Regional statistics and
Geographic Information
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eurostat
TechnicalDocuments
2018

LUCAS 2018

(Land Use / Cover Area Frame Survey)

Technical reference document S1
Stratification Guidelines

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DOCUMENT CHANGE RECORD			
ISSUE	DATE	CHANGE AUTHORITY / AUTHOR	REASON FOR CHANGE AND AFFECTED SECTIONS
V0.1	2016/04/25	Eurostat / E4.LUCAS	
V0.2	2016/05/23	Eurostat / E4.LUCAS	Addition of chapter 10 – Weekly Reports

1 Scope and Introduction

This document is part of a series of reference documents defining the framework of the Land Use / Cover Area frame statistical Survey (LUCAS). The LUCAS reference documents are periodically improved and adapted taking into account the experience from the implemented surveys and the requirements of the LUCAS data & information users.

LUCAS is co-ordinated by The Statistical Office of the European Commission (Eurostat).

The Commission uses the micro data collected in the LUCAS survey to produce land cover and land use aggregated statistical tables and to calculate Sustainable Development Indicators and Land take (these indicators are used in monitoring the implementation of the Europe 2020 strategy). Landscape indicators are also derived from the data collected in the survey.

LUCAS micro data is also used for Agro Environmental Indicators (AEI), LULUCF (land use, land use change and forestry) indicators, for Europe Resource Efficiency indicators.

Moreover in the context of the Copernicus programme CORINE Land Cover (CLC) and other Pan-EU land cover mapping initiatives, such as the Copernicus HRL (High Resolution Layers), LUCAS micro data and photos[1] are used for production, verification and validation processes.

More information on land cover/use statistics and on LUCAS in general can be found on the Eurostat website: http://epp.eurostat.ec.europa.eu/portal/page/portal/lucas/introduction.

The update of the LUCAS point's stratification through photointerpretation plays a crucial role in the quality of its outcome, since the LUCAS sampling is based on two-phase sampling with stratification of the master sample of points.

i) First Phase (Base grid): The LUCAS base is obtained by using a 1 Km2 grid (resulting from the INSPIRE recommendations) with a systematic spatial sampling design which includes around 4.400.000 points in the entire European Union territory.

ii) First Phase (Master grid): The LUCAS master is a subset of the base, comprising around N=1.100.000 points (corresponding to a 2 Km2 grid covering the EU-28 territory, also systematically selected). Each of these points is classified into k land cover categories (the strata) on the basis of photointerpretation of aerial photos or satellite images. In 2005 these points in the master were stratified into 7 aggregated strata. In the present update 10 strata and one parameter are foreseen (see Table 3).

iii) Second Phase (Sample): The final field sample is a sub-selection of the master. A sample of n points, out of N, is selected by strata and by NUTS2 and the n points are visited in order to determine the land cover and land use at a more detailed level. The final aim of this strategy is to estimate the coverage of the full list of categories included in the LUCAS land cover and land use classification over the whole study area. In this way, it is possible to combine the information resulting from the photointerpretation with the information collected during the ground inspection of a portion of the N points selected in the first phase.

The final statistical estimates are based on the weights derived both from the master and the field observations collected on the field.

[1] *Point and landscape photos in the four cardinal directions collected during the LUCAS in-situ survey*

Because of the two—stage sampling process, the quality and timeliness of the stratification is very important for the accuracy of the statistical estimates. A revision of the existing LUCAS stratification, done using a recent image coverage of known positional accuracy, that covers also the countries presently missing in the master grid, is a requirement for the improvement of the quality of the sampling for the next LUCAS surveys.

The project consists in the execution of two main tasks:

- Data collection: selection, acquisition and processing of the aerial images necessary to produce the georeferenced *imagettes* ;
- Photointerpretation: points classification by photointerpretation of the *imagettes*.

The document at hand provides detailed instructions for photo interpreters involved in the stratification process.

2 Changes from previous campaign

The following rules, from the stratification campaign of 2005, are not to be followed on the present campaign.

Multiple leap and combined linear elements	In the 2005 campaign it was possible to combine two or more adjacent linear elements, where each individual element is less than 3m wide, but together they constituted a linear element more than 3m wide. The element would be assigned the strata which was most representative of the linear element (e.g. a road and side vegetation). In the present campaign they are to be treated as separate linear elements, and the Look to the North/East rule is to be used accordingly.
Fallow plots	In the 2005 campaign, fallow plots with vegetation were classified as stratum 3 – grass, but fallow plots with little or no vegetation were classified as stratum 1 – arable land. In the present campaign fallow plots with little or no vegetation are to be classified as (6 – bare surface, low or rare vegetation)
Very small elements	In the 2005 campaign small or tiny unrecognisable objects would be assigned double strata, entering first the most probable one based on the context. If the dual codes did not cover all the land cover options, notes had to explain the choices made. In the present campaign, these are treated as linear elements and the Look to the North/East rule is to be used accordingly.
Arable land and permanent crops	Olive trees and orchards were classified under stratum 2 – permanent crops, but in case of disperse trees being present in an arable plot this would be classified as stratum 1 - arable land. This is the same in the present campaign, but the threshold of 10% of trees was included as a means to better quantify "scattered trees". Therefore if less than 10% of trees are present in the extended window of observation

	the point will be classified as stratum 1 – arable land.
Arable land with trees (other than fruit trees)	In the 2005 campaign, areas where more than 10% of trees and arable land co-existed were classified under stratum 1 – arable land. In the present campaign areas with more than 10% of trees (other than those mentioned as permanent crops) are classified under stratum 4 - wooded areas. If arable land and trees co-exist (i.e. they cannot be considered as separate parcels), stratum 1 – arable land is to be used as second stratum.
Grass	In the 2005 campaign annual fodder crops (but not grain fields) were included under stratum 3 – grass. In the present campaign, annual fodder crops are to be classified under stratum 1 – arable land.
Wooded areas	In the 2005 campaign when a point fell on an area of forest trees in excess of 10% (a situation consistent with the definition of stratum 4 – wooded areas and shrubland) on a plot of arable land, stratum 1 – arable land was assigned and *possibly* a second code would indicate the presence of the trees. In the present campaign such points are classified under stratum 4 – wooded areas and a second stratum 1 – arable land is added. In the 2005 campaign, areas of shrubs were included in stratum 4 – wooded areas and shrub land. In the present campaign a separate stratum 5 – shrubs was added. In the present campaign, clarification was added related to inclusion of palm trees and woody hedges under stratum 4 – wooded areas.
Shrubs	In the 2005 campaign when a point fell on an area of forest trees in excess of 10% and shrubs in excess of 20% the point would be classified under 4 – wooded areas and shrub land. In the present campaign a new stratum 5 – shrubs was added to cover for areas of shrubs where trees are not in excess of 10% of the canopy cover.
Grass	For coherence purposes, the limit of maximum of 20% for shrubs in the stratum 3 – grass is changed to 10% in the present campaign.
Bare surface, rare or low vegetation	In the 2005 campaign these were areas that had no dominant vegetation. 50% or more of the land is bare. In the present campaign, for internal coherence (but also for coherence with the LUCAS Survey) the threshold was raised to 90%. In the 2015 campaign forest or farm tracks that are unpaved and not dressed with gravel were to be assigned to bare areas. For coherence with LUCAS survey definitions, in the present campaign areas that can be

