table 29), the data are a bit different; a higher number of indicators not equal to 1 are found but the gains or losses seem more related to the country than to the variables.

Table 29: Efficiency indicator of sample design by country – land use

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment
AT	1,02	0,72	1,05	0,94	1,13	1,21	0,96	1,07	2,18	0,62	0,86	1,03	0,93	1,21
BE	1,00	0,99	1,00	0,94		1,00	1,00	1,00	1,00	0,97	1,00	1,00	1,00	1,00
CZ	1,00	1,00	0,99	1,01	1,02	1,05	1,00	0,99	1,04	1,00	1,01	1,00	1,01	0,93
DE	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,01	1,00	1,00	1,00	1,00	1,01
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		1,41	1,87	1,57	17,73	0,01	5,71	3,00	0,97	0,38	0,98		
EL	1,01	0,87	1,06	1,08	0,87	1,01	1,01	1,02	0,99	0,97	0,98	1,01	1,02	0,98
ES	1,01	1,02	1,08	1,04	0,92	1,00	0,99	1,00	0,97	0,97	1,03	1,02	0,99	1,00
FI	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
FR	0,99	1,01	1,01	1,02	1,09	1,03	0,98	1,06	1,24	1,00	1,00	1,03	1,02	1,05
HU	1,00	1,00	1,00	1,00	1,01	1,00	1,00	1,00	1,01	1,00	1,00	1,00	1,00	1,00
IE	1,00	1,00	1,00	1,00	1,01	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
IT	0,99	1,04	1,09	1,10	0,88	1,12	1,02	1,04	1,17	0,89	1,03	1,05	1,02	1,15
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		0,84					0,98					0,89	1,07	0,97
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
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	0,99	1,00	1,00	1,00	1,00	1,00	1,00	1,01	1,00	1,00	1,00	1,00	1,00
PT	1,00	1,00	1,01	1,02	0,90	1,02	1,01	1,01	1,01	0,98	1,01	1,02	1,01	1,02
SE	1,00	1,00	1,01	1,00	1,01	1,00	1,02	1,00	1,03	0,97	1,00	1,00	1,00	1,00
SI	0,97	1,05	1,11	1,05		1,11	0,95	1,02	1,03	0,77	0,99	1,02	1,04	1,06
SK	1,00	1,00	0,98	1,02	0,99	1,03	1,01	1,07	1,13	0,98	0,99	1,02	1,01	1,03
UK	1,00	0,99	1,00	1,00	1,00	0,99	0,99	0,99	0,99	1,01	1,00	0,99	1,00	1,00
EU	1,00	1,01	1,01	1,04	0,99	1,01	1,00	1,01	1,05	0,98	1,00	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 30):

- 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, spatial planning and resource management, as carried out by the Copernicus earth observation programme

Table 30: 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 application¹⁰ and, in general, the information available is potentially useful different contexts, such as the following.

¹⁰ 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 ortho-photos 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.

- 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%.

Comparability

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

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 a 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 2009 LUCAS survey was enriched by the acquisition of additional information compared to the survey of 2006 (the pilot survey), the main are reported in the following table 31.

Table 31: Main features of the LUCAS survey 2006 and 2009.

Item	2006	2009
Reference population	EU 11	EU 23
Sampling unit	Point	Point
Sampling scheme	Two-phase design with stratification	Two-phase design with stratification
Sample size (No. of photointerpreted points)	958,325	989,951
Sample size (No. of points surveyed)	169,343	234,545
Number of MSs involved	11	23
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 management information and transect data.
Information collected walking a transect	No	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.

Comparison LUCAS 2006 - LUCAS 2009

The LUCAS 2009 nomenclature is not fundamentally different from the 2006/2007 survey documents. Some minor details have however been changed, always ensuring the comparability with the 2006 exercise. Main changes are the following:

- Elimination of inconsistencies and clarifying some definitions which resulted ambiguous in the 2006/2007 survey exercises;
- New LC (B55, Hxx classes) and LU (U150) classes have been introduced; others (U114) have been deleted or changed (C1x and C2x were replaced by C10, C20 and C30 and their subclasses, if needed);
- Additional parameters have been included: "Area size", "Percentage of LC" and "Land management", "height of trees" (in case of woodland, grassland with tree cover, shrubland with tree cover always with area size larger than 0.5ha) and "width of features" (in case of woodland with area size larger than 0.5ha and height of trees above 5m, shrubland or grassland with tree cover, area size larger than 0.5ha and height of trees above 5m). These parameters allowed the simplification of LC classes definitions;
- The compatibility with FAO forest classification¹¹(see Reg (EC) No 2152/2003 of 17/11/2003 concerning monitoring of forests and environmental interactions in the Community - Forest Focus) has been strengthened by a simplification of the woodland classes definition. At the same time, forest types have been introduced for forestry areas, in line with the EUNIS classification on forests (<http://eunis.eea.europa.eu/about.jsp>), thus receiving more information on forest biotopes than the hitherto used woodland characterization;
- Introduction of further, secondary LC classes, for the subclasses of cropland:
 - B19: Other cereals
 - B23: Other root crops
 - B37: other non permanent industrial crops
 - B43: Other fresh vegetables
 - B53: other leguminous and mixtures for fodder
 - B75: other fruit trees and berries
 - B77: other citrus fruit

¹¹ According to the Regulation the following definitions apply: 'Forest' means land with tree crown cover of more than 10% and area of more than 0,5ha. The trees should be able to reach a minimum height of 5 am at maturity in situ; 'other wooded land' means land either with a tree crown cover of 5 to 10% of trees able to reach a height of 5 m at maturity in situ, or a crown cover of more than 10% of trees not able to reach a height of 5 m at maturity in situ and shrub or bush cover.

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.

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Addendum to 2009 QUALITY REPORT

Introduction

In order to optimize the comparability of LUCAS 2009 and 2012 results at aggregated level (Statistical tables), Eurostat did some improvements in 2012 LUCAS survey and moreover launched a study on relevant issues that lead to change the 2009 survey data. Some of these changes are also reported in 2009 Quality Report that essentially concerns the collected data. In this addendum two important topics, that were only mentioned or not included in 2009 Quality Report, are reported: the impact of new classifications for land cover and land use (adopted for 2012 survey but extended also to 2009 data) and the procedure of “projection” of points between 2009 and 2012 surveys.

Recoding of land cover and land use in 2009 data

In 2012 both classifications for land cover and land use were improved, with the introduction of harmonised criteria of coverage (10%) and further clarification. The main changes concerning Land Cover which impact the final estimates relate to the introduction of a more restrictive definition of bareland (from a coverage of 50% to 90%) and the exclusion of mire and swamp forests from land cover peatbogs and the contextual assignment of points to woodland, if the tree canopy covers more than 10%. In comparison with 2009, this explains mostly the decrease of bareland, due to the more restrictive definition and the swap from Wetland to Wooded areas. As far as land use is concerned, 2 classes were suppressed Hunting and natural reserve as they represent more a “status” rather than a real use; the suppression caused a redistribution of the areas of the different uses and impacted the comparison with previous year.

