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ON-THE-SPOT CHECKS ACCORDING TO ART. 31 AND 33-35 OF R.1122/2009

GUIDANCE FOR ON-THE-SPOT CHECKS AND AREA MEASUREMENT

The purpose of this note is to give guidance to Member States (MS) on how the legal provision in reference are best met, it is not to repeat what is in the legislation. In case part of the work related to on-the-spot checks is contracted out, it remains the responsibility of the MS that the work is carried out in line with the applicable legislation and to the standard required (cf. provisions in R.885/2006). Detailed guidelines for the purpose of instructing the contractor are also the responsibility of the individual MS opting for sub-contracting.

This guidance is either derived directly from the mentioned legal provisions or, whilst not expressing straight-forward legal obligations, constitutes recommendations by the Commission services to the Member States.

It should be emphasised that the considerations contained in this document are without prejudice to any further position taken by the Commission acting as a collegiate body, nor to any future judgement of the European Court of Justice, which alone is competent to hand down legally binding interpretations of Union law.

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1.1. Random selection

1.1.1. The representative sample concept

Art.31(1) of R.1122/2009 fixes the random sample to between 20% and 25% of the minimum number of farmers to be subject to on-the-spot checks as provided for in Art.30(1) and Art.30(2), which means for every premium.

The main use of the (randomly selected) representative sample is to permit an estimate of the background level of anomalies in the system, and therefore support decisions enacting the mechanism for increasing the control rate. It also permits an assessment of the effectiveness of the criteria being applied for risk analysis.

1.1.2. Types of random sampling

The main statistical criterion of random sampling is that all dossiers should have an equal probability of selection. In this regard, two approaches are considered most appropriate:

- Simple random sampling: selection from the full population of dossiers through the generation of a random key. However, this approach may require waiting until the full population is known before the sample can be determined, which is not always recommendable.

- Systematic sampling: for example each 100th dossier delivered at a collection centre or in the computer system. Whilst this approach has the advantage of producing dossiers for on-the-spot check immediately (without waiting for the determination of the full population), care must be taken to avoid creation of bias in the input order of dossiers.

These methods can be applied within the following ways:

- Stratified random sampling: With certain strata (defined with criteria) a certain number of dossiers are randomly selected inside each stratum.

- Cluster sampling: Often geographically clustered (but could be clustered in another dimension), with random selection within the cluster e.g. a CwRS zone.

1.2. Risk analysis and annual assessment

According to Art.31(2) of R.1122/2009, MS are responsible for the definition of the risk criteria to be used for the risk analysis. It is the MS' responsibility to assess the effectiveness of the risk analysis on an annual basis and to update it by establishing the relevance of each risk factor. A first step in this annual evaluation is the comparison of the results of the risk based and randomly selected sample (cf. 1.1.1). In addition, (causes for) material differences between results from one year to another need to be analysed.

The ratio of "area not found" i.e. the total area not determined over the total claimed area computed on the whole risk-based sample, is the key factor in analysing the risk of the fund.

For this, MS can rely on a CART model (i.e. Classification and Regression Tree) with the area not found in individual claims as the dependent variable (i.e. the variable to be predicted). The aim of the CART model is to rely on a set of independent variables (i.e. the explaining variables; here, the potential risk factors) in order to find homogeneous sub-groups of the population (called the "nodes"). Advantages of the CART model are that it is:

- Well implemented in various statistical software (e.g. Matlab, R, S+,…)
- Relatively easy to apply (it only requires the input of the dependent variable and the potential risk factors
- Flexible (no assumption is made how the potential risk factors are affecting the dependent variable)
- Irrelevant risk factors are automatically excluded from the model

When calibrating the model, attention must be paid on the maximum level of the tree (i.e. maximum number of consecutive nodes) and the minimum number of observations in a node (generally at least 50).

After calibrating the model, a procedure named "pruning" must be applied in order to remove the insignificant nodes in the tree. Ideally, the procedure is sequentially repeated to get simpler and simpler models. The final model is then chosen by optimizing criteria (e.g. minimum predicted variance on the validation set). If possible, the validation set should be independent from the calibration set (i.e. the individual claims that were used for the calibration should not be used for the validation).

Using the final CART model, it is possible to estimate the area not found for each application. These estimations can be used as proxy for a probability-proportional-to-size sampling of the applications (ensuring thus to sample mainly the larger expected errors) or, alternatively, to regroup the applications with similar estimated risk (e.g. using the terminal nodes). A stratified random sampling can then be applied on these strata with a sample rate per stratum determined by the total risk of the corresponding stratum.
For instance, a risk stratum that covers 30% percent of the total risk of the population (i.e. the sum of the estimated risk within this stratum is equal to 30% of the total sum of estimated risk) should represent 30% of the total sample size even if they are composed of only 10% of the total population. Knowing this sample size for the stratum, we can then translate it into a sample rate for the stratum. Thus, if the total population is 100k claims, the risk stratum above should be sampled as follows:

	# of claims (a)	% of claims (b)	% of estim. Risk (c)	# of sample (d)	Sample rate of strat (e)
Strat name	10k	10%	30%	1.2k	12%

In the example, column (d) is computed as (100k x 4%) x 30% (i.e. 30% of the risk-based sample). That is the number of claims that must be selected in the stratum and put in the risk-based sample while column (e) is computed as 1.2k/10k and is the percentage of claims within this stratum that must be selected.

1.3. Selection of appropriate control method

Art.26 of R.1122/2009 stipulates that "*Administrative controls and on-the-spot checks provided for in this Regulation shall be made in such a way as to ensure effective verification of compliance with the terms under which aids are granted […]*"

This translates into ensuring the effective verification of a particular claim by selecting the most appropriate control method: a classical on-the-spot check or remote sensing control.

In practice, this is done by, after carrying out a risk analysis on the level of the individual claim, looking at the clustering and / or location of parcels and thereafter choosing the appropriate control method.

As a general rule, it is expected that the level of anomalies found in the random sample should be similar whatever the control method. If this is not the case, the MS should analyse its individual situation and take appropriate action.

1.4. Control zones for CwRS

Contrary to classical checks which can be geographically dispersed, in the case of Control with Remote Sensing (CwRS), the areas where imagery is to be acquired need to be established. This clustering of checks is called a "control zone", and is a geographical area defined on the basis of GIS analysis, taking account of technical constraints (e.g. standard satellite 'scenes').

1.4.1. Selecting control zones randomly

For the selection of the random sample, following strategies may be applied:

- Select applications randomly from the whole list of applications. Most likely this sample will be scattered over the MS territory and will have to be checked by classical inspection for most of the claims. However applications falling in a control zone may be checked with RS (and will be counted as part of the random sample even if the zone was selected on the basis of risk analysis).

- Alternatively, a zone is randomly selected, and inside these zones applications are selected systematically (i.e. all applications falling in the zone are checked) or randomly to constitute (part or a total) of the total random sample. It is not advised to have the random sample concentrated in one or 2 zones (except for smaller MSs); a minimum number of 5 random zones should be defined for the representativeness of the sample.

- A combination of the previous two strategies is also possible, for instance in countries where two distinct strata coexist: one stratum of intensive agriculture inside which random zones could be selected for RS checks and the other of more extensive agriculture (i.e. pastures mingled with non-agricultural features)

in which classical inspections would be used to check the scattered (random) applications.

1.4.2. Selecting control zones by risk analysis

For the selection of the risk based sample, again two strategies are possible:

- Select the control zones at random and perform risk analysis inside the zones (provided there are enough applications in the zones to allow an efficient RA);

- Select control zones using RA and then select applications inside these zones either in a systematic way (e.g. all applications with more than 50% of their parcels falling in the zone) or using RA among the applications falling inside the zones, in case the number of applications inside the zones is larger than the targeted number.

Notwithstanding exceptions, selecting all applications inside a zone selected by RA is likely to result in an overall weaker RA than selecting applications individually out of the whole population of applicants. Moreover, controlling all applications in a given area may enable a more complete check of adjacent applications (for example, when sharing reference parcels).

Selecting control zones on the basis of risk analysis does not necessarily mean selecting all zones in the high risk stratum only (which may be the same every year). Zones could also be selected in medium and low risk strata, but with lower sampling rates than in the high risk stratum (see the example at the end of section 1.2). This strategy presents the advantage of distributing the control pressure in every stratum, which may later be useful at the time of assessing the RA.

2. ART.33 AND ART.34: ELEMENTS OF ON-THE-SPOT CHECKS/DETERMINATION OF AREAS

2.1. Why checking/controlling and measuring?

The purpose of on-the-spot checks is to check the conditions under which aid is granted on a sample of applications. In practice, for each parcel claimed for direct aid, this means checking at least:

- The eligibility of the declared area of the agricultural parcel;

- The compliance with the minimum area of the agricultural parcel where necessary;

- The declared land use to the extent requested by the regulation;

- The number and/or position of trees and other features where necessary;

- The eligibility of the parcel with respect to the reference period where applicable

- Cross-compliance requirements, in particular GAEC;

- Other conditions MS have set as to ensure that parcels declared are indeed the parcels the farmer is entitled to / claim aid on.

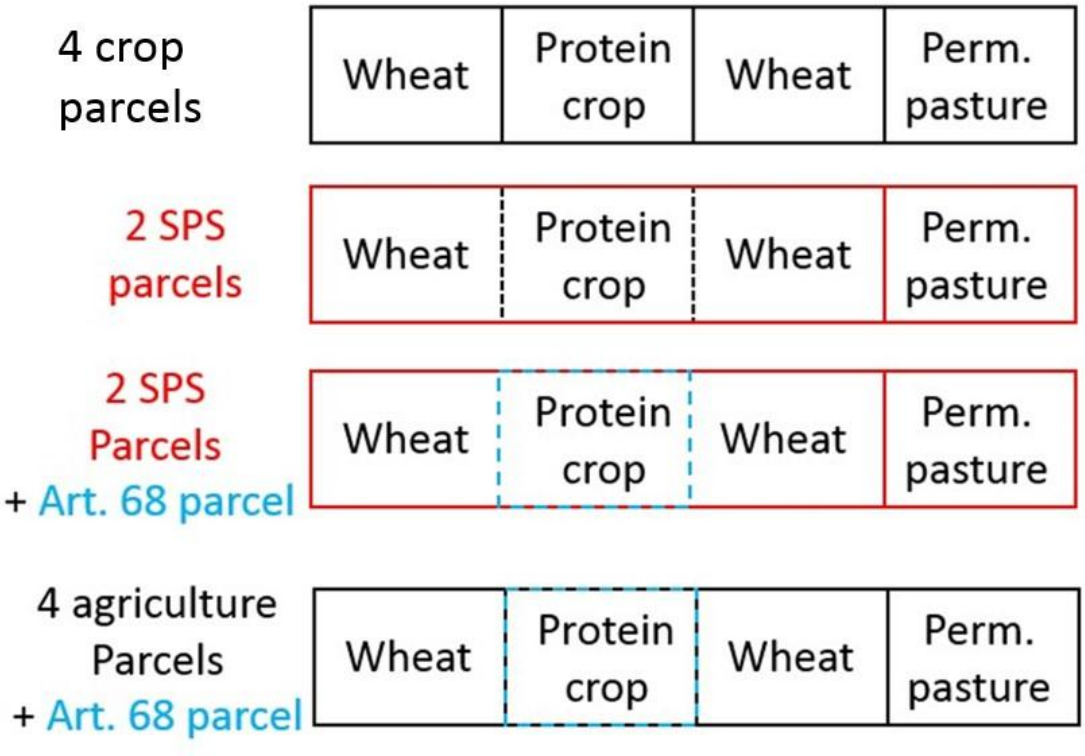
Contracts, seed certificates and other conditions that need to be met but cannot be checked on the imagery (or in the field) will require specific control provisions to be set up by the Administration.