	recognized as tracks and parking lots, even when not paved, are to be classified as 7 – Artificial, constructions and sealed areas. In the 2005 campaign the use of the normal window of observation was mentioned, but in the present campaign it is clarified that the homogeneous plot within the extended window of observation is to be used.
Artificial, constructions and sealed areas	While in the 2005 campaign it was recommended to assign a second stratum for wooded areas "in an area of artificial land". In the present campaign, the parameter ASSOC is to be used instead in vegetated, water or bare areas associated to residential, industrial or services areas.
Inland water	In the 2005 campaign, estuaries and lagoons were part of stratum 7 – water areas. Name and code of the stratum are updated to 8 – inland water. For coherence with the NUTS definition and the water framework directives definitions, in the present campaign estuaries and lagoons are to be classified in the new stratum 9 – transitional waters and coastal waters, together with coastal waters.
Transitional waters and coastal waters	This is a new class in the present campaign, that includes estuaries and lagoons, that were previous classified under stratum 7 – water.
PI not possible	This is a new class in the present campaign, to cover for the cases where a point is in deep shadow, an area covered by clouds or in an area where neither imagery nor ancillary information is available. These are to be considered exceptional situations and approval from Eurostat is needed.

3 Equipment

Adequate IT and communication infrastructure is needed. This includes computers for the photo interpreters and controllers, enough disk space for storage of data and imagery, adequate backup system, a GIS tool for processing points, imagery and other geographic information, website and FTP site.

The following items of equipment are needed for the photo interpreters:

- Instructions (Document S1 and Annexes)
- Appropriate computer for data entry allowing for photo interpretation of a point (a LUCAS point) over the available *imagettes*
- Other useful documents (charts, crop calendars etc.)

The ***imagette*** is an extract of a digital image around a LUCAS point, that can be obtained from an **aerial orthophoto** (an orthorectified aerial photograph, which is free from the distortion caused by inclination angle and relief with a scale that normally, varies between 1:10.000 and 1:2.000) or **satellite image.** The

imagette(s) – as more than one may be available for a certain point- will be the base for the photo interpreter to locate the point and to decide to which strata it belongs.

4 Preparatory work

4.1 Image selection and acquisition

4.1.1 Guidelines for selection of imagery

For the imagery, the contractor will use a suitable dataset in what regards spatial, spectral, radiometric and temporal resolution and positional accuracy (see Table 1).

Table 1 – Guidelines for selection of imagery

Spatial resolution	<=1m (a value of up to 2,5m is accepted if no better source is found)
Spectral resolution	Not less than 8 bit.
Temporal resolution	Most recent image available (2012 or more recent); multiple images of the same year may be needed to better discriminate some classes.
Radiometric resolution	Multispectral (true colour or false colour combinations are accepted); Panchromatic is accepted if no better source is found.
Positional accuracy	Average RMSE <= 2,5m; (Average RMSE up to 5m is accepted if no better source is found)
Cloud cover	<5%; a value of up to 10% can be accepted if presence of clouds does not interfere with correct interpretation of the point feature.
Mosaicking	Mosaicking of images is allowed, but mismatches along seam lines must be <3 pixels. Digital number variation on similar area type should not exceed 10% in average (or 4% in between each of the 3 channels).
Compression	Preference shall be given to lossless formats (e.g. TIFF) over visually lossless ones (e.g. JPEG, MrSID).
General Image Quality	Absence of defects which prevent the visual interpretation of the image.

The contractor will have to investigate available sources of imagery in order to acquire them. These sources will include (but are not limited to) national orthophotos available via map service or physical copy. Presently most countries regularly update the ortho images on a 3 year rolling schedule and most of the EU 28 countries allow the free usage of the orthophotos for other public services and for the implementation of public tasks.

To be considered also is the need to have images of different dates or different sensors (namely of greater spatial, temporal or spectral resolution) to help separate classes (e.g. cropland vs. grassland; forest vs. shrub land; wetland) and achieve a greater accuracy.

4.1.2 Use of VHR IMAGE 2015

If it is not possible to find adequate aerial orthophotographic images for a certain point in a given country, the contractor will have the possibility to use the VHR_IMAGE_2015 - Optical VHR multispectral and panchromatic coverage over Europe, available through the Copernicus Space Component Data Access (CSCDA) which is adequate for the purposes of this project since it is recent and collected under

relatively uniform conditions. This is a multispectral coverage with a spatial resolution of less than 1m (PAN) or 2-4 m (MS), which is at the limit for the desired positional precision of the final result. It is possible to obtain the level 3 products (orthorectified) with national projection (national coordinate reference systems) or with European projection (ETRS89-LAEA, EPSG code 3035). Data availability for the phase 2 core datasets including VHR_IMAGE_2015 - Optical VHR multispectral and panchromatic coverage over Europe can be found at https://spacedata.copernicus.eu/documents/12833/14553/CORE_DWH2_Web_Status. Access to this dataset will be granted via Eurostat under a multiple user and usage sub-licence.

4.1.3 Use of other ancillary data

The contractor may also use other auxiliary information either in vector, raster or tabular form, provided the quality parameters of such data are known and documented.

4.1.4 Metadata

Metadata is to be presented for all data.

A list of providers and conditions for access and use (licensing, costs) per country, for all the datasets that will be used during the process of photointerpretation is to be delivered prior to the initiation of the photointerpretation task. The list has to be validated by Eurostat. This and other metadata for the datasets used shall be provided in INSPIRE compliant manner, using the XML Editor available at http://inspire-geoportal.ec.europa.eu/editor/

The information to provide shall include the following:

Table 2: Orthophoto metadata – Country XX

Identification of the dataset		
Name of the dataset		
Country		
Metadata contact		
Metadata creation date		YYYY-MM-DD
Provider contact	Institution: Name: Phone: Fax: Address: Postal Code: Country: E-mail:	
Access conditions		Purchase | Free | …
Access restrictions		Author rights | Subject to licensing |
Use restrictions		No restrictions | Restricted
Dataset reference year		YYYY
Dataset time span		First date (YYYY-MM-DD) to Last date (YYYY-MM-DD)
Data format		JPG | TIFF | IMG | MrSID | …

Spatial resolution (terrain)		in meters
Radiometric resolution		in bits (8 | 16 |…)
Spectral resolution		Number of bands (3)
Bands	Panchromatic: Red: Green: Blue: Near Infrared: Other:	Yes | No Yes | No Yes | No Yes | No Yes | No Yes | No (if Yes, specify)
Transfer mode from provider		Download | External disk | DVD | …
Transfer size (total)		in MB
Coordinate system reference name	Datum: Ellipsoid: Projection:	
Coordinate system reference code		EPSG code
Geographic extension (envelope) of the dataset	W: E: S: N:	
Data Quality		
Completeness		Complete | Incomplete
Geographic extent of omissions:	W: E: S: N:	If incomplete; repeat line if needed
Positional accuracy (RMSE)	X: Y: Average:	In meters
Maintenance		Frequency of update
Description of processes	Camera Orthorectification Ground control points Mosaic Radiometric correction Accepted cloud cover Image Compression	include DEM details include accepted mismatch along seams, in pixels in % if yes: lossless | lossy