In aligning to the new classifications the 2009 data, replacing the original codes with the new ones, the relationships between the land cover, land use and the other variables had to be taken into account. A specific procedure was set up; it uses different methods to impute the new codes depending on different situations. The simplest one is the deterministic imputation by which the original code is simply replaced by the new one (it is the case, for example, of “wet forest” recoded as “wooded area”). For the points in which, in 2009, land use is equal to “hunting”, “nature reserve” and “unused and abandoned areas” (code that were dropped in the 2012 classification) the procedure uses the information collected over the same point in 2012 if the land cover remain unchanged. For the points in 2009 data that changed the land cover in 2012 or not surveyed in 2012 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 the cross distribution of land cover and land use of the points present both in 2009 and 2012 and belonging to the subset of points whose land use must be changed. In the 2009 data set the new recoded variables are added and the original ones are preserved.

In Table 1 is reported the results of the recoding activity. The recoding of land cover concerns a few amount of points, 206, while the land use codes changed in 39033 cases. Only 32 points were changed in both the variables.

Table 32: Land cover and land use recoding

Land cover	Land use		Total
	not changed	changed	
not changed	195338	39001	234339
changed	174	32	206
Totale	195512	39033	234545

In Table 2 the changes in land cover and land use by country are reported; in the same table are also given the related percentages of changes over the total collected points. In average the percentage of changes in land use is over 16%; the highest percentages are those of Sweden (about 31%), Greece (about 30%) and Spain (about 25%) while the lowest are reported for Luxemburg and Austria (about 4%). The percentages of land cover are negligible for all the countries.

Table 33: Land cover and land use recoding by country

Country	Land use changed	Land cover changed	Total collected points	Percentages	
	(1)	(2)		(1)/(3)	(2)/(3)
AT	198	4	4959	3,99	0,08
BE	130	6	1804	7,21	0,33
CZ	288	1	4663	6,18	0,02
DE	1251	18	21118	5,92	0,09
DK	218	1	2541	8,58	0,04
EE	354	0	2666	13,28	0,00
EL	2359	4	7762	30,39	0,05
ES	7435	27	29912	24,86	0,09
FI	3920	15	19896	19,70	0,08
FR	3856	26	32329	11,93	0,08
HU	419	10	5513	7,60	0,18
IE	314	0	4164	7,54	0,00
IT	3313	9	17849	18,56	0,05
LT	231	0	3861	5,98	0,00
LU	6	0	152	3,95	0,00
LV	539	0	3825	14,09	0,00
NL	309	25	2401	12,87	1,04
PL	2359	23	18502	12,75	0,12
PT	1008	2	5428	18,57	0,04
SE	8204	19	26657	30,78	0,07
SI	144	0	1203	11,97	0,00
SK	318	0	2898	10,97	0,00
UK	1860	16	14442	12,88	0,11
EU	39033	206	234545	16,64	0,09

In Table 3 the transitions between the old codes and the new ones for land cover are given; great part of the transitions (174 cases) are concentrated in the passage from B43 to B23.

Table 34: Land cover changes by code

Old codes	New codes								Total
	B23	B43	H11	H12	C10	C21	C22	C32	
B23	180								180
B43	174	533							707
H11			932		1		1		934
H12				2990	2	3	18	7	3020
total	354	533	932	2990	3	3	19	7	4841

Legend	
B23	B23 Other root crops
B43	B43 Other fresh vegetables
H11	H11 Inland marshes
H12	H12 Peatbogs
C10	C10 Broadleaved forest
C21	C21 Spruce dominated coniferous forest
C22	C22 Pine dominated coniferous forest
C32	C32 Pine dominated mixed forest

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In Table 4 the transitions from old codes and new ones for the variable “land use” are reported; in the row “total” all the codes after the recoding (changed and not changed) are given and in the last row the percentages of changes over these totals. The codes U410 and U420 are new ones and so the percentages are equals to 100%; they derive for the great part from the old U400. Other codes present high percentage of changes: the new codes U130 and U361 derives from the old U364 and U400 in about 30% of the cases. For the other codes the passages are low or in terms of percentages or in terms of absolute value.

Table 35: Land use changes by code

Land use old codes	Land use new codes													
	U111	U112	U120	U130	U140	U210	U221	U223	U225	U226	U227	U311	U312	U313
U150	518	75	792	4	2	2	0	0	0	0	0	1	4	0
U364	572	46	1472	413	41	14	0	0	0	0	0	0	5	24
U400	967	231	2587	282	25	17	1	3	1	6	1	19	85	20
total	98782	7212	73747	2290	848	371	52	78	65	133	64	285	4547	496
%	2,1	4,9	6,6	30,5	8,0	8,9	1,9	3,8	1,5	4,5	1,6	7,0	2,1	8,9
	Land use new codes													
	U314	U317	U318	U321	U322	U330	U340	U350	U361	U362	U363	U370	U410	U420
U150	0	2	0	0	0	0	0	3	15	8	0	2	77	1786
U364	0	1	5	15	0	1	2	27	728	30	9	19	422	7008
U400	3	16	9	17	5	16	12	33	520	31	3	132	2129	17717
total	150	354	125	370	115	249	550	1371	4225	673	171	7241	2628	26511
%	2,0	5,4	11,2	8,6	4,3	6,8	2,5	4,6	29,9	10,3	7,0	2,1	100,0	100,0

Legend			
2009		2012	
U150	Hunting	U311	Railways
U364	Nature reserves	U312	Roads
U400	Unused area	U313	Water transport
		U314	Air transport
		U317	Storage
U111	Agriculture (excluding fallow land and kitchen garden)	U318	Protection infrastructure
U112	Fallow land	U321	Water supply and treatment
U120	Forestry	U322	Waste treatment
U130	Fishing	U330	Construction
U140	Mining, quarrying	U340	Commerce, finance, business
U210	Energy production	U350	Community services
U210	Energy production	U361	Amenities, museums, leisure
U221	Manufacturing of food, beverages and tobacco products	U362	Sport
U223	Coal, oil and metal processing	U363	Holiday camps
U225	Chemical and allied products	U370	Residential
U226	Machinery and equipment	U410	Abandoned
U227	Wood based products	U420	Unused

The impact of the projection procedure

First estimates of survey 2012 showed some incongruences and some bias were identified: a number of actions was implemented in order to increase the comparability of the two data sets, including a projection procedure aiming at aligning the sample selection of the 2009 and 2012 surveys (as different rules were followed). To deal with this problem, after the survey taking in 2012, it was studied the solution to impute, into the 2009 sample, the units randomly collected in 2012 but not present in 2009, hypothesizing a sort of “enlargement” of the longitudinal structure. 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 2012 data not present in 2009, obtaining the estimated status of that point in 2009. 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 2009 variable depending on “2012 land cover”, “country”, “land use” and “altitude”. The independent variables were selected from a wider set of variables after some trials. All the operations were done on the 2012 data set “cleaned” of countries not present in 2012 (in 2009 participated to the survey 23 countries against 27 in 2012).