2.2. Definition of the agricultural parcel

Art.2(1) of R.1122/2009 defines the agricultural parcel in the following way: *"agricultural parcel" means a continuous area of land, declared by one farmer, which does not cover more than one single crop group; however, where a separate declaration of the use of an area within a crop group is required in the context of this Regulation, that specific use shall if necessary further limit the agricultural parcel; Member States may lay down additional criteria for further delimitation of an agricultural parcel;*

When a Member State opts for further limitation of the agricultural parcel, the same definition should be applied systematically and in the whole of the procedure.

Member States have the possibility to choose the most appropriate definition of the agricultural parcel for their context: it could for instance be the single crop parcel or the "crop group" parcel as shown in the example below:



Fields may also make two SPS parcels and Art.68 parcel.

Finally, the Member State may define the single crop parcel as the agricultural parcel. The four fields therefore correspond to four agricultural parcels (one of these, being also claimed for specific support under Art.68 of R.73/2009).

Where the crop or cover type is not explicitly required by the regulation, declaring "crop group" parcels instead of single crop parcels allows declaring parcels that

otherwise might be below the minimum parcel size defined by the Member State. It may also simplify the farmer's declaration and the control, in particular when a "crop group" parcel is composed of one or more fully declared reference parcels.

2.3. Definition of the area to be determined/measured

The total area of the agricultural parcel, in accordance with Art.34(2) and Art.34(3) of R.1122/2009, should be determined /measured. Areas not taken up by agricultural activities such as buildings, woods, ponds and paths are to be excluded from this area (Art.34 of R.73/2009).

When determining the "agricultural parcel area", the following should be considered:

Art.34(4) of R.1122/2009 states that, without prejudice to Art.34(2) of R.73/2009 (parcels with permanent crop trees or parcels afforested under a 2nd pillar scheme), "*an agricultural parcel that contains trees shall be considered as eligible area for the purposes of the area-related aid schemes provided that agricultural activities or, where applicable, the production envisaged can be carried out in a similar way as on parcels without trees in the same area"*.

In this context, **Woods** (in parcels not declared as short rotation coppice) should be interpreted as areas within an agricultural parcel with tree-cover (including bushes etc.) preventing growth of vegetative under-storey suitable for grazing.

With regard to **parcels containing trees**, as a result, areas of trees inside an agricultural parcel with density of **more than 50 trees/ha** should, as a general rule, be considered as ineligible. Exceptions, justified beforehand by the Member States, may be envisaged for tree classes of mixed-cropping such as for orchards and for ecological/environmental reasons.

With regards to **shrubs, rocks** etc, the conditions under which these elements can be considered as part of the agricultural parcel should be defined on the basis of the customary standards of the Member State or region concerned (e.g. land cover type, maximum area percentage) in accordance with Art.34(2) and 34(3) of R.1122/2009.

To assess the eligible area within an agricultural parcel of (permanent) pasture, Member States can use a **reduction coefficient**, which can take the following forms:

– *a predefined pro rata system* whereby the eligible area taken into account is determined according to different thresholds applied at the level of each parcel.

– *a percentage reduction* applied at agricultural parcel level based on an assessment of the parcel using scorecards differentiating the reduction to be applied according to the type of ineligible feature, its predominance within the parcel etc.

In the application of either option, the Member States should consider the exclusion of the ineligible area according to its proportion within the geographical area of the encompassing parcel. An exhaustive procedure taking into account all features can also be used.

A pro-rata system that goes below the 50%-eligibility threshold bears substantial risk for error. The higher the share of ineligible area in a reference parcel, the more difficult it is technically to identify the boundary between the agricultural area and the surrounding non-agricultural area which may significantly hamper the correct area determination. In addition, it should be ensured that agricultural activity remains pre-dominant, which becomes more doubtful the less eligible area is present.

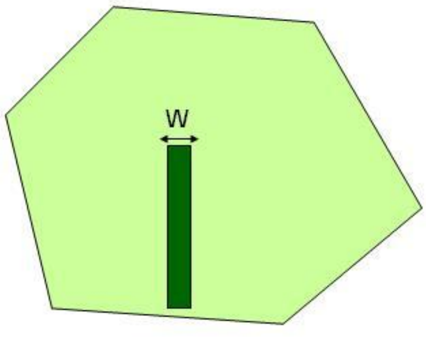
With regards to **ponds**, only permanent ponds are to be excluded.

Paths that cannot be used for agriculture activity, other than those created by animal access or necessary to access the agricultural area, are to be excluded. In general rule, a path has to be excluded if it is part of a transport network (even if used by tractors only) entering and exiting a parcel.

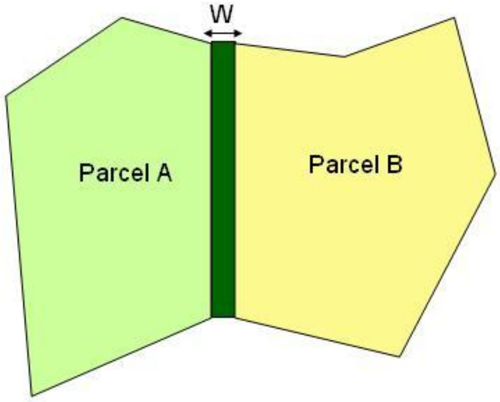
Member States shall define beforehand the criteria and procedure used to delimit the (in)eligible part of the parcel in order to ensure that these criteria are communicated to farmers, where necessary, correctly transposed in the LPIS and adequately included in the instructions for the on-the-spot checks; this all with the view to ensure that the land declared and accepted for payment complies with all legislative requirements (e.g. agricultural activity / parcel).

An exception to the above is given in the first subparagraph of **Art.34(2) of R.1122/2009**, which provides for an option in which the area to be measured can be the total area of the agricultural parcel provided that it is fully utilized according to the customary standards of the Member State or region concerned.

Where, in accordance with the second subparagraph of Art.34(2) of R.1122/2009 **features of up to 4m wide** (walls, ditches, hedges) serve as **boundaries** between agricultural parcels and are traditionally part of good agricultural practice in the region concerned (e.g. terrace walls, drainage ditches), such features may be considered as being included; half of their width up to a maximum of 2m being attributed to each adjacent agricultural parcel. **Internal features** are, under the same conditions, accepted as forming part of the agricultural parcel where their width is less than or **equal to 2m**.
Where the feature is >4m wide (or >2m wide if internal to the parcel), the feature should be removed from the area to be measured (see figures below), **unless** the feature has been recognized under Article 34(3) of R.1122/2009 as part of the good agricultural and environmental condition.



Internal feature of width W: if W<2m include the feature in the agricultural parcel; otherwise exclude the feature



Boundary feature of width W: if W<4m include 50% of the feature area in parcel A and 50% in parcel B; otherwise exclude the whole feature from both parcels.

Where, under Art.34(3) of R.1122/2009, features that are **part of the good agricultural and environmental condition obligations** or the statutory management requirements (e.g. hedges, drainage ditches, small woods according to the local regulations) have been specifically recognised and defined as (landscape) features eligible for area payment, it is recommended that during the on-the-spot checks (i.e. remote sensing or otherwise) such features should be digitized as points, lines or polygons with their corresponding attributes in the LPIS, this way making possible the control of their maintenance (cf. the respect of the GAEC obligations).

2.4. On-the-Spot check general principles

2.4.1. Definitions

Area declared: this is the value declared by the farmer for a given agricultural parcel. Using a reference value or a measurement, the administration will have to decide on acceptance or rejection of this area declared.

Area measured: this is the area measured by the administration. Since it is a measured area, a tolerance may be applied to take into account the uncertainty of the considered tool.

Area determined: for a given agricultural parcel, the area determined is the value kept following the decision made after comparing various area candidates: the declared value, a reference value, and a measured value.

Control method: In a classical on-the-spot check, the eligibility and area of the agricultural parcels declared are controlled in the field by an inspector. When the MS carries out the on-the-spot check by remote sensing (second paragraph of Art.33 of R.1122/2009), the eligibility and area is controlled by photo-interpretation of satellite or aerial ortho-imagery. Where the photo-interpretation does not allow concluding satisfactorily for all conditions, a Rapid Field Visit is made.

2.4.2. *General considerations*

The inspector / photo-interpreter should have received sufficient instructions and training (e.g.: knowing accuracy of tools, conditions of use of tools, limitations of use of tools …), and be largely able to undertake the work autonomously, and should have no conflicts of interest.

In order to provide a result to the appropriate precision and to ensure effective verification, s(he) must have access to appropriate claim data (including map information) and (for the field visit) measuring equipment.

According to "good practice", decision rules for eligibility check, parcel borders definition etc. should be commonly shared between farmers, photo-interpreters, field inspectors and LPIS custodians.

Every on-the-spot check shall be the subject of a control report in accordance with Art.32 of R.1122/2009 which makes it possible to review the details of the checks carried out independently.

2.4.3. *Sample of parcels to be controlled*

In principle, on-the-spot checks shall cover all the agricultural parcels for which an application has been submitted (cf. Art.33 of R.1122/2009).
By way of derogation, the actual determination of the areas as part of an on-the-spot check may be limited to a sample of at least 50% of these agricultural parcels. In this case the Member State shall establish the sample which must guarantee a reliable and representative level of control (cf. Art.33 of R.1122/2009); parcels, once selected, should not be dropped from the set to be checked.

In a first step, a scan of all agricultural parcels should be performed. In a second step, the actual area determination can be limited to 50%.

According to Art.30(4) of R.1122/2009, the extent and scope of the sample shall be extended appropriately if the checks on the initial sample reveal irregularities. To ensure a correct determination of the sanctions and reductions, either the sample is extended to include all the remaining parcels of the crop group concerned or the difference found shall be extrapolated to all parcels in the crop group.