Table 3: Topographic maps metadata – Country XX

Identification of the dataset		
Name of the dataset		
Country		

Metadata contact	Institution: Name: Phone: Fax: Address: Postal Code: Country: E-mail: Website:	
Metadata creation date	YYYY-MM-DD	
Provider contact	Institution: Name: Phone: Fax: Address: Postal Code: Country: E-mail: Website:	
Access conditions		
Access restrictions		
Use restrictions		
Dataset reference year	YYYY	
Dataset time span	YYYY-MM-DD to YYYY-MM-DD	
Data format		
Map scale	1:*.000	
Transfer mode from provider		Download online | CD | paper copies |…
Transfer size (total)		In GB
Coordinate system reference name	Datum: Ellipsoid: Projection:	
Coordinate system reference code		EPSG
Geographic extension (envelope) of the dataset	W: E: S: N:	
Data Quality		
Completeness		Complete | Incomplete
Geographic extent of omissions:	W: E: S: N:	If incomplete; repeat line if needed

Positional accuracy (RMSE)	X: Y: Average:	In meters
Maintenance		In years

4.1.5 Licenses

Suitable licensing is mandatory for every dataset used. A copy of the licenses shall be made available for Eurostat.

4.2 Image and data processing

4.2.1 Coordinate conversion

In what regards conversion of data, namely due to different coordinate systems, the point coordinates (which will be given in ETRS89-LAEA) can be projected to the local national systems for the purpose of photointerpretation. Information on coordinate system parameters and conversion parameters is to be presented in the appropriate tables of the reports.

4.2.2 Image extracts (*imagettes*)

The imagette is an extract of the full image (aerial or satellite) over which the photo interpreter will determine the strata of the point. These geo-referenced image extracts are squares with 500 m sides, centered on each point of the master grid.

Use the imagette to photo interpret the point	 The orthophoto has to be taken as main reference for the photo interpretation.

They are to be delivered to Eurostat in hard disk with the accompanying metadata. In case of use of satellite image (VHR_IMAGE_2015) image enhancement operations may be needed.

Accepted formats are TIFF(+TFW), GeoTIFF or JPG(+JGW). Other formats may be accepted on demand by the contractor but Eurostat will have to explicitly accept it. Before final delivery, the ready imagettes shall be stored in a location where Eurostat can access them via FTP (read permissions).

4.2.3 KML/KMZ Ground overlay files

For each image a ground overlay KML file will be delivered to Eurostat in hard disk. The file will combine the imagette with the point circumference (1.5m radius around the point), the extended window of observation circumference (20m radius around the point) and if relevant, any ancillary vector information to be used in the photointerpretation process.

Google ground overlays enable you to "drape" an image onto the Earth's terrain. The <Icon> element contains the link to the file with the overlay image. The positioning of a ground overlay is controlled by the <LatLonBox> tag. Bounding values are given for the north and south latitudes, and east and west longitudes. In addition, rotation values are given for images whose y-axis doesn't coincide with grid north. Below is the example ground overlay, with an image which shows Mount Etna erupting in 2001