The model can be write

- $LC^{t^1} = f(LC^{t^0}, LU^{t^0}, Elevation, Country)$, where t^1 represents the “imputation” year, in this case 2009;
- t^0 represents the “base” year, in this case 2012;
- LC^{t^1} land cover estimated for “imputation” year;
- f identifies a linear logistic function;
- $LC^{t^0}, LU^{t^0}, Elevation, Country$ 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 301 mt. 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 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 2009. The modality with the highest probability, or, in other words, the most probably *land cover* for the 2009, is chosen. Then, each point to be projected in the current year, stands 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 adopted 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 5 reports the results of the imputation strategy; it contains the number of records that remained unchanged (in the principal diagonal) and those that were imputed with the most similar. More than 63000 points were imputed and 945 of them (1,5%) were changed with the above described methodology; the great part of changes is due to the transition from bareland to cropland.

Table 36: Points from 2012 projected in 2009

		To 2009								Total
		Artificial land	Cropland	Woodland	Shrub land	Grass land	Bare land	Water areas	Wetland	
From 2012	Artificial land	2521	0	0	0	0	0	0	0	2521
	Cropland	0	10564	0	0	0	0	0	0	10564
	Woodland	0	0	30615	0	0	0	0	0	30615
	Shrub	0	0	165	4995	17	0	0	0	5177
	Grassland	0	0	0	0	10180	2	0	0	10182
	Bare land	0	690	29	0	41	348	0	0	1108
	Water	0	0	0	0	0	0	2245	0	2245
	Wetland	0	0	0	0	0	0	1	946	947
	Total	2521	11254	30809	4995	10238	350	2246	946	63359

In Table 6 the number of imputed, original and the ratio between imputed and original points by country is given. In average, the imputed points were the 27% of the original ones but there is a great variability among the countries; the ratios range from about 59% for Belgium and 51% for Portugal to about 7% for Ireland and Latvia.

Table 37: Projected points from 2012 in 2009, original points and their ratios

Country	Imputed points	Original points	Ratio imputed/original
AT	2329	4959	47,0
BE	1063	1804	58,9
CZ	978	4663	21,0
DE	6191	21118	29,3
DK	1241	2541	48,8
EE	306	2666	11,5
EL	2020	7762	26,0
ES	10361	29912	34,6
FI	3014	19896	15,1
FR	10666	32329	33,0
HU	105	5513	1,9
IE	298	4164	7,2
IT	6394	17849	35,8
LT	756	3861	19,6
LU	66	152	43,4
LV	1370	3825	35,8
NL	179	2401	7,5
PL	5458	18502	29,5
PT	2790	5428	51,4
SE	5584	26657	20,9
SI	488	1203	40,6
SK	138	2898	4,8
UK	1564	14442	10,8
EU	63359	234545	27,0

The impact on Land Cover

Putting together the imputed and original points in a “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 7 the estimated land cover area for the participating countries in 2009 is reported and in Table 8 the corresponding percentages are given.

Table 38: Land cover areas (km²) by countries - projected data

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
AT	4062	1517	13893	21465	1784	1537	235	39433	83927
BE	3570	218	8483	10227	211	405	64	7490	30668
CZ	3357	461	27679	16068	589	1067	166	29484	78871
DE	25355	1789	118556	83392	2791	6322	1832	117730	357766
DK	2959	365	20935	9485	709	689	439	7483	43065
EE	770	359	5212	9113	1188	2329	2239	24162	45372
EL	4409	3099	30463	18376	32703	1892	734	40016	131692
ES	17324	19792	151490	76929	82313	4482	688	145523	498542
FI	5287	3838	20446	11662	18314	33794	19787	224707	337836
FR	28139	5375	166047	149520	21496	7637	1082	169759	549055
HU	3042	457	44241	19387	1876	1830	1235	20946	93013
IE	2669	486	3536	44879	4116	1897	4202	8161	69947
IT	20696	5856	96082	51817	20753	7492	682	97255	300633
LT	1557	393	15922	21094	885	1810	518	22721	64899
LU	251	36	515	941	13	19	0	823	2596
LV	1049	460	8207	16802	1856	2097	1494	32622	64587
NL	4318	391	8840	14251	632	2162	320	4605	35518
PL	9851	1397	111174	75240	3150	5752	1454	103906	311925
PT	4741	3183	16752	13831	15588	1350	289	33109	88843
SE	6998	12417	19999	24172	37057	40556	23970	284555	449722
SI	637	363	2046	4311	554	158	62	12145	20277
SK	1217	176	13887	9353	1673	530	51	22139	49026
UK	14562	3563	49022	104550	23168	5652	6281	37772	244572
EU	166819	65993	953428	806866	273419	131458	67823	1486545	3952351

Table 39: Land cover areas (percentages) by countries - projected data

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
AT	4,84	1,81	16,55	25,58	2,13	1,83	0,28	46,98	100,00
BE	11,64	0,71	27,66	33,35	0,69	1,32	0,21	24,42	100,00
CZ	4,26	0,59	35,09	20,37	0,75	1,35	0,21	37,38	100,00
DE	7,09	0,50	33,14	23,31	0,78	1,77	0,51	32,91	100,00
DK	6,87	0,85	48,61	22,03	1,65	1,60	1,02	17,38	100,00
EE	1,70	0,79	11,49	20,08	2,62	5,13	4,93	53,25	100,00
EL	3,35	2,35	23,13	13,95	24,83	1,44	0,56	30,39	100,00
ES	3,48	3,97	30,39	15,43	16,51	0,90	0,14	29,19	100,00
FI	1,57	1,14	6,05	3,45	5,42	10,00	5,86	66,51	100,00
FR	5,13	0,98	30,24	27,23	3,92	1,39	0,20	30,92	100,00
HU	3,27	0,49	47,56	20,84	2,02	1,97	1,33	22,52	100,00
IE	3,82	0,70	5,06	64,16	5,88	2,71	6,01	11,67	100,00
IT	6,88	1,95	31,96	17,24	6,90	2,49	0,23	32,35	100,00
LT	2,40	0,61	24,53	32,50	1,36	2,79	0,80	35,01	100,00
LU	9,65	1,37	19,83	36,23	0,49	0,72	0,00	31,70	100,00
LV	1,62	0,71	12,71	26,02	2,87	3,25	2,31	50,51	100,00
NL	12,16	1,10	24,89	40,12	1,78	6,09	0,90	12,97	100,00
PL	3,16	0,45	35,64	24,12	1,01	1,84	0,47	33,31	100,00
PT	5,34	3,58	18,86	15,57	17,55	1,52	0,33	37,27	100,00
SE	1,56	2,76	4,45	5,38	8,24	9,02	5,33	63,27	100,00
SI	3,14	1,79	10,09	21,26	2,73	0,78	0,31	59,90	100,00
SK	2,48	0,36	28,33	19,08	3,41	1,08	0,10	45,16	100,00
UK	5,95	1,46	20,04	42,75	9,47	2,31	2,57	15,44	100,00
EU	4,22	1,67	24,12	20,41	6,92	3,33	1,72	37,61	100,00