In order to improve the efficiency of the control, applications sharing a reference parcel with any application from the control sample may be included. This recommendation is valid for any type of on-the-spot check (classical control or CwRS), and particularly for checking joint cultivations. Such "ancillary" applications are likely to be incomplete and should hence not be completed in the field, in contrast with the applications from the control sample. However, although very partially checked, these applications could be rejected on the basis of irregularities found on the parcels checked.

2.4.4. *Location of the claimed parcel*

For classical on the spot checks the GNSS receiver could be used to find and correctly identify the parcel to be controlled.

With imagery (that can be used also for field check) each parcel will be located on screen with the help of the reference parcels vectors, the farmer's sketch map wherever necessary and the imagery as background.
It is important to locate all declared parcels, including those for which no aid is claimed, so as to detect possible multiple claims and depending on control strategy defined by the Member State, to verify cross compliance issues.

The area measured will be expressed as the area projected in the national system used for the LPIS.

2.4.5. Checking eligibility conditions

Decoupled Payment and land use check

In practice, land use check for decoupled payment will consist in checking that the parcel is cultivated (i.e. not abandoned) or, if not cultivated, maintained in GAEC for SPS.

Coupled payments: crops claimed for specific support under Art.68 of R.73/2009

The Member State administration defines the list of crops receiving supplementary or coupled payments, applicable in the Member State (cf. Art.68 of R.73/2009).

For parcels declared for coupled payments, the declared crop is checked either on the field or using the available imagery (VHR and HR).

Reference year eligibility checks - cf. Art.124(1) of R.73/2009

For the 8 MS applying SAPS that entered the European Union on 1st May 2004, the reference year check consists in checking that any claimed parcel was in good agricultural condition at 30 June 2003.
For Bulgaria and Romania, there is no reference year check: a parcel is eligible for SAPS in a given campaign if it is in good agricultural condition, whether in production or not, in that campaign.

Checking other schemes than SPS/SAPS

Depending on the choice of the Member State, parcels benefiting from other area subsidy schemes included in the accompanying measures for rural development, or in national environment protection schemes, and included in the sample, may also be checked during the control,.
Examples of such schemes are the compensatory allowances paid for less favoured areas (LFA) and for areas with environmental restrictions, and support measures for agri-environment and afforestation measures. For these schemes, the role of the on-the-spot check is generally restricted to the measurement of the parcel area and the identification of the land use. The controls needed to verify the other commitments related to these schemes (e.g. farm inspections) should be clarified by the Administration. In practice, the parcels claimed in these schemes may be managed as special groups.

2.4.6. *Determination of the parcel area, use of the technical tolerance*

For the purpose of the determination of the area to be taken into account for the calculation of the aid in accordance with Art.57 of R.1122/2009, the area assigned to each agricultural parcel will be computed as follows:

- Where no area measurement is needed (LPIS reference parcel similar with field reality) the estimated area (= declared area) will be considered as determined.

- If a measurement is done, a tolerance can be applied. If such, then where the absolute (unsigned) difference between the measured and declared area is greater than the technical tolerance (expressed as an area in hectares to two decimal places), the actual area determined through physical measurement will be used.
- In the alternative case i.e. when the declared area is within technical tolerance of the measured area (below reported as the confidence interval) the area declared will be considered as determined.

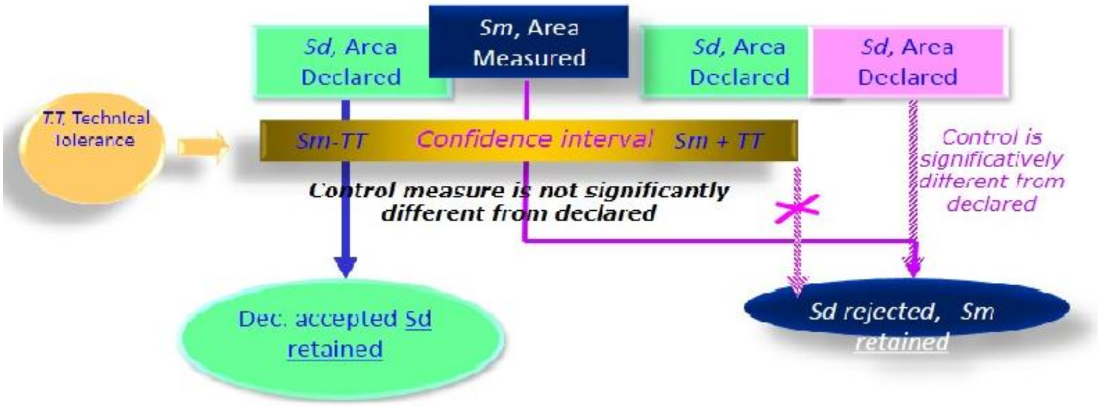


Figure: Applying technical tolerance to decide on acceptance or rejection of declared area in case of area measured

2.4.7. *Determination of the crop group area*

The area at the crop group level will be determined by summing up the individual areas of the agricultural parcels, determined as described above. Over and under-declarations at parcel level can thus be compensated. In any case, if the area determined at the crop group level is found to be greater than that declared in the area aid application, the area declared shall be used for calculation of the aid.

Account should be taken of the fact that in total the area of all parcels declared is topped-off at maximum eligible area of the reference parcel.

2.4.8. *Quality Control*

The administration is required to carry out an internal quality assurance (classical or photo-interpretation) which will result in quality control records. In addition, the Member States have the responsibility to carry out an external quality control in case (part of) the work is carried out by a contractor.

As a general rule, it is recommended for quality control reasons to verify in the field a minimum number of the accepted dossiers (for example 2% with a maximum of 100 dossiers).

2.4.9. Feedback of on-the-spot check results into the LPIS

Where the on-the-spot check shows that not all permanent ineligible features are registered in the LPIS, the up-date procedure should be triggered.

This should include features >0,1 ha to be digitally mapped in the LPIS and features between 0.01 and 0.1 ha should be at least alphanumerically recorded; when they are located at the border of the reference parcel, it could be more appropriate to map them out of the reference parcel albeit ensuring this situation does not lead to an artificial inflation of the perimeter, which in turn would lead to an incorrect "determined area".

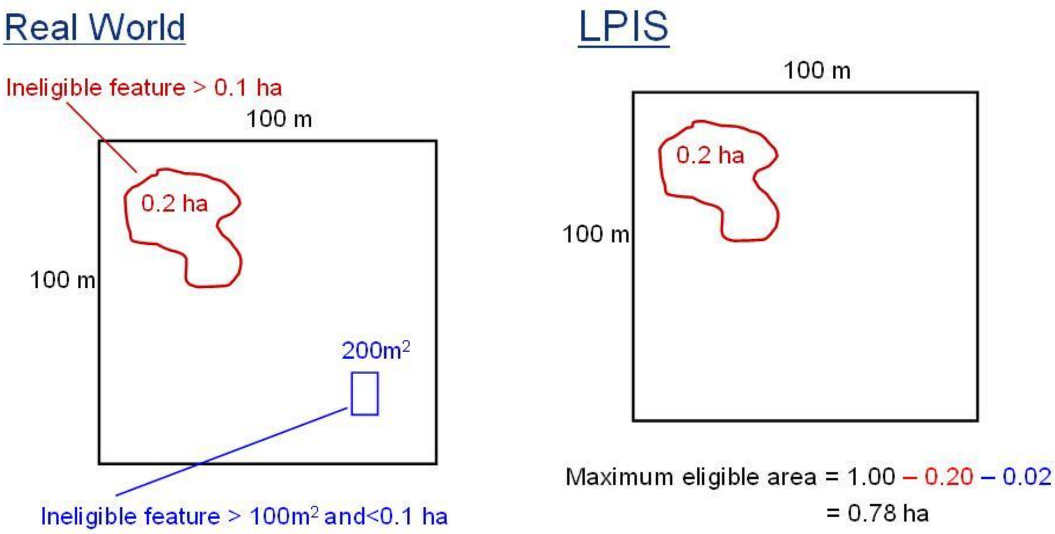


Figure: Situation in the field (real world) and "transcription" into the LPIS i.e. mapping of ineligible features > 0.1 ha and updating of the maximum eligible area.

3. CLASSICAL ON-THE-SPOT CHECKS

3.1. Preparation, timing, and advance warning

The entire check, especially in situ visits, has to be performed in a timely manner to ensure that unambiguous identification of the agricultural parcel limits and cropping (where necessary, e.g. for supplementary or recoupled payments) is possible.

In practice, inspections of crops, where necessary, have to be carried out in the appropriate period before, or (at latest) soon after the harvest to be effective; on-the-spot checks are completely ineffective from the moment the farmer starts to cultivate the land for the next crop season.

The use of advance warning should be kept to the minimum necessary, in order not to jeopardise on-the-spot checks, and in any case shall not exceed the limits laid down in Art.27(1) of R.1122/2009.

3.2. When to determine eligible area through a measurement

3.2.1. Introduction

Where the LPIS, possibly together with ancillary data such as ortho-photos, permits the confirmation of the declared area (boundaries, ineligible areas), a measurement is not necessarily needed; the declared area is then considered "determined".

When measurement is required, the following options exist:

(1) Where the LPIS permits the confirmation of the "correctness" of the boundaries of the declared agricultural parcel, the area measurement may focus on the determination of ineligible areas and deductions.
This method is only applicable where:

- the LPIS reference parcel is an agricultural parcel;
- the reference parcel is fully declared;
- use is made of geospatial declaration of agricultural parcels, which allows an overlay of boundaries and eligible area as reported on the image;
- areas not to be accounted for can be easily identified.

(2) In all other circumstances a measurement of the parcel area is required.

3.2.2. Determination of area through deduction of ineligible features

The workflow below is covering both ineligible features that are permanent or temporary as for area measurement their areas should be deducted from the maximum eligible area of the reference parcel / area of the geospatial declared parcel.

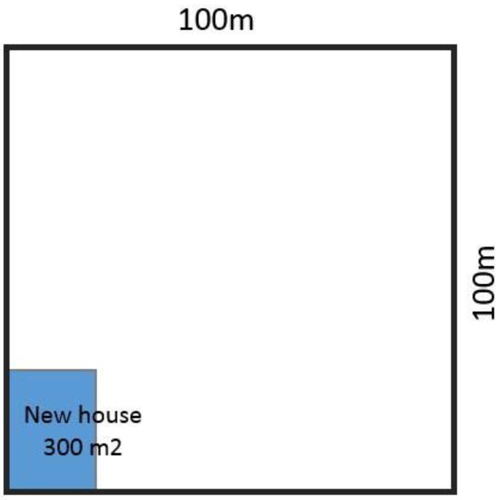
- When ineligible features of significant size (i.e. >100 m^2) are identified in the parcel, the determined area is obtained by deducting the area of these features.
- Deductions of minor (i.e. <100 m^2) ineligible features, but exceeding 100 m^2 when added up, would only need to be made if the inspector considers that all together these features present a significant area i.e. an area larger than the technical tolerance.
- Where there are both scattered features <100m^2 and ineligible feature of >100m^2, the combined area has to be taken into consideration when deciding on the "significance" referred to above.