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
 <Folder>
  <name>Ground Overlays</name>
  <description>Examples of ground overlays</description>
  <GroundOverlay>
   <name>Large-scale overlay on terrain</name>
   <description>Overlay shows Mount Etna erupting  on July 13th, 2001.</description>
   <Icon>
    <href>http://developers.google.com/kml/documentation/images/etna.jpg</href>
   </Icon>
   <LatLonBox>
    <north>37.91904192681665</north>
    <south>37.46543388598137</south>
    <east>15.35832653742206</east>
    <west>14.60128369746704</west>
    <rotation>-0.1556640799496235</rotation>
   </LatLonBox>
  </GroundOverlay>
 </Folder>
</kml>
```

This example uses a JPEG image for the overlay. Google Earth also supports BMP, GIF, TIFF, TGA, and PNG formats. For more information on KML ground overlay see https://developers.google.com/kml/documentation/kml_tut#ground-overlays.

Symbology of vector data will be limited to outline, in order to allow visualization of the orthophoto. Before final delivery, these files shall be stored in a location where Eurostat can access them via FTP (read permissions).

5 Health and Safety

People who do continuous, intensive computer work, such as data entry, for prolonged periods during a shift are at increased risk of developing a number of health problems. These include: visual fatigue, headaches, upper limb musculoskeletal injuries (e.g., carpal tunnel syndrome), and back pain. Such is the case for the photo interpreters.

The risk of computer related health problems can be reduced by appropriate work station design (e.g., suitable desks and adjustable chairs), proper lighting (e.g., appropriate illuminance and elimination of glare sources), training, and the use of suitable equipment (e.g., monitors of a suitable size for the task).

Where the computer work is intensive, as in the case of stratification, the photo interpreters should take, at least, a 3-5 minute break away from computer operation in each hour. This can either mean a period of other work, not involving a computer, or a full break during which the operator does no work. Ideally, the alternate work should be as dissimilar from computer work as possible. The 3-5 minute breaks

should not be accumulated. This is because short, frequent breaks are much more effective in preventing excessive fatigue and possible injury than longer, less frequent breaks.

The photo interpreters and their supervisors shall take action to eliminate, minimize, avoid or report any hazards of which they are aware and follow occupational, safety and health instructions.

The photo interpreters shall not place his or other people's safety or health at risk. They must accept appropriate medical advice where relevant and disclose to the supervisor any limitation imposed by their health that may affect their ability to participate safely in any activity. This obligation applies both before and during the work. Information provided must be treated as confidential information.

Everyone participating in the contractual tasks must be adequately insured.

5.1 Guiding questions on health and safety

Please find below some guiding questions[2] that you should ask yourself while photo interpreting. If you cannot answer accordingly, adjust your working environment or your posture.

5.1.1 Can you answer YES to all of the following?

When you are sitting in a working position, can you rest your feet flat on the floor or on a footrest?? If you are > 160 cm, adjust the height of the seat so that the seat reaches just beneath the kneecaps while standing. If needed (>180 cm), adjust the height of the desk so that your forearms are sufficiently supported, with the elbows in a right angle.

When you are sitting in a working position, are your elbows at least 2 cm higher than the work surface? The arms have to stay aside your body. Do not extend the arms. If you are < 160 cm, adjust the height of the seat so that, with the elbows in a right angle, the forearms are well supported by the desk.

When you are sitting in a working position, can you slide 3 or 4 fingers between the back of your knee and the edge of your seat?

When you are sitting in a working position, can you easily slide your hand under your thigh without having to raise your legs? Ask for a foot support if you cannot reach the floor entirely with the feet.

When you are sitting in a working position, is your back against the back of your chair and is the small of your back supported? If possible, adjust the bend of the backrest so that it supports the hollow part of your lumbar region. Always try to stay with the back against the backrest.

Is the monitor placed on the work surface (and not on top of the CPU)?

Is the upper edge of the screen at eye-level or slightly lower? Position the top of your screen at the height of your eyes.

When you are sitting in a working position, is the monitor at least an arm's length away from you? Position the screen at an « arm length » distance (eye-screen distance 60-70 cm in case of a 15-17 inch screen). A larger screen can be put even further (80 cm). Reminder: adjust the height of your chair first.

Is the screen at right angles to the windows? Position your screen perpendicular to the windows or in any case, don't allow light projecting or reflecting in to your screen.

[2] *Source: http://www.cc.cec/home/dgserv/digit/everybody/intro/ergonomics/checklist/index_en.htm*

When you look at the centre of the screen, are your eyes directed downwards? If you watch your screen through the lower part of your bifocal or progressive spectacles, position the screen lower (and closer) in order to avoid tilting the head upwards.

Is the screen contrast positive (dark characters on light background)?

Is the keyboard separate from the monitor and movable?

Are the keyboard feet folded in? Don't use the support feet of the keyboard. The keyboard has to remain flat on the desk.

When you use the keyboard, can your forearms rest on the work surface? Position mouse and keyboard, so that you don't need to stretch the arms (with or without armrests).

When you use the mouse, is your arm along your body?

When you use the mouse, is your wrist extending in a straight line from your forearm?

When you use the mouse, can your forearm and elbow rest completely on the work surface? Don't move the mouse sideways with your wrist. The movements of the mouse are generated by your forearms and elbows. Use mouse and keyboard in a relaxed way, without tensing the muscles.

Is the surface on which you move the mouse uncluttered and adequate? Clean your desk from time to time. Never leave unuseful objects that may avoid you from positioning your chair, keyboard, mouse and screen at ergonomic distances.

Is the mouse at the same height as the keyboard?

Do you regularly change your working posture? Move your arms and neck every 20 minutes.

Do you take a break (3-5 minutes) every hour? It is better to take a short break every hour rather than a longer break after a longer shift.