In order to evaluate the impact of the “projection” methodology over the original data, in Table 9 are reported the same percentages calculated for the 2009 original data.

Table 40: Estimated land cover areas (percentages) by countries - original data

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland	Total
AT	4,00	3,57	16,02	25,21	2,58	1,65	0,28	46,69	100
BE	10,87	1,06	26,96	33,53	0,84	1,29	0,43	25,02	100
CZ	4,23	0,66	35,33	20,34	0,67	1,32	0,24	37,22	100
DE	6,85	0,59	32,93	23,14	0,79	1,80	0,56	33,34	100
DK	6,48	0,91	48,37	22,26	1,71	1,57	1,15	17,54	100
EE	1,57	0,78	11,55	20,04	2,35	5,21	5,26	53,24	100
EL	3,38	2,53	22,92	13,92	26,24	1,39	0,60	29,02	100
ES	3,32	5,06	30,11	15,25	17,04	0,95	0,15	28,12	100
FI	1,59	1,25	5,99	3,33	6,40	10,12	5,74	65,58	100
FR	4,94	1,16	30,13	26,71	4,29	1,41	0,20	31,16	100
HU	3,24	0,50	47,51	20,87	2,01	2,00	1,32	22,54	100
IE	3,75	0,77	5,09	63,92	6,04	2,76	6,05	11,62	100
IT	6,63	2,11	31,85	17,73	7,29	1,74	0,25	32,40	100
LT	2,37	0,64	24,24	32,64	1,55	3,09	0,56	34,92	100
LU	8,04	1,26	21,82	33,27	0,69	0,62	-	34,30	100
LV	1,68	0,83	12,14	26,57	3,63	2,88	2,28	49,99	100
NL	11,99	1,08	24,98	40,04	1,85	6,29	0,99	12,77	100
PL	2,95	0,54	36,08	24,65	0,98	1,88	0,46	32,45	100
PT	4,93	3,96	18,59	15,40	18,34	1,40	0,42	36,95	100
SE	1,51	2,86	4,46	5,15	8,78	9,18	5,87	62,19	100
SI	2,92	2,06	9,62	20,45	2,71	0,61	0,28	61,36	100
SK	2,41	0,37	28,34	18,94	3,48	1,09	0,1	45,26	100
UK	5,96	1,51	19,94	43,2	10,02	2,27	2,27	14,83	100
EU	4,09	1,94	24,17	20,49	7,29	3,26	1,73	37,04	100

In Table 10 the percentage ratios between projected and original land cover are given. For the total of the 23 participating countries, the imputation procedure increases the artificial land, water and woodland; the highest increase is about 3.2% for artificial land. It decreases the other typologies of land cover; in particular it has a relevant impact for bareland, where the ratio is about 86% or, in other words, the area is 14% shortened. Of the three most relevant areas cropland and grassland remain substantially unchanged while woodland shows a light increase of 1.5%.

The procedure produces an increase in estimation (ratios greater than 100) in the most of countries for artificial land (19 countries) followed by cropland, grassland and woodland (15 and 14 countries); for water areas the increase equals the decreases (11 countries) while for bareland, shrubland and wetland the number of ratios lower than 100 are the majority (respectively 20, 18 and 14).

Regarding the “intensity” of changes operated by the procedure, it can be pointed out the increases greater than 5% in 8 and 6 countries respectively for artificial land and water areas and the decreases lower than 5% for bareland shrubland and wetland (respectively in 16, 11 and 12 countries).

Table 41: Percentages ratios between projected and original land cover by countries

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland
AT	120,88	50,64	103,31	101,45	82,42	111,01	101,60	100,63
BE	107,06	67,20	102,61	99,47	81,37	102,40	48,67	97,60
CZ	100,51	88,00	99,35	100,17	111,79	102,69	89,23	100,45
DE	103,45	84,07	100,63	100,72	99,15	98,37	91,11	98,71
DK	106,03	93,15	100,50	98,95	96,19	101,97	88,34	99,06
EE	108,49	101,32	99,44	100,22	111,46	98,57	93,74	100,02
EL	99,05	93,00	100,92	100,24	94,64	103,38	92,83	104,71
ES	104,67	78,46	100,92	101,19	96,90	94,63	92,00	103,81
FI	98,43	90,88	101,04	103,66	84,70	98,84	102,04	101,42
FR	103,74	84,40	100,37	101,95	91,26	98,65	98,50	99,22
HU	100,96	98,20	100,11	99,87	100,35	98,35	100,61	99,91
IE	101,76	90,26	99,33	100,38	97,42	98,26	99,31	100,41
IT	103,83	92,32	100,35	97,21	94,69	143,22	90,80	99,85
LT	101,22	94,53	101,21	99,58	87,94	90,26	142,50	100,26
LU	120,02	108,73	90,89	108,90	71,45	116,45	0,00	92,42
LV	96,67	85,90	104,67	97,91	79,15	112,74	101,45	101,04
NL	101,38	101,94	99,64	100,21	96,11	96,79	90,91	101,53
PL	107,05	82,96	98,78	97,85	103,06	98,09	101,30	102,65
PT	108,24	90,48	101,43	101,09	95,67	108,50	77,38	100,86
SE	103,05	96,54	99,71	104,37	93,85	98,24	90,80	101,74
SI	107,57	86,99	104,86	103,97	100,81	128,03	109,64	97,61
SK	102,99	97,30	99,95	100,72	98,07	99,17	104,00	99,77
UK	99,90	96,49	100,52	98,95	94,54	101,81	113,13	104,14
Total	103,20	86,07	99,81	99,63	94,90	102,03	99,19	101,54