Workflow and examples:

1. Establish the tolerance of the agricultural parcel (i.e. parcel perimeter x buffer width corresponding to the tool used);

2. Identify ineligible features >100m^2, measure their area;

3. Identify ineligible features <100m^2, measure their area;

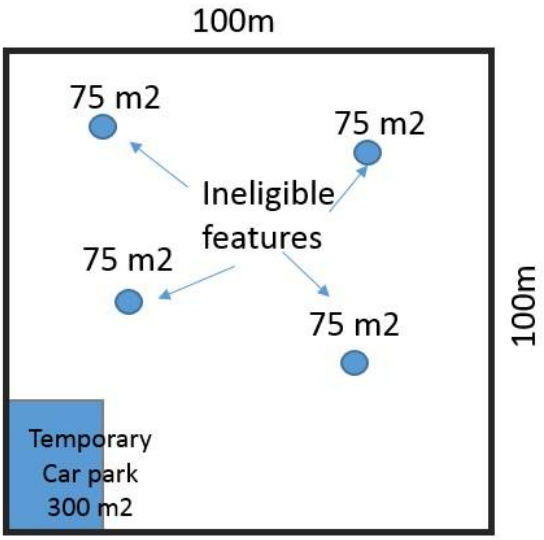


4. If the total area of the ineligible features thus defined is significant i.e. exceeding the tolerance in point 1, measure their area and deduct from the reference area.

Example 1: New house 300m²

1. Area declared area = 1.0 ha, tolerance = 400m x 0.75m = 0.03 ha (buffer equal to 0.75m because parcel digitized on 0.5m ortho-photo);

2. One ineligible feature of 300m² (e.g. a new house). The area does not exceed the tolerance and therefore the area determined is equal to the area declared (1ha) i.e. the reference area;



Example 2: Car park temporarily ineligible + 4 ineligible features < 100 m².

1. Area declared = 1.0 ha, tolerance = 400m x 0.75m = 0.03 ha;

2. One temporary ineligible feature of 300m² (e.g. temporary car parking). This area alone does not exceed the tolerance;

3. Four scattered features of 75m² each, give a total ineligible area of 300m² which does not exceed the tolerance;

4. However, the combined area of the ineligible features in points 2) and 3) must be considered: 0.03+0.03=0.06 ha, which is above the tolerance. The determined area is therefore 1.0-0.06=0.94 ha.

3.2.3. Direct measurement

In all other situations than those in point 3.2.2, a direct measurement along the general measurement principles 2.4 and using the appropriate tool must be carried out. See section 5 for appropriate tolerance and tool validation.

3.2.4. Combination of partial field measurements and on screen measurement

Combining partial field measurements with archive ortho-imagery may prove less time consuming than direct measurement of the whole parcel in the field. It could be an alternative to cases where measurement with GNSS equipment is hardly feasible due to obstacles, the nature of the area to be measured (e.g. common permanent pasture areas) or due to the particular nature of the measurement requested (e.g. permanent tree crop).

The inspector should find a starting and ending point for the field measurement (encompassing the invisible border on the image) that are clearly identifiable on both the image and the field. Since this field measurement should be accurately repositioned on the ortho image, the measurement should be performed with precise tools (e.g. dGPS).

The recommended tolerance is the maximum of the GNSS buffer width and the buffer width recommended for the (archive) ortho-imagery.

3.3. Tools used for physical field measurements

3.3.1. GNSS receivers (standalone or differential corrected signals: EGNOS, dGNSS real time or post-processing)

3.3.1.1. Introduction

The GNSS receivers can be used for area measurement in *standalone mode* or with *differential corrections* applied in real time or post processing (dGNSS). The use of differential corrections (EGNOS, beacon, local/regional/national base stations networks) allows improving the quality of positioning of measurements.

The accuracy in the absolute position of the single points recorded by stand-alone GNSS is characterized by a RMSE in the range of 0.5 – 5 m in x,y. As a result, parcels measured by stand-alone GNSS may be slightly shifted or present local boundaries errors.

Due to the uncertainty of point positioning of standalone GNSS devices, measuring linear features with these tools are not recommended.

Differential Global Navigation Satellite System (dGNSS) is an enhancement to Global Navigation Satellite System that provides improved location accuracy, from the 10-15 meter nominal GPS/GLONASS accuracy, to about 1.0 m (10-50 cm in case of the best implementations). The differential corrections comes from different base stations networks (local, regional, national) and can be applied on real time via GSM/radio connections or in post-processing.

In measurements there shall be made use of the EGNOS “open service”. Technical performance parameters and terms and conditions of the use of the Open Service can be found in the Open Service Definition Document at this website (http://ec.europa.eu/transport/egnos/programme/open_service_en.htm and http://egnos-portal.gsa.europa.eu/).

3.3.1.2. General considerations

The appropriate method of measurement as well as advice for optimizing the measurement accuracy is usually suggested by the manufacturer. However validation of the measurement method together with the device through an area measurement is strongly recommended (details on method see point 5.4).

In open horizon, the use of the **continuous measurement method** is recommended as it increases the possible compensations between point position errors. Where obstacles are present (e.g. a wood or a hedge), the **vertex (stop & go**) method may give better results.

Continuous measurement method consists in measurements carried out by the inspectors walking around the parcel to be measured, following the parcel borders with the GNSS receiver-antenna. The frequency of the recording data is usually set to one measurement/sec.

Vertex measurement method consist in measurements carried out only in vertices situated on the parcel borders on changing of directions but also on the straight parts with a frequency of one “vertex” every 25/30 meters. On each vertex one or more positions can be recorded to improve the accuracy of the position.

Time-effectiveness, accuracy and reliability of the measurement are depending on the measurement method. The following should be considered:

- measurement with logging vertices method proved to be significantly longer than the continuous measurement method;
- the perimeter of the feature measured may be significantly exaggerated with the continuous measurements method;
- the accuracy of the measurement is strictly related to the number of epochs logged, therefore the logging interval in the continuous measurements method and the number of epochs collected on each point when logging vertices only method should be analysed;

- it can be easier to visually identify an incorrect measurement (through unexpected 'picks' in the shape of the measurement) with the continuous measurements method.

The tracks of the measurements taken with the continuous measurements method might look 'worse' (more noisy) on the screen of the device (and in the GIS) than the ones collected by logging vertices only. The purpose of the on-the-spot controls is to find the actual area eligible for payments and to verify the farmer's declaration. Therefore, the reliability of the measurement and the best practice in taking the measurement should be a priority over the 'sharp' shape of the field. In other words, the method of the measurements should be adjusted to the tool and conditions of the measurements rather than to the preferences for seeing 'straight' borders in the GIS database.

3.3.1.3. Difficulties with sufficient satellites in the range

Whenever the measurements need to be taken in a "difficult" area like a valley or near a forest, it is advised to use a measurement planning software. This software allows simulating the configuration of the GNSS system at a certain point and time of the day, month and year. As the position of satellites is changing in time, selecting the optimum time of the day for the measurement can help achieving a reliable result in a short time.

Some software is also able to take into account the features potentially blocking the signal from the satellites. This is done by introducing a simple sketch of the position of the obstructions influencing the test field in the software. The horizon is therefore reduced according to this sketch, making the simulation more realistic (see figure below).

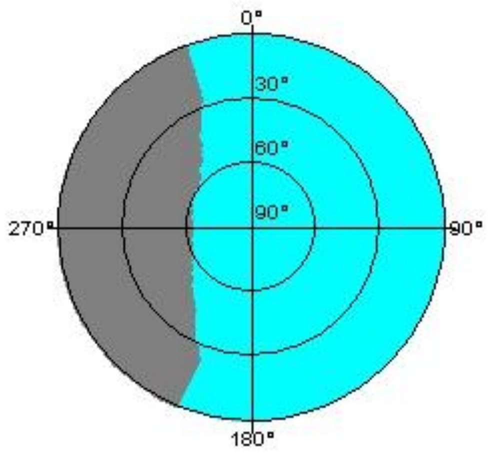


Figure explaining the situation when a mask (forest, building, etc ..) is existing on the field in western part of the parcel to be measured.
The different elevation angles of GNSS satellites are represented from 0º to 90º.

3.3.2. Other tools for physical field measurements

- **Topographic survey instruments** (single of dual frequency phase GNSS, electronic total station)

These instruments are normally used for re-measurement in the case of disagreement by the applicant and therefore they will be operated by skilled, professional survey staff. A statement of their precision for area measurement expressed as buffer width around the parcel perimeter (e.g. a certificate provided by the manufacturer or a validation test result) should be a pre-condition of their use.

Even if experience has shown that such instruments have a buffer width below 0.35m, a 0.5m buffer width is recommended.

- **Wheel, tape**

  These systems are considered as backup tools, primarily suitable for the measurement of lengths (strip width, offset measurements from parcel boundaries, track lengths), for which the geometry (shape) and slope is regular. The use of a wheel on rough ground is strongly discouraged.

  For lengths of up to 100m, a linear tolerance of 2% can be accepted. This is to avoid problems when the feature is not perfectly straight, and/or the terrain is sloped or irregular. Care should be taken with all such “analogue” tools to adjust the measured length to the projected (horizontal) length. Above 100m, other tools (e.g. dGNSS) should be applied.

- **Laser range-finder tools**

  These tools can be used for area measurement and could be also the preferred approach for distance measurements of absolutely straight features. They can be used for longer distances, provided that corrections for slope are possible and that the expected accuracy of the tools for such distance measurement is better than 2% linear length.

4. ART.35 ON-THE-SPOT CHECKS USING REMOTE SENSING (CWRS)

4.1. Number of control zones

The CwRS strategy which, due to timing constraints, has to be defined in the summer / autumn preceding the control campaign can be characterized by the following parameters or options:

- The rate of CwRS checks with respect to the total number of on-the-spot checks to be carried out in a given MS or region;

- The method of selection of these control zones (at random or on the basis of risk analysis);

- The method of selection of the applications inside the control zones; although not directly related to the definition of control zones, this criterion may affect indirectly their number or extent (e.g. in case applications are selected on the basis of risk analysis inside the control zones);

- The effectiveness of Remote Sensing (RS) with respect to the alternative classical inspections: independently of the number of applications to be checked per zone, this effectiveness may depend on the landscape structure (e.g. sufficient

presence of extensive agricultural areas, large fields, disperse farm structure or large farms for which the classical field inspections are time consuming and costly) and of the control needs (e.g. type of crops or GAEC to be checked, proportion of applications for Agri-Environmental Measures for which a field visit is requested);

- The number of applications to be subjected to CwRS;

- The average size of the zone (compromise between the technical capacity of the satellites, logistical constraints) and the average number of applications per zone (to be estimated based on historical claims).