Do you often look away from the screen? Blink the eyes or move/close them, in order to avoid eye fatigue.

Are everyday items (such as your telephone) within easy reach or easily accessed by moving around on your chair? While on the phone never hold it between neck and shoulder.

Can you easily work on the screen and keyboard and use other documents (files, folders, reports, etc.) at the same time?

Is your office lamp directed at the documents and not at the screen?

Is your screen clean? Clean your screen from time to time. As resolution increases, eye fatigue diminishes.

Are you hydrating yourself every hour? Water transports energy and stimulates your concentration. It may also avoid eye dryness.

Are you breathing calmly and without interruption? A cramped respiration causes cramped muscles.

5.1.2 Can you answer NO to all of the following?

Are there reflections on the screen from artificial light sources or windows? Lower curtains, or reposition your screen perpendicular to the light source.

Are there leads and cables trailing in places where you have to move around in your office? Clean and organize cables.

6 Observation of the point

6.1 Exact location of the point

It needs to be stressed the strata must be observed **at the point.**

The strata shall be determined at the point	This means that the general rule is that the observation is made at the point.

6.2 Photointerpretation

The interpretation of the strata is based on the orthophoto (the *imagette*).

Use the orthophoto to make the photointerpretation	The orthophoto is the reference for the determination of the strata.
Confirm the strata if ancillary data was used	In the case the point was previously classified using ancillary data, or automated image classification techniques, the photo interpreter has to confirm or correct the machine result.
Use comments	Use comments to justify the decision taken whenever needed.

6.3 Photointerpretation impossible

It is possible that some images have shadows, clouds or other elements that make the photo interpretation of the point impossible. Also coverage of a certain country may be incomplete. In such case the photo interpreter assigns the corresponding class [Impossible to PI] and justifies his option by using appropriate comments. Note that points which are impossible to PI should be an exception and the acceptance of such points is subject to Eurostat approval.

7 Rules for data collection

Theoretically, a point has neither width nor length. Considering the subject of the LUCAS survey – land cover and land use – there is a standard definition to be applied for the size of the point: in the LUCAS survey the point corresponds to a circle with a 1.5 m radius (or 3 m diameter), therefore representing an area of about 7m^2. This rule is the same for the stratification.

Normally, the point falls in a homogenous area (e.g. arable land, top of a house etc.) and the point definition can be easily applied as well as the location of the point can be identified without any doubt.

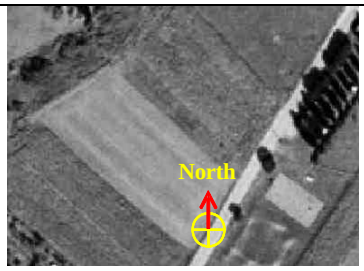
However, some cases might occur, where the location of the point and the observation of the strata are ambiguous:

- if the point falls on a boundary or small linear feature
- if there is heterogeneity in the land cover

7.1 Look to the North/East

It can happen that the point is located on the boundary of two parcels and it is ambiguous which parcel has to be observed, or the point is located on a linear feature < 3 m wide (small hedge, small track, roadside verge) or even over a small object (e.g. a tool shed < 3 m wide in a garden) and in this case, the criterion of point definition (minimum width of 3m) is not fulfilled.

A simple rule has been defined to clarify such situations: the photo interpreter has to apply the "look to the North" rule, which means that he has to observe the strata present to the north of the point.

		
Point location clear, since it is entirely located in an agricultural field.	Point located on a border	Point located on a small linear feature (roadside verge)

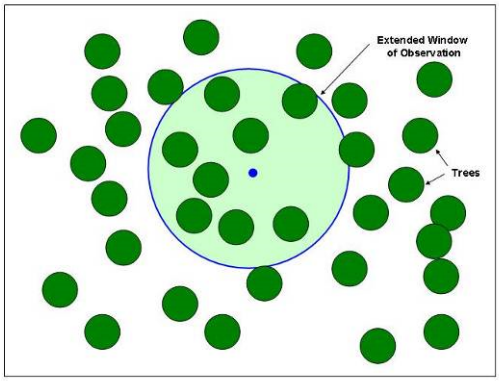
Look to the North	If the point is located on a boundary between two land cover types, the photo interpreter has to observe the land cover north of the point. If the point falls on a small linear feature (i.e. smaller than 3 m in width) these small linear features are not considered as the "point area", so the same "look to the north rule" has to be applied.
Look to the East if feature is oriented N/S	In exceptional cases the border between two parcels may be exactly in North-South direction (=meridian) and even when applying the "look to the north" rule a clarification cannot be obtained. In this (rare) case, he simply moves to the East and assigns the strata he observes there. The photo interpreter must note this "virtual" shift of the point by filling the adequate field in the table. Moreover, if needed, he has to explain the decision under the comments field.

Look to the East if more than one linear feature exist to the North	 In the example above, the point is located on a linear entity (path). If the look to the North rule is applied and a second linear entity found (grass margin), the surveyor should then look to the East.

7.2 Extended window of observation (general)

When the land cover is not homogeneous, for example when it is composed of trees or shrubs interspersed with grass, the scale of observation has to be changed to classify it. In these cases a systematic observation of the "environment" in the vicinity of the point, which in LUCAS is called the extended window of observation, has to be adopted.

The extended window of observation expands to a radius of 20 meters of distance (or 40 m diameter) from the point (representing an area of 0.13 ha).

Using the extended window	 In the example above, the point is located in an area with a sparse tree coverage and grass. By means of the extended window of observation, the

	area share of the tree canopy can be estimated. If the extended window was not used and only the point with its $7m^2$ is considered, it is not possible to obtain a reasonable estimation of the tree canopy. In this example, the area share of the tree's canopy is approximately 20%, so the point has to be recorded as wooded area (minimum coverage of the tree crown 10%). If the tree coverage would range between 5 –10%, the corresponding strata would be shrub, grass or areas of sparse coverage (depending on the land cover).
When to use the extended window	Normally, the window of observation has to be extended whenever the land cover at the point is heterogeneous. This occurs systematically in areas such as: - parcels of permanent crops where the trees or other plants alternate with bare soils and/or grassland or another crop - wooded areas - shrub, where a mix of e.g. shrubs and trees might occur - grass, where land features may alternate (e.g. grassland with trees) - bare surface