In Table 11 the percent coefficients of variations (CVs) of the projected data are given; in Table 12 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 42: Coefficient of variations (%) for land cover estimates by country – projected data

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland
AT	4,89	16,35	2,08	2,04	8,45	6,51	23,41	1,11
BE	4,21	22,69	2,54	2,40	22,23	12,53	36,06	2,48
CZ	4,88	16,86	1,35	2,31	15,28	7,74	28,86	1,18
DE	2,03	8,17	0,73	1,03	6,83	3,73	8,30	0,64
DK	5,62	16,46	1,52	3,03	11,99	11,25	15,70	3,10
EE	11,57	20,39	4,52	3,31	11,09	4,43	7,88	1,25
EL	4,99	6,56	1,49	2,47	1,69	6,67	13,69	1,36
ES	2,24	2,44	0,58	1,11	1,10	4,19	13,31	0,68
FI	4,60	6,28	1,74	3,30	2,83	1,31	2,61	0,40
FR	1,69	4,80	0,57	0,69	2,30	3,06	11,15	0,53
HU	6,01	18,85	1,03	2,33	9,15	6,33	11,33	1,81
IE	6,54	17,00	6,05	1,00	5,85	5,51	5,80	3,48
IT	1,98	5,41	0,75	1,36	2,40	3,90	14,14	0,73
LT	8,21	19,21	2,35	1,98	12,28	6,72	16,04	1,35
LU	15,68	58,40	11,15	7,43	97,41	49,48	0,00	7,35
LV	9,98	15,89	3,44	2,13	7,91	6,09	7,58	1,02
NL	4,11	18,50	2,91	2,13	13,97	5,19	20,53	3,93
PL	3,51	9,69	0,76	1,09	6,42	3,66	9,41	0,69
PT	4,22	5,67	2,09	2,48	2,32	7,40	18,55	1,31
SE	4,43	3,29	2,22	2,33	1,85	1,20	2,32	0,38
SI	13,26	14,93	6,97	4,62	14,47	26,55	42,39	1,90
SK	8,90	30,73	2,03	3,20	9,55	12,07	57,32	1,30
UK	2,57	6,38	1,27	0,82	2,27	3,96	4,66	1,61
EU								

Table 43: Land cover – percentage ratios (projected/original) of coefficients of variations (%) by country

	Artificial land	Bare land	Cropland	Grassland	Shrubland	Water areas	Wetland	Woodland
AT	78,25	181,25	87,66	88,14	94,52	87,13	87,15	93,82
BE	87,79	99,65	84,65	84,81	87,32	87,13	105,32	87,94
CZ	93,12	95,32	95,28	92,59	85,63	94,10	95,87	94,45
DE	89,61	95,23	92,97	90,39	88,39	90,52	91,28	93,32
DK	84,97	85,52	85,12	83,41	79,86	86,08	84,15	83,63
EE	91,89	92,58	99,26	97,36	89,23	100,36	98,07	96,37
EL	91,59	90,04	95,17	88,45	89,77	88,16	90,63	84,34
ES	88,06	99,00	92,11	86,42	85,09	89,00	86,74	82,00
FI	94,25	95,34	96,28	91,40	100,00	96,39	89,66	90,93
FR	89,99	99,39	92,47	88,69	88,56	91,04	88,59	89,22
HU	98,50	99,74	99,50	99,29	97,98	98,22	98,02	99,09
IE	96,67	99,43	99,19	97,25	97,13	97,83	97,45	94,73
IT	88,41	90,79	91,55	88,60	84,52	82,02	88,97	86,51
LT	96,26	93,79	96,02	95,92	93,90	95,60	69,88	94,29
LU	88,71	81,23		82,89	100,41			103,25
LV	91,79	92,30	88,52	92,00	96,59	77,84	82,62	89,13
NL	97,88	95,31	99,05	97,54	97,17	99,05	101,70	96,38
PL	87,51	98,33	92,27	91,98	86,73	91,63	87,26	86,73
PT	82,26	85,10	84,45	82,65	83,42	80,57	87,85	81,97
SE	93,52	91,68	97,63	91,80	93,79	95,87	95,20	89,31
SI	80,87	86,98	82,50	82,52	83,92	73,93	79,26	87,36
SK	98,15	98,39	99,55	98,73	98,09	98,22	100,00	98,41
UK	96,91	93,52	99,10	96,56	95,18	91,48	84,70	88,43
EU	89,36	96,41	86,67	86,49	90,42	94,65	89,95	87,19

The impact on Land Use

In Table 13 the estimated land use area for the participating countries in 2009 is reported and in Table 14 the corresponding percentages are given.

Table 44: Land use areas (km²) by countries - projected data

Country	Land use areas (Km ²)														
	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment	Total
AT	31933	159	246	105	169	250	40263	113	255	4313	1215	2599	2251	57	83928
BE	16142	161	403	68	11	91	6051	161	61	1295	624	3870	1676	53	30668
CZ	40018	159	1460	20	41	653	27312	333	198	3529	932	2093	1769	353	78870
DE	186940	1811	4473	326	591	1525	105413	1403	1975	13231	7202	16737	15356	788	357766
DK	27618	345	406	71	21	263	5175	132	37	2938	1780	2794	1424	60	43065
EE	12477	0	31	32	140	500	24038	29	617	4260	1987	738	524	0	45372
EL	50726	204	288	155	416	722	33941	154	349	39123	731	1803	2799	281	131692
ES	259882	378	1565	727	768	902	89707	623	1396	121518	2353	6521	9377	2822	498537
FI	26153	139	916	44	568	12369	214812	142	1683	54075	17585	4007	5298	48	337839
FR	298514	1428	3514	544	604	2394	142767	752	1027	44732	7132	27118	17888	648	549061
HU	58598	60	311	100	65	566	21099	299	265	4653	1293	3429	1809	467	93013
IE	51113	48	171	80	26	398	6220	34	2622	4644	1399	1847	1248	96	69946
IT	150239	1407	1080	800	857	1233	65788	1083	800	52701	3500	11623	9257	268	300633
LT	34786	66	71	17	41	861	22773	114	131	2707	950	1248	1064	70	64899
LU	1352	19	19	0	0	5	839	0	0	61	42	93	154	13	2596
LV	21000	38	55	0	90	1088	32861	45	413	5810	1179	982	955	71	64586
NL	20838	227	448	67	0	114	1740	258	47	2754	2400	2724	3804	97	35518
PL	163944	646	1900	190	128	2271	95890	558	727	25391	4018	9642	6251	371	311928
PT	35525	220	250	203	157	116	32705	134	220	13912	360	2153	2762	126	88843
SE	38392	198	1084	50	2294	11985	260720	499	585	103026	19522	5073	6188	103	449718
SI	6016	10	57	54	24	43	11285	33	44	1306	451	460	463	31	20277
SK	20867	50	601	32	92	249	20998	95	102	3470	555	1056	763	96	49026
UK	158863	1186	3378	217	251	1817	25729	770	1169	24829	8105	11962	5449	851	244574
EU	1711935	8958	22724	3903	7354	40413	1288123	7764	14723	534279	85313	120570	98529	7769	3952353