- Logistical constraints: it must be ensured that the work (ortho-rectification, photo-interpretation, follow-up in the field) can be carried out within a realistic timeframe.

- The number of control zones to achieve the targeted number of CwRS checks.

There is no simple rule to define the number of control zones. This number is usually set as the result of experience as well as logistical, landscape and other constraints.
A large number of zones may allow a better distribution of the control pressure as well as a better representativeness (in case random zones are selected) while reducing the number of classical inspections in case of failure of image acquisition over some zones.

4.2. Principles of CwRS and possible strategies

The philosophy of CwRS is to check the claimed parcels in the office as much as possible using available current year imagery. The primary result of these checks is a control result (diagnosis) at parcel level. Parcel results will then be aggregated to derive a diagnosis at crop group level (i.e. the level where aid and penalties are calculated) and dossier level.

Whenever the available imagery does not allow a satisfactory verification (land use, or land cover or area) a field visit is to be carried out.

In case the respect of the cross compliance requirements and particularly of the Good Agricultural and Environmental Condition (GAEC) are controlled with RS, it must be ensured that they provide an effective verification of compliance of the requirements and standards as stipulated by Art.26 of R.1122/2009.

4.3. Parcel area check

The limits of the parcel will be determined using the available current year VHR imagery. Only in exceptional circumstances, i.e. in case of failure of acquisition of the VHR imagery (prime and back up sensors), may archive VHR imagery be used in combination with current year HR imagery to determine the limits of the parcel. In this latter case, field visits may be needed to verify the parcel boundaries.

As a general rule, the area of each declared agricultural parcel will be verified. The result of the digitization will be the photo-interpreted area, also called measured area.

Parcels falling outside all current year images and that therefore cannot be checked by photo-interpretation of ortho-imagery must either be visited in the field or, in case more than 50% of the parcels have been controlled and anomalies are found on the other parcels belonging to the same farmer, the results must be extrapolated.

When using (VHR) ortho-imagery to perform area measurements, part of the parcel boundary may not be visible. In such case, the missing boundary length can be measured during a classical field inspection. The recommended tolerance is the maximum of the GNSS buffer width and the buffer width recommended for the (archive) ortho-imagery.

4.3.1. Determination of land use

Land use may be checked by Computer Aided Photo Interpretation (CAPI) of the available imagery, possibly with the help of results of automatic/semi-automatic image classification. The land use/land cover may be derived from photo-interpretation of 1 Very High Resolution image (<0.75m pixel) and 1 (and up to 3) HR images acquired during different points in time. It can also be done through the use of two VHR images.

Depending on farm structure, land use and land cover characteristics, the Administration may decide to use the ortho-imagery only to perform area checks. In this case, the land use/land cover will be checked by performing systematic Rapid Field Visits.

4.4. Ortho-imagery for the CwRS

For details on the acquisition of satellite images and guidelines for ortho-rectification, refer to: http://g-lio.jrc.ec.europa.eu/G-LioDotNet

http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Guidelines-for-Best-Practice-and-Quality-Checking-of-Ortho-Imagery-v-3.0

4.4.1. VHR imagery

Very High Resolution (VHR) imagery is satellite or airborne imagery with a Ground Sampling Distance (GSD) less than or equal to 0.75m.

In CwRS, there are 2 categories of sensors: VHR prime and VHR back up. To qualify as VHR prime sensor, the following conditions must be met:

- Geometric accuracy: the 1D RMSE measured on independent Check Points should be below 2m;
- Tolerance: the buffer width determined through a parcel area measurement validation test should be less than or equal to 1.5m.

This is tested (either directly by the JRC or via the image provider) before accepting a sensor into the CwRS programme. Failure to meet any one of above conditions qualifies the VHR sensor as back up in the CwRS programme.

The choice of the imagery to be used is to be made according to local conditions. As a general rule, at least one VHR (satellite or aerial) image of the current year should be available for each control zone. The choice of the imagery to be used is to be

made according to local conditions. The information content (resolution, radiometry, etc.) of the VHR sensor (including the back-up sensor) should be sufficient to ensure proper parcel identification and area measurement cf. Art.34 of R.1122/2009.

VHR Profiles for 2014:

Image Profile ID	Description	Spatial Res	Radiometric resolution (*) and spectral bands	abs. 1-D rmse	Cloud Cover (CC) over AOI	Acquistion programming	Remarks	Possible sensors
A1. VHR prime - CwRS	Pan+Multispectral (Bundle)	GSD≤0.75 m	PAN	x,y ≤ 2m	≤10%	Priority programming		WV2, GE1, QB2, K3**
		GSD≤3 m	MS (at least 4 bands)					
	Pan-sharpened	GSD≤0.75 m	at least 4 bands				MS GSD≤3 m	
A2. VHR prime - LPIS and CwRS/LPIS "hilly/mountainous" or "complex topology"	Pan+Multispectral (Bundle)	GSD≤0.75 m	PAN	x,y ≤ 2m	≤10%	Priority programming		WV2, GE1, QB2, K3**
		GSD≤3 m	MS (at least 4 bands)					
	Pan-sharpened	GSD≤0.75 m	at least 4 bands				MS GSD≤3 m	
A3. VHR prime - Pan only	Pan	GSD≤0.75 m	PAN	x,y ≤ 2m	≤10%	Priority programming		WV2, GE1, QB2, WV1, K3**
A4. VHR Stereo	Pan+Multispectral (Bundle)	GSD≤0.75 m	PAN	x,y ≤ 2m	≤10%	Priority programming		WV2, GE1, QB2, K3**
		GSD≤3 m	MS (at least 4 bands)					
	Pan-sharpened	GSD≤0.75 m	at least 4 bands				MS GSD≤3 m	
B. VHR archive	as any of above	as any of above	as any of above	as any of above	as any of above	Archive	used for archive search	as any of above
C. VHR re-task	as any of above	as any of above	as any of above	as any of above	as any of above	Priority programming	used for re-task	as any of above
D. VHR proposed	as any of above	as any of above	as any of above	as any of above	10%>CC≤30%	Priority programming	proposed	as any of above
E. VHR back up	Pan+Multispectral (Bundle)	GSD≤3 m	PAN	x,y ≤ 5.0m	≤10%	Priority programming		any of above plus IK2, EROSB, etc.
		GSD≤12 m	MS (at least 3 bands)					
	Panchromatic	GSD≤3 m	PAN					
	Pan-sharpened	GSD≤3 m	at least 3 bands					

(*) - minimum 8 bits/pixel, recommended 11-12.
(**) Kompsat 3 - after benchmarking

4.4.2. HR imagery

High Resolution (HR) imagery is satellite imagery with a Ground Sampling Distance (GSD) less than or equal to 25m (in case of multispectral imagery) or GSD<=5m (in case of Pan-sharpened imagery).

As a general rule, the VHR and HR window(s) should be defined so as to avoid acquiring both types of images over the same period (e.g. with less than 2-3 weeks difference). To avoid acquiring such redundant images, Member State will define the "dead period" between the date of acquisition of an image (VHR or HR) and the following window.

The HR Profiles for 2014:

Image Profile ID	Description	Spatial Resolution	Radiometric resolution (*) and spectral bands	abs. 1-D rmse	Cloud Cover (CC) over AOI	Acquistion programming	Possible sensors
F. HR prime - CwRS	Multispectral	GSD≤25 m	3 bands at least including G, R, NIR (preferrably also B, and SWIR)	x,y ≤ 1.5 x GSD	≤ 1% validated (profile F1) ≤ 5% proposed (profile F2) ≤ 20 % retained (profile F3)	Priority programming	SPOT5/6, Formosat2, UK-DMC2, DEIMOS-1
	Pan-sharpened	GSD≤5 m					SPOT5/6, Formosat2
G. HR archive - CwRS	as any of above	as any of above	as any of above	as any of above	as any of above	archive	as any of above

(*) - minimum 8 bits/pixel, preferrably 11-12.

4.4.3. *Satellite technical constraints*

The technical constraints of (satellite) sensors should be taken into account to optimize the probability of image acquisition.

The main constraint is the size and shape of the zone with respect to the coverage of the Very High Resolution (VHR) satellites: since these have narrow swaths (of the order of 10 - 15 km), it is advisable to define a zone that can be acquired in one pass (or one day for satellites able to make several adjacent passes in a short time) so as to avoid, weather permitting, zones covered with scenes fragments acquired with several weeks difference. High Resolution (HR) satellites are usually not a constraint when defining a control zone since swath widths are significantly larger (of the order of ≥ 60km).

Accepting low elevation angles (higher off-nadir view angles) for VHR satellites increases the number of acquisition attempts, therefore reducing the expected period needed to cover the zone. However MS should ensure that the ancillary data needed to orthorectify the VHR imagery (e.g. DEM, GCPs) is of adequate accuracy over the selected zone. The elevation angle may also have to be limited in function of the use of the imagery; for example, LPIS QA or the terrain characteristics (“hilly/mountainous” or “complex topology”).

The geographic coordinates of the selected zones (.shp file in Geographic coordinates (decimal degrees, WGS 84 ellipsoid) will be checked by the JRC before sending the zones to the VHR Framework Contractor for feasibility assessment (assessment of whether the zones can be acquired within the time windows set). The VHR Framework Contractor may suggest a small adjustment to the zones and acquisition windows in order to maximise the likelihood of covering the zone (e.g. to optimise use of satellite passes).

4.4.4. *Synergy with LPIS ortho-imagery*

Control zones may fall or be chosen in regions where there is a plan to acquire VHR (satellite or aerial) imagery for the updating of the LPIS. In such a case, the Administration should request the acquisition and processing of the VHR imagery corresponding to these control zones as a priority. Depending on the timing of the flight and processing of the images, they could be used either as the main VHR image or as back up.

4.5. CAPI

4.5.1. *CAPI Methodology*

The computer assisted photo-interpretation (CAPI) is the core task of the CwRS for both the eligibility checks and determination of area.

The photo interpreter's work could be summarized as follows:

- detect non eligible features (water, building, forest) and determine the eligible area;
- check the crops subjected to coupled payments ;

- check the minimum eligible area of the individual agricultural parcels;
- validate the reference parcel boundaries, where appropriate.

During CAPI, it should be possible to edit each agricultural parcel individually so as to subdivide it or modify its boundary. It must also be possible to check that no other parcels (totally or partially) overlap with it. The interpreter must be able to simultaneously display all available images (up to 3 multi-spectral and the VHR ortho-imagery and possible historical images) and the vector and alphanumeric data for each application.