Example: an orchard	 The orthophoto above shows a heterogeneous area with grass and fruit trees. This is a situation where the extended window of observation is to be applied.
Note the use	The use of the extended window of observation has to be recorded with "Y" under EWO.

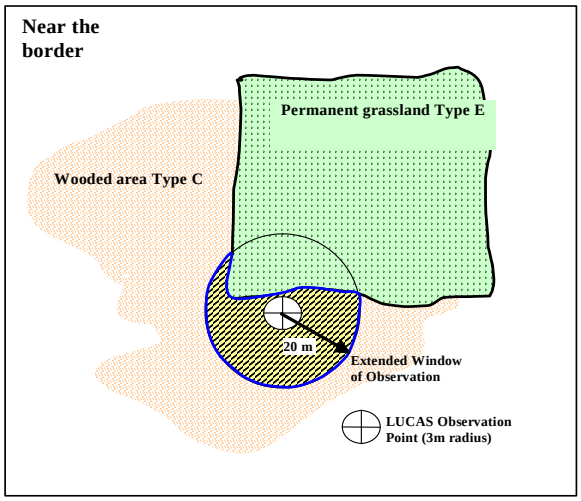
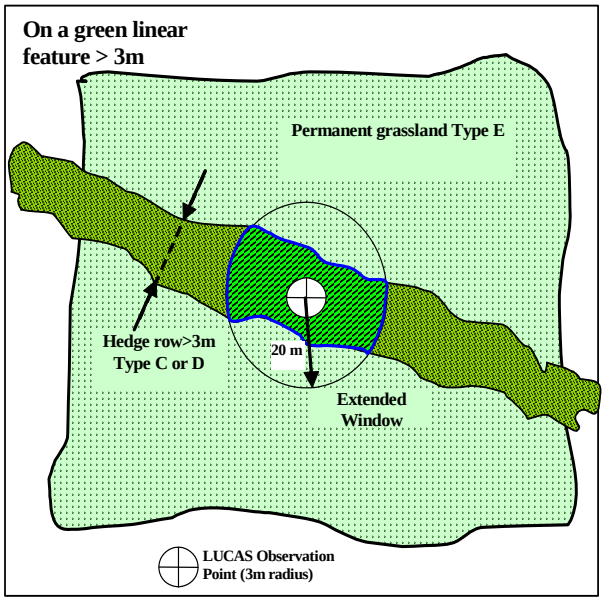
7.3 The extended window of observation and the homogeneous plot

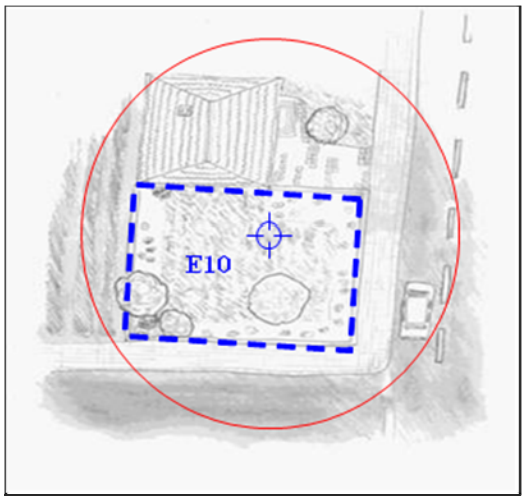
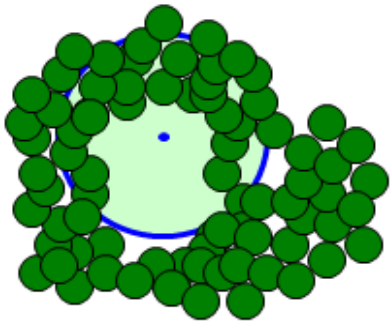
Note that when the extended window of observation is applied, the surveyor has to observe the land cover **within the borders of the parcel where the point is located**. This means that in many cases not all the extended window will be observed, but only the **homogeneous plot** within it.

Generally speaking, the extended window covers the maximum area within the 20 m radius circle having the same land cover and use.

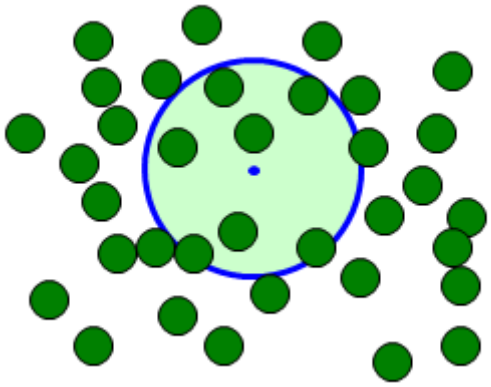
Specific examples are presented below for clarification of the concept.

7.3.1 The border between the elements is easily detectable

The extended window of a point spanning two adjacent parcels	 At the point, the cover being a wooded area, the observation has to be done **within** the extended window. The extended window has to be extended only **within the parcel** defined by the border of the wooded area and the grass, not considering the zone inside the grass area (which is a different parcel). The density of trees and or shrub is to be assessed in the hatched part of the circle to decide whether it is a shrub or a wooded area.
The extended window of a point falling on a linear feature wider than 3 m	 In this case, the point is assigned to the existing land cover of the specific linear feature (road, water, wooded area). The assessment has to be made within the area defined by the linear feature in order to assess the density of trees and/or shrubs (but it is not extended into the adjacent parcels).

	In the example the density is to be assessed in the hatched part of the circle to define whether it is a shrub or a wooded area.
The extended window of a point falling on the grassy area of a garden belonging to a residential building	 Once again, the photo interpreter has to observe the parcel in which the point is located. In this example the grass zone enclosed by a wall (dashed square in the figure) defines the plot to be observed within the extended window of observation. As within this area shrubs and trees are growing, the point is to be classified as grass because the tree crown (within the homogeneous plot) is below 10 %.
The area of the extended window is surrounded by a different strata	 The point falls on an area of grass, namely a small clearing inside a dense forest. The observation must be carried out using the extended window. The extended window (the circle with a 20m radius) contains a wooded area that covers substantially more than 10%. By definition though, the extended window must always be limited to the plot containing the point. In this particular case the small clearing is clearly definable as a plot and therefore the correct stratum to be applied is grass.

7.3.2 The boundary between the elements is not easily determined

Difficult to define the limits of the plot	 The point falls on a grassland area within a non-compact wood. The observation must be carried out using the extended window, where the percentage of trees is again more than 10%. In this case it is impossible to define the plot, therefore the extended window includes the entire area enclosed by the 20m radius from the point. The strata to be applied is wooded area.
Use all the EWO when the limits are not clear	If the boundary between two strata (e.g. grass and wooded areas or grass and shrubs) is not detectable (two or more interpreters wouldn't be able to draw any line or they would probably draw different lines to identify the boundary) apply the standard rule: make the observation in the extended window non considering the plot
In case of doubt apply two strata	If the interpreters have still doubts, (they can't easily decide if the boundary of the plot is detectable or not) apply dual strata

7.4 Multiple registration of strata

In some cases it may be required to use more than one stratum in the same area to describe the point. This is common in specific landscapes such as agro-forestry areas and complex or heterogeneous areas.

To harmonize the usage of dual strata a table with possible combinations is provided.

7.4.1 Possible combinations

See below the indicative table for possible combinations of strata.

Table 4: Multiple registration of strata

												IMPOSSIBLE = 0
	S2											RARE = 1
S1	Null	1	2	3	4	5	6	7	8	9	10	OK=2
Null	0	0	0	0	0	0	0	0	0	0	0	
1	2	0	0	0	0	0	0	0	0	0	0	
2	2	2	0	0	0	0	0	0	0	0	0	
3	2	0	0	0	0	0	0	0	0	0	0	
4	2	2	0	0	0	0	0	0	0	0	0	
5	2	0	0	0	0	0	0	0	0	0	0	
6	2	0	0	0	0	0	0	0	0	0	0	
7	2	2	0	0	0	0	0	0	0	0	0	
8	2	0	0	0	0	0	0	0	0	0	0	
9	2	0	0	0	0	0	0	0	0	0	0	
10	2	0	0	0	0	0	0	0	0	0	0	

8 Strata definition

LUCAS surveys follow a harmonized classification in order to obtain comparable data across Europe. Each class is given a definition that is consistent with the LUCAS nomenclature for field survey, with cases of inclusion and exclusion and with photointerpretation criteria.

Stratum	**Description**	**Correspondence to LUCAS Land Cover classification[3]**
1	Arable land	(B1X..B5X) Cereals, root crops, non-permanent industrial crops, dried pulses, vegetables and flowers, fodder crops
2	Permanent crops	(B7X..B8X) Fruit trees and fruit bushes, other permanent crops (vineyards, olive trees)
3	Grass	(EXX) Grassland, with or without sparse tree/shrub cover
4	Wooded areas	(CXX) Areas where at least 10% is covered by tree canopy
5	Shrubs	(DXX) Shrub land with or without sparse tree cover
6	Bare surface, low or rare vegetation	(FXX) Bare land: areas with no vegetation (rocks, sand, and lichens) or areas covered less than 10% by dominant species of vegetation.
7	Artificial constructions and sealed areas	(AXX) Built-up and artificial non built-up areas
8	Inland water	(GXX, except G30) Surfaces covered by water or ice, either permanently or for most of the year
9	Transitional waters and	Points that are not part of "land" nor "inland water"

[3] *For more detailed data on LUCAS Classification, Technical Document C3 can be found at http://ec.europa.eu/eurostat/documents/205002/6786255/LUCAS2015-C3-Classification-20150227.pdf/969ca853-e325-48b3-9d59-7e86023b2b27*

	coastal waters	areas (includes G30)
10	Impossible to PI	Points that cannot be photo interpreted (e.g. image not available, clouds…). Points in this class are considered an exception subject to acceptance from Eurostat.

8.1 Arable land (1)

Cultivated land that is planted with herbaceous crops, on a rotational basis.

More than one image may be needed to determine whether a crop was grown in a plot or not.