Table 45: Land use areas (percentages) by countries - projected data

Country	Land use areas (percentages)														Total
	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, storage	Water and waste treatment	
AT	38,05	0,19	0,29	0,13	0,20	0,30	47,97	0,14	0,30	5,14	1,45	3,10	2,68	0,07	100,00
BE	52,64	0,53	1,31	0,22	0,04	0,30	19,73	0,52	0,20	4,22	2,04	12,62	5,47	0,17	100,00
CZ	50,74	0,20	1,85	0,03	0,05	0,83	34,63	0,42	0,25	4,48	1,18	2,65	2,24	0,45	100,00
DE	52,25	0,51	1,25	0,09	0,17	0,43	29,46	0,39	0,55	3,70	2,01	4,68	4,29	0,22	100,00
DK	64,13	0,80	0,94	0,17	0,05	0,61	12,02	0,31	0,09	6,82	4,13	6,49	3,31	0,14	100,00
EE	27,50	0,00	0,07	0,07	0,31	1,10	52,98	0,07	1,36	9,39	4,38	1,63	1,15	0,00	100,00
EL	38,52	0,16	0,22	0,12	0,32	0,55	25,77	0,12	0,27	29,71	0,56	1,37	2,13	0,21	100,00
ES	52,13	0,08	0,31	0,15	0,15	0,18	17,99	0,13	0,28	24,38	0,47	1,31	1,88	0,57	100,00
FI	7,74	0,04	0,27	0,01	0,17	3,66	63,58	0,04	0,50	16,01	5,21	1,19	1,57	0,01	100,00
FR	54,37	0,26	0,64	0,10	0,11	0,44	26,00	0,14	0,19	8,15	1,30	4,94	3,26	0,12	100,00
HU	63,00	0,06	0,33	0,11	0,07	0,61	22,68	0,32	0,29	5,00	1,39	3,69	1,95	0,50	100,00
IE	73,08	0,07	0,25	0,12	0,04	0,57	8,89	0,05	3,75	6,64	2,00	2,64	1,79	0,14	100,00
IT	49,97	0,47	0,36	0,27	0,29	0,41	21,88	0,36	0,27	17,53	1,16	3,87	3,08	0,09	100,00
LT	53,60	0,10	0,11	0,03	0,06	1,33	35,09	0,18	0,20	4,17	1,46	1,92	1,64	0,11	100,00
LU	52,08	0,71	0,71	0,00	0,00	0,21	32,30	0,00	0,00	2,36	1,62	3,59	5,93	0,49	100,00
LV	32,52	0,06	0,09	0,00	0,14	1,68	50,88	0,07	0,64	9,00	1,83	1,52	1,48	0,11	100,00
NL	58,67	0,64	1,26	0,19	0,00	0,32	4,90	0,73	0,13	7,75	6,76	7,67	10,71	0,27	100,00
PL	52,56	0,21	0,61	0,06	0,04	0,73	30,74	0,18	0,23	8,14	1,29	3,09	2,00	0,12	100,00
PT	39,99	0,25	0,28	0,23	0,18	0,13	36,81	0,15	0,25	15,66	0,41	2,42	3,11	0,14	100,00
SE	8,54	0,04	0,24	0,01	0,51	2,67	57,97	0,11	0,13	22,91	4,34	1,13	1,38	0,02	100,00
SI	29,67	0,05	0,28	0,27	0,12	0,21	55,65	0,16	0,22	6,44	2,22	2,27	2,28	0,16	100,00
SK	42,56	0,10	1,23	0,07	0,19	0,51	42,83	0,19	0,21	7,08	1,13	2,15	1,56	0,20	100,00
UK	64,96	0,49	1,38	0,09	0,10	0,74	10,52	0,32	0,48	10,15	3,31	4,89	2,23	0,35	100,00
EU	43,31	0,23	0,57	0,10	0,19	1,02	32,59	0,20	0,37	13,52	2,16	3,05	2,49	0,20	100,00

In order to evaluate the impact of the “projection” methodology over the original data, in Table 15 are reported the same percentages calculated for the 2009 original data.

Table 46: Land use areas (percentages) by countries - original data

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment	Total
AT	37,3	0,2	0,3	0,1	0,1	0,3	47,5	0,1	0,1	6,8	1,9	2,7	2,6	0,1	100,0
BE	52,9	0,4	1,6	0,2	0,0	0,2	20,1	0,6	0,2	4,3	2,3	11,6	5,4	0,2	100,0
CZ	50,8	0,2	2,1	0,0	0,1	0,8	34,4	0,3	0,2	4,5	1,1	2,5	2,4	0,5	100,0
DE	52,1	0,5	1,2	0,1	0,1	0,5	30,2	0,4	0,6	3,5	2,0	4,6	4,1	0,2	100,0
DK	64,9	0,8	0,8	0,2	0,0	0,7	13,2	0,2	0,1	6,0	4,3	5,6	3,0	0,1	100,0
EE	27,5	0,0	0,0	0,1	0,3	0,6	52,8	0,0	1,2	9,7	5,0	1,4	1,2	0,0	100,0
EL	38,7	0,2	0,2	0,1	0,4	0,6	27,8	0,1	0,2	27,5	0,6	1,4	2,0	0,2	100,0
ES	54,6	0,1	0,3	0,1	0,1	0,2	17,5	0,1	0,3	22,5	0,4	1,3	1,9	0,6	100,0
FI	7,6	0,0	0,3	0,0	0,1	3,4	62,9	0,0	0,5	16,9	5,4	1,1	1,6	0,0	100,0
FR	54,4	0,3	0,7	0,1	0,1	0,4	26,7	0,1	0,2	7,7	1,4	4,7	3,1	0,1	100,0
HU	62,9	0,1	0,3	0,1	0,1	0,6	22,7	0,3	0,3	5,0	1,4	3,6	1,9	0,5	100,0
IE	73,0	0,0	0,3	0,1	0,0	0,5	9,3	0,0	3,8	6,3	2,1	2,6	1,8	0,0	100,0
IT	50,5	0,5	0,4	0,2	0,2	0,4	19,6	0,4	0,3	19,7	1,1	3,6	3,1	0,1	100,0
LT	53,6	0,1	0,1	0,0	0,1	0,9	35,3	0,2	0,2	3,8	2,0	2,0	1,7	0,1	100,0
LU	52,8	0,9	0,0	0,0	0,0	0,0	34,4	0,0	0,0	2,1	1,9	2,4	4,8	0,7	100,0
LV	32,7	0,1	0,1	0,0	0,1	1,6	51,2	0,1	0,7	9,0	1,6	1,3	1,4	0,1	100,0
NL	58,9	0,6	1,3	0,2	0,0	0,8	5,0	0,8	0,1	7,4	6,7	7,5	10,5	0,2	100,0
PL	53,6	0,2	0,5	0,1	0,0	0,8	30,0	0,2	0,2	8,2	1,3	2,8	1,9	0,1	100,0
PT	38,3	0,2	0,2	0,2	0,1	0,2	39,1	0,1	0,3	15,6	0,5	2,4	2,6	0,2	100,0
SE	8,5	0,0	0,2	0,0	0,5	2,3	56,6	0,1	0,1	25,0	4,1	1,1	1,3	0,0	100,0
SI	29,1	0,1	0,1	0,3	0,0	0,1	56,9	0,2	0,1	7,1	1,8	2,1	2,0	0,1	100,0
SK	42,6	0,1	1,3	0,1	0,2	0,5	42,6	0,2	0,2	7,3	1,2	2,1	1,5	0,2	100,0
UK	66,0	0,5	1,4	0,1	0,1	0,7	9,8	0,3	0,5	9,6	3,4	4,9	2,2	0,5	100,0
EU	43,8	0,2	0,6	0,1	0,2	1,0	32,3	0,2	0,4	13,6	2,2	2,9	2,4	0,2	100,0