In case image data with more than 3 bands are used, it is advisable to select the band combinations that contain the most significant information. This usually includes the near-infrared band, the mid (or short-wave) infrared and one of the visible bands, although the classical false colour composite (near-infrared, red, green) is in general sufficient for checking the crops/uses that need to be discriminated. The use of multi-temporal index images (e.g. NDVI image) is another option.

Where reference parcels contain several (full or partial) agricultural parcels, the CAPI operator will have to locate and digitize the declared agricultural parcels inside the reference parcels using the sketch maps attached to the farmer's application and taking account of the applicable definition of the agricultural parcel. Since farmers' sketch maps are only indicative, operators are advised to report cases where the retained area significantly exceeds the declared area so that complementary checks may be carried out by the Administration (particularly for dossiers where the possible excess retained area compensates for an over-declaration). Such cases may occur when the operator is not having in possession all declared parcels in the reference parcel (e.g. as a result of the sample selection) or because some parcels may not be declared (e.g. because they belong to non-farmers or the farmer failed to declare all his land cf. Art.19(1a) of R.73/2009).

4.5.2. Automatic, semi-automatic image classification

4.5.2.1. Overview

Satellite image can be automatically classified using only the prior land cover map and existing images; therefore human involvement is reduced to a minimum, ensuring the operability of the method. Semi-automatic approach for land cover classification integrates the accuracy of visual interpretation and performance of automatic classification methods.

Image classification shall be used purely <u>as a guide</u> to help the photo-interpreter at the CAPI stage (e.g. for the identification of specific crops such as the ones receiving supplementary payments or on the contrary the ones not eligible for aid) or as a means of automatically identifying mismatches in the land use of a parcel, i.e. to optimise the CAPI work. A reliable classification result permits the photo-interpretation staff to concentrate CAPI on parcels for which the classification result does not correspond to the declared class, land-uses that have not been included in the classification or parcels that may correspond to non-eligible land uses. In case automatic classification is used in the control programme, it is of the utmost importance that the methodology used is fully detailed and includes an analysis of the classification results obtained.

4.5.2.2. Training data

For any classification method, training data are needed to "seed" the classifier. Data from field surveys at the early stage of the work (e.g. for training of CAPI staff) are usually best suited to this purpose, since they form an independent data set from the application data. Field surveys should be aimed at providing a representative set of known locations for the main cultivations and land use classes, and preferably covering the characteristic terrain conditions in the control zone. Ideally, a subset of the survey data is used for training, while the remainder is used to evaluate the quality of the classification.

4.5.2.3. Ground truth collection

As training and help for the visual interpretation of the satellite images, interpreters will carry out during the period most appropriate for the crops of interest, a field survey in a sample of control zones. The survey will cover at least 750 ha (or 300 parcels) and should ensure a good representation of the crops of interest. The survey sample size may be reduced or the field survey may be focused on crops of interest or rare crops. In the case of SPS, the photo-interpretation staff should pay special attention to crops that may be ineligible as well as to crops subject to additional payments (Cf. Art.68 of R. 73/2009).

It is recommended to build a database of reference fields (photo from the ground plus corresponding ortho-images). Data taken during ground truth collection can also serve as training and validating data in case image classification are used.

4.6. Rapid Field Visits

Rapid Field Visits (RFV) are intended as means to check the land use and possibly some cross-compliance issues (GAEC) in the field without contacting the farmer.

As a general rule, area measurement is not carried out during rapid field visits. However, for parcel boundaries not clearly identifiable on the VHR imagery, some distances or positions may be taken in the field so that the parcel area could be measured on screen at a later stage.

It is distinguished between RFV directed to problems identified during CAPI/parcels for which doubts remains after photo-interpretation, and "systematic RFV" carried out on all parcels of the CwRS sample.

- "Classical" CwRS (VHR image + one or more HR images) <u>must plan RFV for problem parcels</u> when the available images do not permit a satisfactory verification of the land use/eligibility, unclear boundaries or cross compliance issues.

- Systematic RFV are usually carried out for systematically checking the land use and cross compliance on field. In this method, the task of CAPI operators is mainly limited to measuring parcel areas on the screen. The advantages of this method are the following:

    - field visits are made at the best possible timing for identifying the crop and assessing its extent;

- crops likely to be poorly recognized on the imagery (e.g. durum wheat versus soft wheat or barley) can be identified and a sample taken as a proof if requested;

- cross compliance issues, whose the verification may not be feasible on the imagery, can be verified in the field, whenever possible;

- in principle no follow-up field inspection is needed; the follow-up action usually consists in summoning applicants to a meeting.

Digital photographs of the parcels visited and (especially) parcels with problems may be taken during the visit, and stored in a database with their location, so as to be presented to the applicant in a follow-up meeting, thus reducing the number of follow up field inspections to a minimum.

Predefined codes should be used to report on the actual land use and any anomaly found. In "classical" CwRS, RFV may be used to assess the quality of the diagnosis derived from the imagery. In this case the diagnosis established before and after RFV should be recorded.

4.7. Technical codes

At the end of the CwRS process (i.e. after the pre-CAPI check in case of clouds or parcels located outside the image, the CAPI or RFV), each claimed parcel should be assigned at least one technical code, a measured area (wherever feasible) and an observed land use or crop group. The retained area should then be compared (capped) to the maximum eligible area of the reference parcel.

The roles of the technical codes are the following:

- Allow to compute the retained area for each claimed parcel;

- Describe the problem found to the administration (and the inspector for parcels to be visited in the field);

- Allow a posteriori analysis and identification of particular problems (e.g. high occurrence of a given code in a region).

- Trace the work of the interpreter (e.g. for quality control purposes);

Several codes may be used simultaneously if necessary. When several codes are assigned to a parcel, the retained area and land use should correspond to the least favourable condition. If both the declared area and the declared crop group are accepted, the controlled parcel will be coded as "OK".

Some codes are likely to change after a rapid field visit (if this option is chosen). In the latter case, it will be preferable to keep track of the two successive situations: i.e. to keep the code(s) before and code(s) after the rapid field visit.

In the frame of the control of Cross-Compliance, specific codes should be applied to flag parcels for which a breach to a specific GAEC or, if applicable SMR, issue is observed or suspected during the CAPI process.

- The Tx codes are assigned to parcels not checked for some technical reason independent from the interpreter (e.g. parcel outside the image). As assigning a T code implies giving the benefit of doubt to the applicant, these codes should not be assigned to parcels deemed doubtful during CAPI.

- The Ax codes correspond to anomalies, in particular those related to eligibility, and lead to the rejection of part or a totality of the parcel.

- The Cx codes are assigned to the interpreted parcels (i.e. checked parcels) but for which the declared area or crop group is not accepted by the interpreter. Different rules apply for computing the retained area.

- The E code relates to obvious errors

Code T2: Parcel outside all current year imagery (refer to the change to be made in case of anomalies)

Code T3: Parcel outside VHR control zone

Code T4: Parcel covered by clouds

Code A1: Parcel declared or found, after the application of the tolerance rule, below the minimum size of agricultural parcel defined by the MS. For such parcels, the retained area is set to 0.

Code A2: Parcel claimed more than once, i.e. with a partial or total overlap. In case several farmers declare a part of a reference (LPIS) parcel, the code A2 may be applied when the sum of the declared areas exceeds the maximum eligible area (overclaim). The retained area for A2 coded cases not solved before CAPI is calculated by subtracting the overlapping (or overclaimed) area to each of the parcels involved. Alternatively, disallowing the whole area of these parcels is also acceptable.

Code A3: Parcel "not found" should be an exception and are no longer a technical but an administrative problem, i.e. a declaration anomaly coded A3, with a retained area set to zero. In all MS, specific codes may be used to better characterize the different types of LPIS anomaly identified. Alternatively an A5 code may be defined for agricultural parcels declared in an existing LPIS parcel but found to be in another LPIS parcel.

Code A4: The check of reference year eligibility should be made separately i.e. after the normal crop / area checks. The parcels found ineligible, fully or partly, will be assigned an A4 code and the ineligible part of the parcel will be set to zero.

Code C1d: Parcel claimed for decoupled payment is not eligible

Code C1c: Parcels claimed for coupled payment and where the observed crop group differs from the declared crop group.

Code C2: Parcels declared in only one crop group and found to be in more than one group. It is a transitional code and mainly for coupled crop groups; another code should be added to explain the decision made on the subparcels resulting from the division (e.g. C3+, overdeclaration).

Code C3: The use of the technical tolerance makes it possible to detect the parcels whose declared area is significantly different from the measured one, i.e. is out of the range of the measured area ± tolerance. The C3+ and C3- codes are applied to over-declared and under-declared parcels respectively (i.e. with a declared area greater / smaller than the measured area). For such parcels, the measured area will be retained (whereas the declared area is retained for parcels found within tolerance).

Code C4: Regroups cases of "land use interpretation impossible" and "parcel limit problem not re-solved on the image". In contrast with the T codes, the C4 code is the result of some interpretation and an indication of possible disagreements with the declared land use or area. It should hence require some follow-up action (e.g. RFV).

Code E1: Only applies to the cases that comply with the definition of obvious error given in the document "Interpretative note 2011-09".

As a general rule, the declared, measured and determined areas as well as the measured perimeter must be saved for any parcel.

Additional codes may be defined by the Administration to record specific cases not described by existing codes (e.g. LPIS boundary to be updated, or codes for other schemes). In order to avoid confusion it is preferable not to reuse already existing codes (by changing their definition) or to create new codes by subdividing existing codes. Moreover, the new code(s) should be connected to an existing category (T, A, C) as much as possible.

A dossier will be categorized as "complete" if the percentage of parcels with T codes with respect to the claimed parcels is lower than 50% and no anomalies have been found. The assessment of the representativeness of the sample of parcels checked in terms of area and aid claimed is left at the discretion of MS.

5. TECHNICAL TOLERANCE

5.1. Determination of the buffer width of a measurement tool

According to Art.34 of R.1122/2009, MS are required to use "means proven to assure measurement of quality at least equivalent to that required by applicable technical standard, as drawn up at Community level".

MS should only use tools that allow measuring both area and perimeter. Measurement devices are provided with an estimation of accuracy for point measurements, but not of area measurement accuracy. It is therefore crucial to rely on a validation method in order to estimate the technical tolerance for each tool (both orthoimagery and GNSS receiver) to be applied for area measurement.

In order to determine the measurement accuracy of a given tool, MS are requested to systematically perform an area measurement validation test (see 'JRC Area measurement tool validation method' in Annex). The output of this test is a reproducibility limit at 95% confidence level, expressed as buffer width.