Non cultivated elements wider than 3m at the border of field or within fields are an independent object and should be classified on the base of their strata (typically bare land or grass). However if the interpreters can't easily decide if the linear element is cultivated or not, the point should be classified on the base of the land cover of the cultivated field (arable land or permanent crops or grass). Representative situations are: photos of poor quality, elements with very irregular shape, with colour close to the one of the field.

🗁 **This class includes**

- Grains
- Root crops
- Industrial crops
- Pulses
- Vegetables and flowers grown in the open air or under the protection of temporary covers that cannot be classified as greenhouses (tunnels).
- Domestic vegetable patches
- Arable land with sparse trees, when the tree cover does not exceed 10%

✂ **This class excludes**

- Alternating grass fields and meadows for the production of grass (3 – grass)
- Fallow plots with grassy vegetation (3 – grass)
- Fallow plots with little or no vegetation (6 – bare surface, rare or low vegetation)
- Abandoned plots (to be classified according to the type of vegetation present)
- Arable land with trees other than those in permanent crops, when the tree cover exceeds 10% (4 – wooded areas)

8.2 Permanent crops (2)

In this situation the extended window of observation is always applied. It is therefore irrelevant whether the point falls on the trees or in the space between the rows. Even traditional olive groves with wide distance between the trees are classified as permanent crops. If the point falls on fruit trees scattered across a cultivated field (less than 10% of tree cover in the extended window of observation), this falls within the situation already described under the heading of arable land.

🗁 **This class includes**

- Orchards
- Berries
- Olive groves
- Vineyards
- Nurseries

even if abandoned

✂ **This class excludes**

- Scattered fruit trees over arable land, when the tree cover is less than 10% (1 - arable land)

8.3 Grass (3)

Points where land is predominantly covered by communities of grass, grass-like plants and forbs.

This class includes permanent grassland and permanent pasture that is not part of a crop rotation (normally for 5 years or more), which can be used to grow grasses and other herbaceous forage naturally (self-seeded) or through cultivation (sown).

Artificial temporary grassland sometimes shows characteristics that are somewhere between those of arable land and permanent meadows and pastures. They can be recognised as such and thus assigned to stratum 3 – grassland if they are 3-4 years old and have uneven vegetation cover and no tractor tracks or they show the typical tiers caused by field drying and reaping or they are cultivated in marginal areas on hillsides and mountainsides where there are also permanent meadows and pastures.

Grass covered fallow plots can sometimes be recognised by the irregularity of the vegetation.

This class may include sparsely occurring trees within a limit of a canopy below 10% and shrubs within a total limit of cover (including trees) of 20%. These can themselves be also grazed, provided that grasses and other herbaceous forage remain predominant as well.

For this stratum, the homogeneous plot in the extended window is always applied in order to confirm that the tree and shrub cover is less than the established limits.

🗁 **This class includes**

- Pastures and meadows
- Abandoned arable land with mainly grass cover
- Fallow plots with mainly grass cover
- any other surface covered in grassy vegetation, whether in residential, commercial or industrial areas, transport infrastructures, parks, gardens
- wetland areas covered in grassy vegetation

✂ **This class excludes**

- Areas of lawn or pasture where the tree cover or shrub cover exceed 10% or a combination of both is over 20% (to be classified according to present vegetation)

8.4 Wooded areas (4)

These are areas of trees that can or have already reached heights of 5m and that cover at least 10% of the ground. Also woody hedges and palm trees are included in this class.

For this stratum, the homogeneous plot within the extended window is always applied in order to confirm that the tree cover corresponds with the definition provided.

🗁 **This class includes**

- Partially deforested areas
- Coppices
- Burned areas
- Areas with grassy vegetation where the tree cover exceeds 10%
- Hedges of woody species more than 3m wide
- Specialised cultivations of timber species (poplar, walnut …)
- Young plantations where the trees have not yet reached a height of 5m
- Wetland areas covered with trees
- Any artificial area or bare land where the tree cover exceeds the abovementioned percentage of cover (trees in parking areas, industrial, commercial or residential areas, …).

as long as the tree cover is above 10%

✂ **This class excludes**

- Areas where the forest has been completely cut down (classified according to the present cover e.g. stratum 3 – grassland; stratum 5 – bare land, low or rare vegetation)
- Hedges of woody species more than 3m wide where trees do not exceed 10% (5 – shrubs)

8.5 Shrubs (5)

These are areas covered with woody shrubs (woody vegetation that is generally lower than 5m) and that represent a ground cover of at least 10%. It may include sparsely occurring trees with a canopy below 10%.

🗁 **This class includes**

- Areas with grassy vegetation where the shrubs exceed 10%
- Any artificial area or bare land where the bush cover exceeds 10% (in parking areas, industrial, commercial or residential areas, …).

✂ **This class excludes**

- Bare areas (5 - bare land, low or rare vegetation)

8.6 Bare surface, rare or low vegetation (6)

These are areas that have no dominant vegetation. 90% or more of the land is bare.

The observation is to be made on the homogeneous plot of the extended window of observation.

🗁 **This class includes**

- Cliffs
- Rock faces
- Block litter
- Mountain top debris
- Beaches
- Dunes

- Areas laid bare by excavation
- Areas of recent volcanic activity
- Areas without vegetation
- Clear cut areas where forest has been cut down completely

✂ **This class excludes**

- Areas without vegetation that fall within the definition of artificial (7 - artificial, constructions and sealed areas)
- Areas with more than 10% of tree cover (4 – wooded areas)
- Areas with more than 10% shrubs (5 – shrubs)
- Rural roads (7 – artificial, constructions and sealed areas)

8.7 Artificial, constructions and sealed areas (7)

Areas characterised by artificial and often waterproof cover that is either constructed or paved.

For this stratum, observation is normally limited to the point itself (within a radius of 1.5m around the point).

Agricultural greenhouses are to be given dual strata: 7 – artificial land and 1 – arable land. For vegetated, water or bare areas associated to residential, industrial or services areas use the parameter ASSOC instead of applying a second stratum.

🗁 **This class includes**

- All buildings, no matter what their height