In Table 16 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 “commerce, financial and business”, “energy production”, “fishing”, “industry”, “mining” and “forestry”; in particular the area of “energy production” is enlarged for about 15 % but it is related to not relevant amount. The procedure decreases the areas of the remaining types of land use where the higher decrease, about 1%, is related to “agriculture”. The bigger areas remain substantially unchanged; the increase or decrease for “forestry”, “agriculture”. are not relevant (percentages lower than 1,1%).

Generally, the procedure produces for the most of countries, a number of decreases greater than increases ; for “energy production” and mining the increase equals the decreases (10 countries) while for the remaining typologies the number of ratios lower than 100 are the majority (it varies from 14 to 20).

Regarding the “intensity” of changes operated by the procedure, it can be pointed out that increases greater than 5% are present in almost all the land use typologies even if their number ranges from 1 to 10;

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the number of countries that show decreases lower than 5% ranges from 2 to 6; all the decrease/increase for “agriculture” are lower than 5%.

Table 47: Percentages ratios between projected and original land use by countries

Country	Agriculture	Commerce, finance, business	Community services	Construction	Energy production	Fishing	Forestry	Industry and manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment
AT	102,0	123,5	99,0	100,0	236,5	103,5	101,0	217,7	217,1	75,2	76,8	116,6	103,6	98,6
BE	99,4	131,5	83,5	96,9	.	186,8	98,2	93,9	89,2	99,2	87,5	108,9	100,6	78,6
CZ	99,8	112,9	88,6	51,0	81,3	106,7	100,7	124,1	109,1	99,9	105,5	104,5	93,4	85,5
DE	100,3	106,5	103,4	91,0	117,0	89,1	97,7	103,2	97,7	104,4	100,7	101,9	104,8	122,2
DK	98,8	106,8	116,4	69,6	123,1	89,5	91,3	156,6	106,3	112,8	95,4	114,9	109,4	121,7
EE	99,9	.	183,8	94,6	110,0	176,7	100,4	175,7	114,4	96,5	87,3	113,1	92,6	.
EL	99,4	80,3	107,4	116,8	82,5	91,2	92,8	87,3	111,3	108,1	96,2	96,9	108,6	94,2
ES	95,6	131,0	101,6	103,5	124,2	73,0	102,8	99,2	102,2	108,5	109,3	102,9	99,9	92,5
FI	101,3	100,0	101,5	100,0	128,2	107,5	101,1	100,0	106,9	94,8	95,6	103,2	97,9	87,5
FR	99,9	97,7	97,4	95,2	129,4	99,8	97,3	116,1	109,4	106,4	93,9	104,2	104,7	92,9
HU	100,1	118,5	107,7	99,1	94,6	103,1	99,7	98,2	94,4	99,6	95,9	101,2	100,2	95,4
IE	100,1	140,8	94,2	95,0	90,2	124,0	95,9	100,0	97,6	105,2	95,3	102,3	97,4	279,6
IT	98,9	99,6	91,6	112,2	182,7	95,6	111,9	96,0	100,8	88,8	110,8	106,0	100,5	84,8
LT	100,1	98,1	79,0	100,0	64,9	145,2	99,5	96,7	120,2	109,4	73,9	97,6	97,4	111,3
LU	98,6	79,4	,	,	.	.	93,8	.	.	113,3	83,8	152,7	123,1	71,8
LV	99,4	105,4	77,3	.	125,0	107,8	99,4	83,3	98,2	99,7	111,5	113,9	108,3	85,3
NL	99,6	99,4	100,4	91,7	.	39,1	98,3	89,6	100,0	105,1	101,3	102,7	101,7	127,1
PL	98,0	94,5	112,4	93,8	110,8	92,0	102,6	114,0	95,9	99,0	99,2	108,5	105,7	100,0
PT	104,3	122,2	118,6	106,5	126,4	68,9	94,2	118,0	90,8	100,4	83,3	102,9	120,4	91,6
SE	100,4	97,8	109,0	100,0	97,0	115,8	102,4	100,9	103,2	91,5	106,7	104,9	102,3	135,3
SI	101,8	70,8	404,3	91,4	.	308,7	97,8	72,2	146,9	91,0	123,0	109,3	112,7	231,3
SK	99,9	100,0	95,9	100,0	106,8	94,2	100,5	100,0	115,6	97,4	98,2	104,2	101,6	100,5
UK	98,4	99,8	98,1	88,1	119,8	103,5	107,1	98,4	101,5	105,5	97,6	99,8	100,9	73,1
EU	98,9	102,6	100,3	99,5	114,8	104,9	100,8	103,5	101,5	99,5	99,1	104,2	103,1	93,9

In Table 17 the percent coefficients of variations (CVs) of the projected data are given.