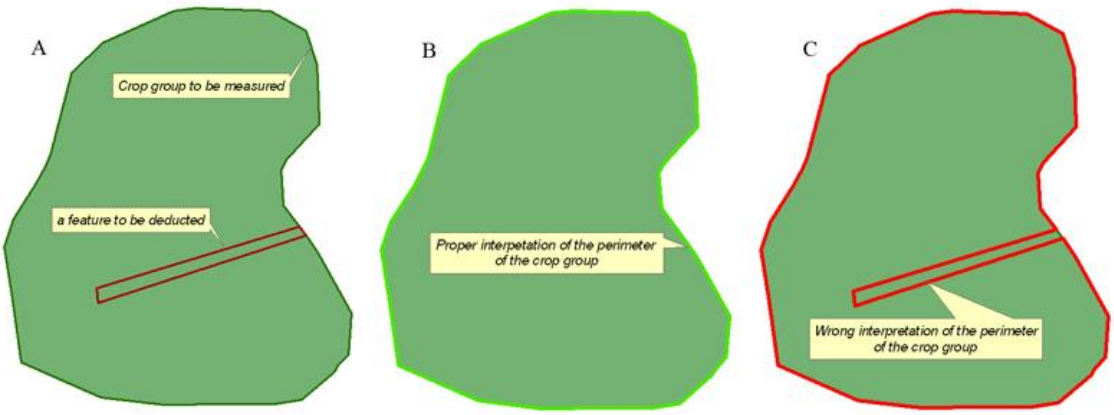
The buffer tolerance, which cannot exceed 1.0 ha, is calculated by multiplying the parcel perimeter by a (buffer) width in accordance with the "factual reproducible accuracy" of the measuring equipment used for the measurement.

Validation should be done in "field conditions", i.e. on the type of parcels and landscape characteristics in which the tools will be used for on-the-spot checks.

5.2. Application of the technical tolerance on parcel area measurement

It may be argued that the tolerance should apply to the measured object and therefore to the deducted area i.e. to an area (significantly) smaller than the eligible area to be measured. However, for the sake of equality of treatment of farmers, a tolerance based on the agricultural parcel perimeter should be used, as this tolerance is close to the one that would be obtained with a direct measurement

The technical tolerances should be applied only to agricultural parcels and not to subdivisions of an agricultural parcel (e.g. internal cadastral parcels) as this would lead to the application of an excessive technical tolerance. Perimeter length should not be artificially increased when performing the measurement. The outer perimeter should be used for tolerance calculation as shown on the next figure.



Example of correct and wrong perimeter interpretation.

Ineligible features included in the controlled area, like roads, ditches or hedges, should not be taken into account when calculating the tolerance (Figures B and C) since this would create an inflated and thus incorrect tolerance, which would lead to incorrect determined area. These features would have to be deducted as ineligible features inside a parcel - cf. points3.2.)

5.3. Tools used in conjunction with area measurement of cartographic materials (analogue or digital)

Under the requirement to have an LPIS at a scale of at least 1:10.000, orthoimage quality / digital map quality meets the geometric specification (2.5m RMSE).

- Measurement on-screen on a digital ortho-image

The following tolerances apply:

Table 1. Tolerance equated to map scale and pixel size

Map scale	Equivalent pixel size (m)	Calculated tolerance, on-screen (m)	Tolerance, on-screen (m)
1:10,000	1.0	1.5	1.5
1:5,000	0.5	0.75	0.75
1:2,000	0.25	0.40	0.50

Table 2. Tolerance to be used with VHR prime sensors

VHR sensor (GSD at nadir)	**Recommended buffer width**
Worldview 1 & 2, Geoeye-1 (0.5m)	1.0m
Quickbird (0.6m)	1.0m

When linear features are to be measured on a digital orthoimage, it is recommended that the vector is digitised with a ground interval of around 50m (i.e., 5mm on a 1:10,000 scale image, or 10mm on a 1:5,000 scale image). A 2% tolerance may be applied to the length.

The above is also applicable for buffer width during the creation or update of LPIS reference parcels.

- Measurement on screen on a digital map object (raster or vector)

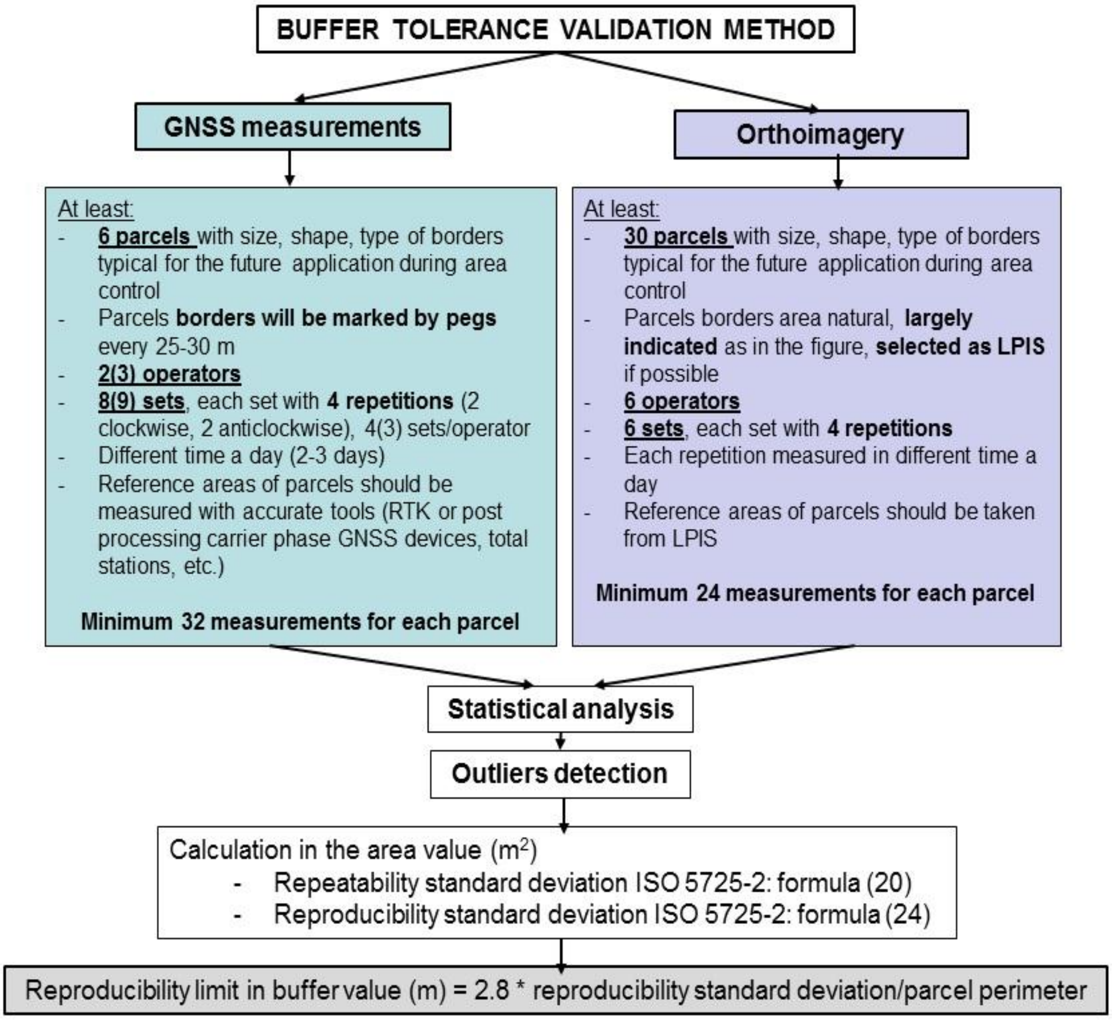
The tolerance will be based upon the nominal scale of the digital map dataset which acts as source material. The values related to map scale are given in Table 1.

5.4. JRC 'Area measurement tool validation method'

The validation method is designed to determine the inherent tool error (accuracy). It should be set to limit as much as possible other possible errors (e.g. bad use of instrument, non-respect of parcel border …). It is not a proficiency test. The result of the validation is strictly related to the tested method of measurement and not only to the device. Therefore the certificate or the validation report remains valid as long as the operators use the tested method.

The quality of a measurement tool can be characterized by a number of parameters such as its bias, precision and accuracy. Assuming there is no bias, it can also be characterized by its reproducibility limit, which is the parameter used to determine the technical tolerance.

The buffer validation method for both GNSS devices and ortho-imagery, is summarised in the following flow chart:



A. Data collection

- A. 1. For validation of GNSS devices

The test shall cover hardware, software, settings and method

The test parcels should have unambiguous borders to ensure that all measurements cover the same object (for instance the borders could be marked with wooden sticks with a density of at least 1 peg per 25m); objects should be of variable sizes (at least covering the range over which the GNSS should be working, for instance between 0.2ha and 4ha) and shapes (at least one elongated parcel should be included).

Number of fields

The more fields chosen for the test, the more reliable the assessment: more data collected give more points on the receiver characteristic curve. It is recommended to take at least 6 fields with sizes spread along the typical size range of the country.

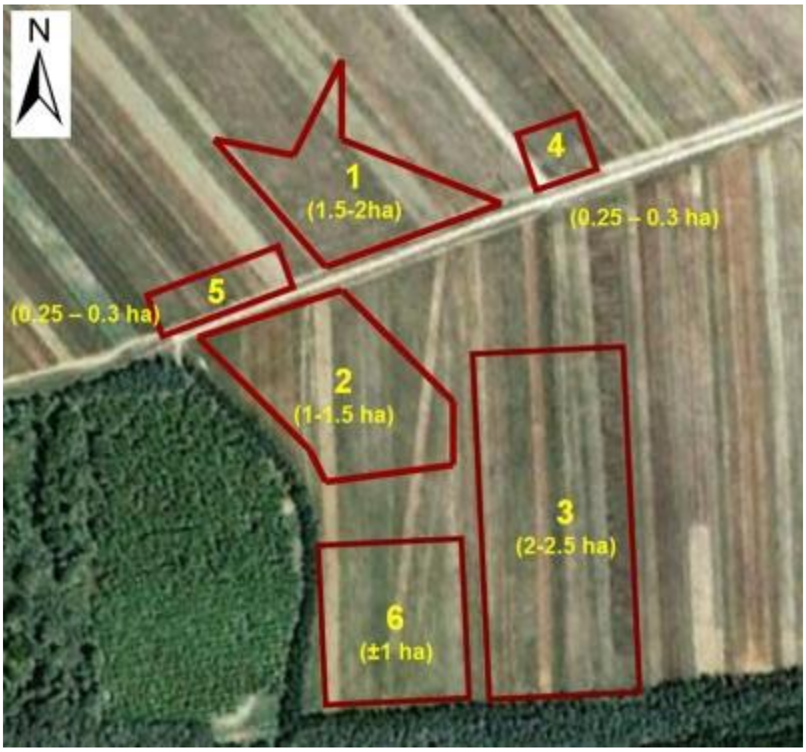
Shape

The shape of the fields should vary from very simple shapes (e.g. rectangular) to some irregular shapes with high perimeter to area ratio

Obstructions of the horizon

Validation test results conducted showed, a high impact of horizon obstruction on the buffer, e.g. parcels with trees to the south often show a significantly higher R-limit than parcels without tree obstruction. Selecting most test parcels in an open horizon environment is likely to result in a (low) buffer which may not be appropriate to the usual conditions in which the device is used.