- All greenhouses, whether for agricultural or non-agricultural use
- All paved or waterproofed surfaces, whether overhead or linear (parking garages, roads, railways, bridges, squares, farmyards, courtyards….).
- Forest and rural roads, whether paved or not
- Surfaces dressed with gravel or other inert material

✂ **This class excludes**

- All areas with dominant vegetation
- Bare areas (5 – bare land, low or rare vegetation)
- Areas covered by inland water (8 – inland water)

8.8 Inland water (8)

All bodies of inland water, whether standing or running. Areas covered by permanent snow or ice.

🗁 **This class includes**

- Lakes
- Ponds
- Swimming pools
- Bodies of water on industrial or residential sites
- Rivers
- Canals
- Areas permanently covered by ice or snow

✂ **This class excludes**

- Rice paddies (1 – arable land)
- All those areas that are covered by water but also have dominant vegetation (3 – grass, 4 – wooded areas or 5 – shrubs). These should be assigned the parameter WET=Yes

8.9 Transitional waters and coastal waters (9)

These areas correspond to the transitional waters and coastal waters as defined in the water framework directive (Directive 2000/60/EC): bodies of surface water in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows. It includes water surfaces in estuaries (the wide portion of rivers at their mouths subject to the influence of the sea into which the water course flows: the limit is fixed at the point where width is less than 5 km at high tide and greater than 3 km at low tide) and lagoons (water areas cut off from the sea by coastal banks or other forms of relief with, however, certain possible openings).

These areas are not part of the NUTS definition.

🗁 **This class includes**

- Estuaries
- Lagoons
- Points in marine sea

✂ **This class excludes**

- Inland water areas (8 – inland water)
- Rice paddies (1 – arable land)

8.10 Impossible to PI (10)

If it is not possible to PI a point on any of the available *imagettes*, this class is to be assigned. Justification is required.

🗁 **This class includes**

- Points covered by clouds
- Points in deep shadows
- Points for which there is no *imagette* available

✂ **This class excludes**

- Points that can be photo interpreted

9 Internal quality checks

The quality checking procedures are needed to define the quality of the final product and of each stage of the work.

It is important to note every unusual circumstance in the **remarks** fields and to give a brief description to justify the decisions of the surveyor and to ensure the quality and timeliness of the results. Structured comments are to be used whenever possible.

No special characters should be used to fill in free text fields. The use of English is mandatory in case of free text comments.

In the previous campaign a system of classification of errors (3-serious, 2-medium, 1-small, 0-suggestion) was proposed and is given only as an example since the tender conditions require that the tenderer proposes a quality check workflow and description adapted to the internal organization.

9.1 Code list – Structured remarks

9.1.1 Type and list of comments for photointerpretation

CODE	TYPE OF COMMENT
BA	Quality of background information
BC	Application of the look N/E rule
BD	Stratum
BH	Data entry

BA02	Orthophoto not available
BA03	Not updated orthophoto
BA99	Other
BC01	Applied because of a border
BC02	Applied because of a linear feature
BC99	Other
BD01	Dehesa
BD02	Layered crop
BD03	Local knowledge
BD04	Tilled arable land not sown during current season
BD99	Other
BH01	Problem with data input: hardware
BH02	Problem with data input: software

9.1.2 Type and list of comments for quality checks

CODE	TYPE OF COMMENT (Quality checks)
EA	**Overall quality**
EB	**Observation problems**
EC	**Land cover**

EA01	Point ID and location do not match
EA02	Data entry not complete
EA03	Observed data do not belong to the point
EA04	Point not correctly photo interpreted
EA05	Point corrected after DR (double rejection)
EA06	Point not correctable after DR (double rejection)
EA99	Other
EB01	Incorrect date
EB02	Incorrect start/end time
EB07	Observation direction questionable/wrong
EB12	Incorrect application of look to the north/east rule
EB99	Other

EC01	Strata questionable/not corresponding to the orthophoto
EC07	Dual strata missing

10 Weekly reports

To enable monitoring the project effectively, Eurostat requires weekly progress reports prepared by the contractor for the duration of the project. Weekly reports have to be structured per country.

These reports are most important during the data collection period, for monitoring the progress and for quickly identifying problems and delays. The reports should not be more than five pages long and should summarise the progress of the project, structured as shown below.

10.1Cover page and table of contents

eurostat

Institution

Logo

LUCAS 2018
Stratification

Weekly report [calendar week XX]

Contractor

Contract number

vX.X of YYYY.MM.DD

10.2 Work done

The list of tasks shown in Table 5 below is purely indicative.

Table 5: Action List

Task	Person responsible	Date / period of execution	Description / Remarks / Problems encountered – solutions applied
Training	Trainer	YYYY.MM.DD – YYYY.MM.DD	Training went according to plan. See dedicated report (DLV5B) for details.
Control of the data collected	Supervisors	YYYY.MM.DD – YYYY.MM.DD	Comparison with orthophotos, landscape photos, coherency check
Weekly meeting of project staff	Project manager	YYYY.MM.DD	Discussion of problems, solutions
(…)			

10.3 Progress report

The progress is to be reported in tabular form (Table 6 and Table 7) and graphic format[4] (Figure 1: Planned and actual photo interpreted points Country XX (Status: YYYY/MM/DD) and Figure 2) The dates and the number of points in the table and figures are only indicative.

Tables per country are shown below. A similar set for project totals is also required.

Table 6: Progress report (Status: YYYY/MM/DD) – COUNTRY XX

Photo interpreter ID	Total points	Date started	No. of PI points		No. of remaining points		No. of checked points		No. of points transmitted to ESTAT		Remarks
			total	%	total	%	total	%	total	%	
Total	2569	[first date]	4	0.15	2565	99.85	4	0.15	4	0.15	
PI 1	652	2016.05.12	4	0.61	4	99.39	4	0.61	4	0.61	
PI 2	644	-	0	0	644	100	0	0	0	0	
PI 3	662	-	0	0	662	100	0	0	0	0	on leave
PI 4	611	-	0	0	611	100	0	0	0	0	delayed by shortage of imagettes

[4] *map with spatial extent of the progress are welcome too*

(…)											

Table 7: Strata summary report (Status: YYYY/MM/DD) – COUNTRY XX

Photo interpreter ID	Average time per point	No of points per strata						
		1	2	3	(…)	8	9	10
PI 1	00:03	0	2	1	(…)	0	1	0
PI 2		0	0	0	(…)	0	0	0
PI 3		0	0	0	(…)	0	0	0
(…)		0	0	0	0	0	0	0

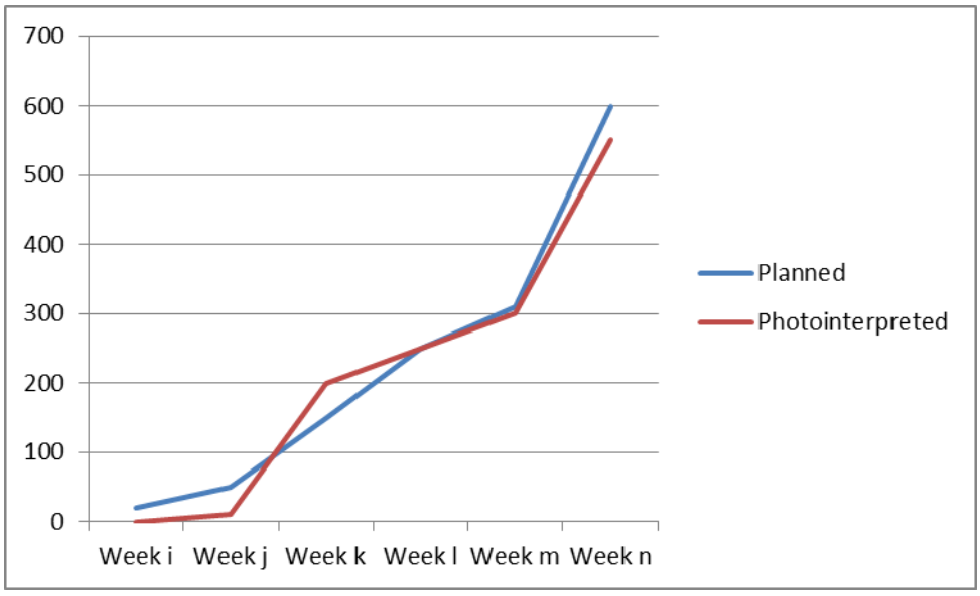


Figure 1: Planned and actual photo interpreted points Country XX (Status: YYYY/MM/DD)

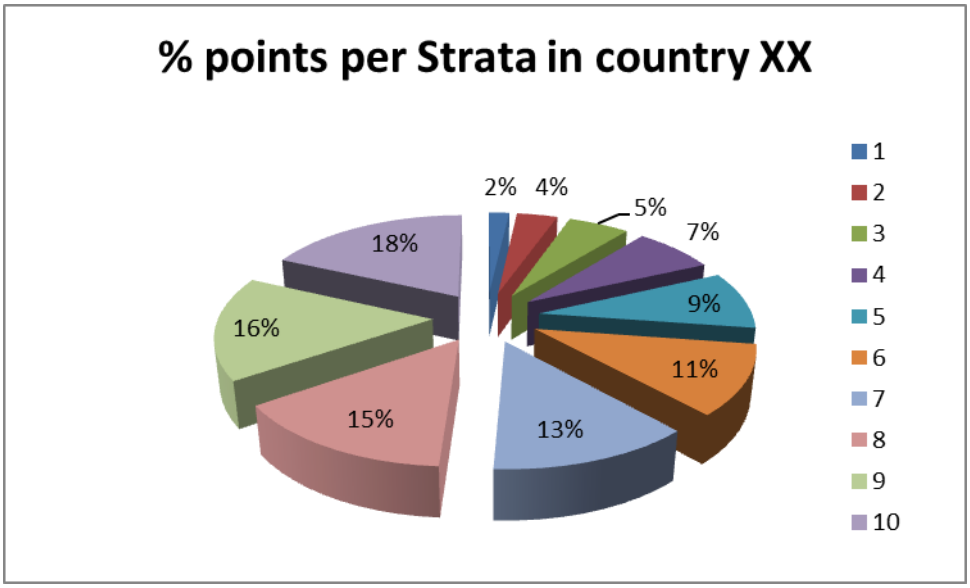


Figure 2: Percent points per strata in country XX (Status: YYYY/MM/DD)