Table 48: 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 manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stores	Water and waste treatment
AT	1,38	25,82	20,23	32,48	25,55	21,40	1,04	30,05	44,94	7,01	8,96	5,84	6,89	42,83
BE	1,43	26,93	16,44	38,92	106,27	32,47	2,98	27,08	35,48	8,69	12,73	4,81	7,41	44,11
CZ	0,91	29,65	9,61	82,36	57,17	11,91	1,32	20,34	24,01	6,06	12,09	7,72	8,16	18,38
DE	0,45	8,68	5,33	20,81	15,08	8,69	0,68	9,82	7,39	3,07	4,10	2,59	2,85	12,93
DK	1,05	17,93	15,72	40,72	70,65	21,56	3,71	29,51	55,85	5,85	7,47	5,83	8,77	45,05
EE	2,10	70,78	.	70,86	33,36	15,49	1,30	70,69	14,90	5,62	6,50	14,14	16,08	.
EL	1,10	26,43	22,20	29,72	17,71	12,02	1,55	30,67	20,11	1,50	13,66	8,52	6,67	22,36
ES	0,40	18,10	8,96	13,15	12,37	11,72	1,00	14,30	9,89	0,84	7,39	4,19	3,42	5,69
FI	1,59	27,22	12,56	55,48	16,29	3,07	0,44	26,39	9,67	1,52	2,48	5,77	4,77	53,11
FR	0,33	9,78	6,03	15,63	14,65	6,93	0,64	13,45	11,86	1,53	4,16	2,06	2,49	14,34
HU	0,74	51,93	22,92	40,58	48,40	15,15	1,83	23,41	24,35	5,69	10,06	6,29	8,99	18,39
IE	0,81	57,57	30,37	44,15	75,54	16,85	4,29	70,48	7,41	5,27	10,08	8,89	10,79	38,08
IT	0,51	9,38	11,03	13,41	11,81	9,33	1,04	10,64	15,69	1,33	6,11	3,06	3,48	24,02
LT	0,96	49,49	44,80	100,00	57,81	11,67	1,37	37,26	32,92	6,95	11,37	10,38	11,20	44,70
LU	4,37	81,56	81,56	.	.	106,73	7,16	.	.	44,09	46,68	34,99	25,00	97,41
LV	1,52	59,74	50,16	.	33,05	8,72	1,01	57,28	14,84	4,25	9,30	11,35	11,15	39,36
NL	1,27	25,09	17,02	46,26	.	31,85	7,89	23,37	51,11	6,54	6,96	6,57	5,24	38,14
PL	0,50	14,70	8,18	26,77	32,25	6,90	0,72	15,71	13,41	2,18	5,33	3,60	4,58	19,01
PT	1,20	22,46	21,01	23,31	25,60	29,43	1,33	29,05	21,97	2,48	17,32	6,83	6,04	28,44
SE	1,49	28,75	11,50	56,72	7,73	2,97	0,43	17,93	15,92	0,99	2,40	5,34	4,74	35,40
SI	3,64	105,31	45,65	44,72	67,93	51,81	2,08	57,08	50,71	10,08	19,19	15,60	15,76	61,58
SK	1,40	58,11	16,11	72,12	41,06	21,93	1,47	42,74	40,99	6,47	16,83	11,66	13,75	40,06
UK	0,49	11,54	6,69	27,28	24,83	9,14	2,03	14,31	11,16	2,21	4,24	3,24	5,17	13,94
EU	0,15	3,78	2,40	5,71	4,22	1,60	0,21	4,03	3,02	0,45	1,19	0,97	1,09	4,07

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In Table 18 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 49: 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 manufacturing	Mining and quarrying	Not used and abandoned	Recreation, leisure, sports	Residential	Transport, communication networks, stora	Water and waste treatment
AT	93,79	75,98	87,38	98,92	52,59	79,47	91,42	58,09	49,66	132,18	102,72	82,43	81,82	86,64
BE	88,27	72,76	88,43	73,24		55,40	83,72	86,70	71,63	78,58	84,67	78,09	83,88	88,71
CZ	94,68	84,48	96,23	121,64	98,09	84,64	92,94	80,69	81,86	90,66	87,79	88,24	94,41	96,34
DE	91,87	88,06	86,20	95,75	82,43	91,79	93,01	88,40	88,60	85,89	87,47	90,54	87,43	79,79
DK	86,32	81,44	72,32	101,42	73,19	89,34	87,22	67,66	79,72	74,97	81,58	78,42	80,46	73,14
EE	97,95		70,78	100,21	88,34	64,28	95,29	70,69	85,06	96,27	108,09	89,13	99,39	
EL	89,47	99,35	85,78	85,30	94,81	94,48	92,93	95,50	83,17	82,03	88,35	91,28	88,18	87,71
ES	89,51	78,65	84,30	85,88	74,12	97,01	81,57	88,48	83,33	78,95	81,05	86,81	87,95	92,93
FI	95,04	92,51	91,85	91,93	81,90	90,75	90,66	95,52	85,98	94,70	98,18	91,61	94,91	99,70
FR	91,41	91,55	88,52	90,15	76,42	87,57	88,69	83,24	85,98	81,60	89,65	85,79	87,32	91,72
HU	99,20	90,03	95,08	99,61	97,36	92,53	99,24	100,25	99,82	98,75	99,40	98,27	98,40	99,50
IE	96,31	81,90	100,84	100,51	102,37	70,53	97,57	99,71	98,04	91,63	94,55	96,97	97,50	54,19
IT	89,67	90,20	89,59	79,75	54,99	83,45	75,97	92,30	81,71	90,40	80,74	84,82	88,09	93,90
LT	96,30	100,02	99,18	100,00	99,37	65,06	94,47	100,08	73,84	84,94	102,48	96,90	93,82	76,83
LU	100,00	96,66					101,23			79,30	100,00	70,03	78,94	100,41
LV	93,13	84,91	100,57		72,79	78,09	91,31	100,22	82,94	86,78	79,47	83,26	84,11	95,32
NL	98,98	99,73	95,51	103,09		127,98	97,35	101,71	81,66	92,80	91,49	96,55	92,46	86,75
PL	92,63	94,26	82,26	92,80	84,49	94,26	86,16	85,27	91,92	89,19	88,09	87,13	87,60	89,21
PT	82,84	74,40	75,95	79,31	68,92	91,51	87,92	76,85	83,24	80,61	88,42	82,48	75,59	80,03
SE	94,01	101,04	88,53	98,32	91,98	80,73	88,77	98,16	90,32	96,13	86,15	92,54	92,24	75,34
SI	83,72	101,31	41,18	87,37		46,74	87,12	100,14	69,63	100,15	91,92	80,94	79,40	57,06
SK	99,29	100,00	98,59	100,00	93,08	100,48	96,52	98,59	88,94	98,67	97,67	97,03	98,16	96,13
UK	95,37	98,85	95,19	101,30	82,60	82,54	86,35	96,77	86,34	88,09	93,22	96,37	96,17	100,70
EU	87,69	88,90	89,18	87,64	82,35	83,55	85,97	87,18	87,72	88,24	90,76	87,22	87,95	90,82