Terrain characteristic and the type of cultivation is an important issue due to possible disturbances of the satellite signal. In mountainous areas or on fields (partly) bordered by trees, the "visibility" of the satellites may be limited, which may result in higher measurement errors. If parcels with partially obstructed borders are common in the region or country, such parcels should be included in the test so as to reflect the average conditions of measurement in the region/country.



Example of reference shapes set

Comfort of walking

The test fields should have easily accessible borders (no stones, bushes to cross, marshy spots etc.) to allow operators to feel comfortable while walking around the borders. This will reduce the impact of the operator on the result of the measurements.

Reference value

Standard deviation of measurement repetitions should be estimated against a reference area of the considered parcel. The reference area of the test parcels should be established with a surveying tools or GPS RTK measurements. It can also be taken from a LPIS reference area if a reference shape corresponds to it.

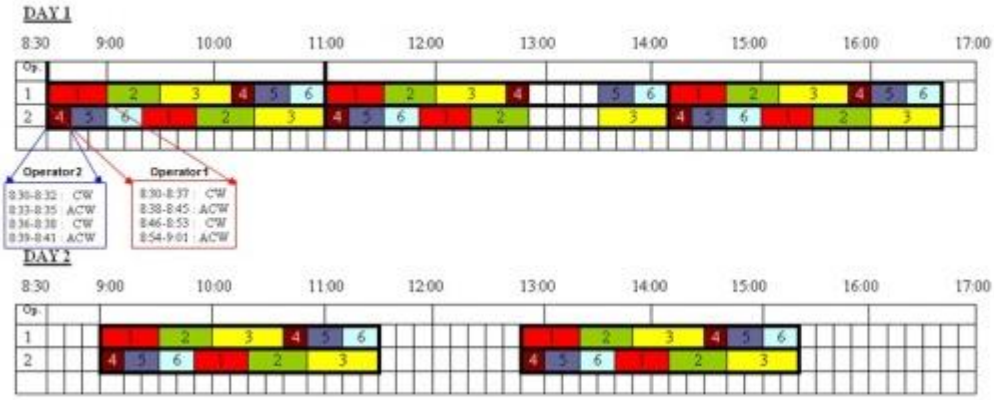
Repetitions

The GNSS constellation should be considered as relatively stable while collecting data on each field. In other words, the time needed to measure one field four times is short

enough (normally 10 to 30 minutes, depending on the perimeter of the field) to consider the satellite constellation as stable. The four measurements taken in a short period of time, by the same operator, will allow to derive the repeatability variance of the area measurements.

Runs (sets) of measurements

The revisit time for the GPS satellite constellation is equal to ~12h. In order to make measurements under different constellations (i.e. different number of satellites and different satellites in view), the different runs should start at different times of the day. At least 1.5 - 2 hours should be left between two successive runs so as to consider that the satellite constellations have changed. The variance between runs of measurements will be used to derive the reproducibility variance of the area measurements.



Parcel	Approximate perimeter	Estimated time to measure the **4 repetitions** (1 set = CW, ACW, CW, ACW) for each field
1	500-600 m	± 30 min
2	500-600 m	± 30 min
3	650-700 m	± 40 min
4	± 200 m	± 15 min
5	± 250 m	± 20 min
6	± 400 m	± 30 min
Total for one set		2:30h - 3:00h

An example of organization of field measurements for 6 parcels with 2 operators

Settings

Perform the test with exactly the same settings that will be used during OTS check work (max DOP, S/N ratio, logging interval).

Method

Perform the test with exactly the same method that will be used during the on-the-spot-check (**continuous logging** of the points along the field border, or **log of the vertices** of the field). In case of area measurement done by logging of the vertices of the reference fields, the distance between two successive vertices should not be greater than 25m. This is to "simulate" the natural landscape measurement conditions, where the borders are rarely straight and data are logged more frequently than when measuring rectangles. **As during the real field controls there are situations where the GNSS device is used in *continuous* AND *vertex* measurement method we strongly recommend to validate the device for the both methods.**

Avoiding systematic errors

Operators should not disturb each other while measuring so if possible one operator should measure one parcel at one time. If this is not possible, special attention should be paid to the location of the antenna while passing each other. In order to avoid potential systematic errors related to left/right handed operators, the direction of walking when measuring fields should be both: clockwise and anticlockwise: e.g.: for all the runs: 1st repetition – always clockwise, 2nd repetitions always anticlockwise, 3rd – clockwise, 4th – anticlockwise.

- A.2. For validation of orthoimagery

For orthoimagery, since repetitions of measurement are less time consuming than field measurement, the minimum number of parcels and repetitions could be increased as follow.

  – Selection of **at least 30 parcels**. In order to ease the work, it is advised to select parcels corresponding to LPIS reference parcels (reference area already available). Otherwise it will be necessary to measure the reference area on field using a surveying tools or GPS RTK measurements.

  – Area measurements of these parcels performed by **at least 6 operators** (for proper statistical analysis)

  – Each operator performing **at least 4 measurements** (repetitions) of each parcel (for proper statistical analysis)

For what concerns the parcels' selection:

- Parcels selected should be a representative sample of the control area zone (strongly related to the parcel structure)
- Parcel sizes should cover the range observed in the control area
  - S : small
  - M : medium
  - L : large
- Parcel shapes should vary
  - SF1 : compact
  - SF2 : elongated
  - SF3 : very elongated
- Some parcels should be selected with easily identifiable borders as to avoid interpretation problems and lead to some parcels rejections later on during the analysis

Remarks concerning choice of the parcel size and shape ranges

Before parcel set definition (size and shape) statistical analysis of the parcel structure on the area to be controlled should be performed. In the first step parcel areas are sorted and

5% of outlying values are discarded (percentiles: 97.5% and 2,5%). In the next step the remaining range is divided by 3 equal parts (small, medium and large size). Parcel area and perimeter allow for Shape Factor calculation (SF=(perimeter/4)^2/area). The same procedure should be performed for SF (compact, elongated and very elongated parcels).

Example of parcel set (30 parcels):

- good border: 15 parcels
  - S and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels
  - M and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels
  - L and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels
- "fuzzy" border: 15 parcels
  - S and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels
  - M and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels
  - L and SF1/SF2/SF3 - 2/2/1 i.e 5 parcels

Example of parcel border

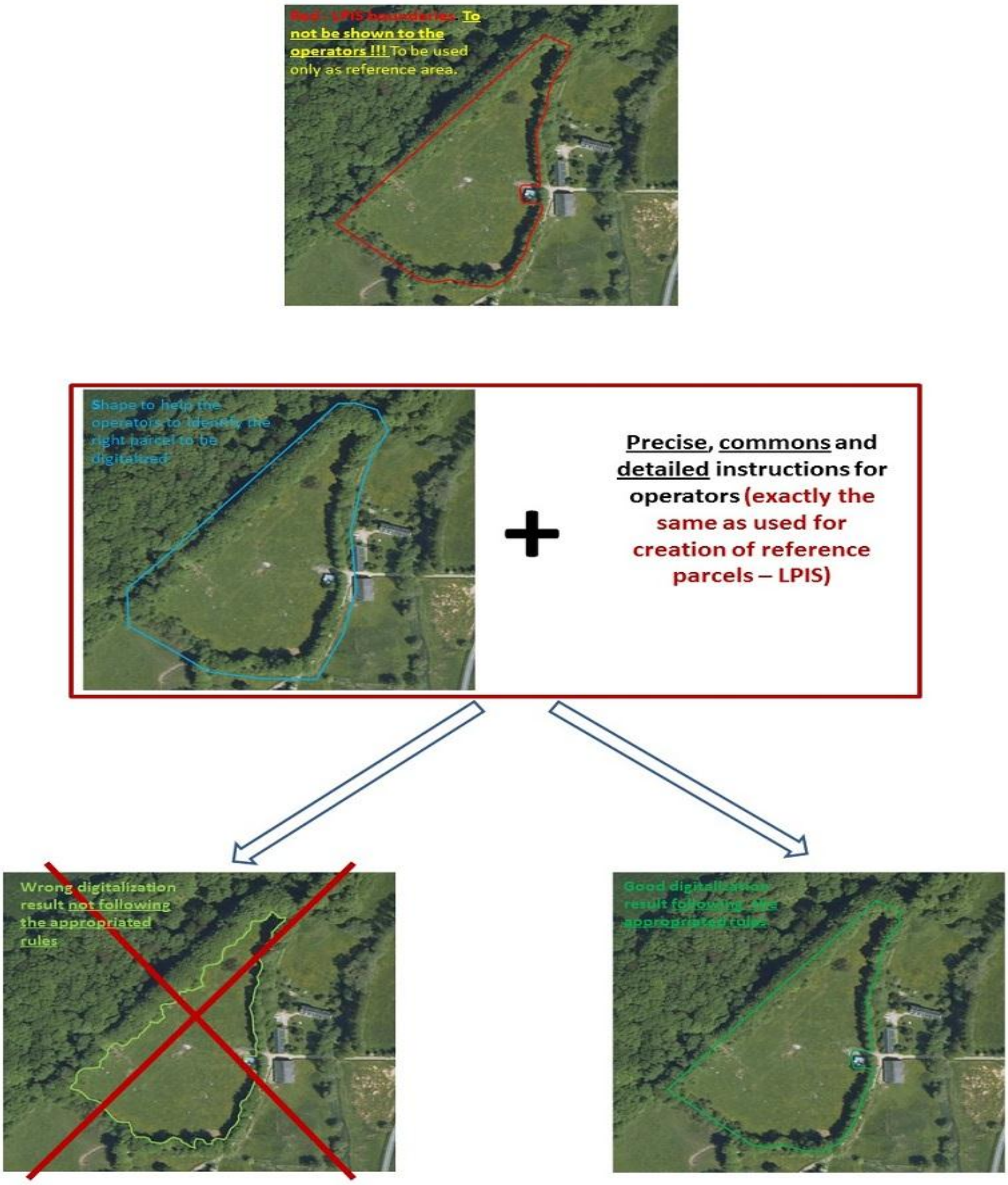
Some examples are provided hereafter in order to illustrate the concepts of ‘easy border’, ‘fuzzy border’ and ‘borders leading to interpretation problems’.

Examples of ‘easy’ and ‘fuzzy’ borders that should be part of the parcels sample

Examples of parcels with limits difficult to delineate (photo interpret) and that should not be part of the selected parcels sample.

Precise, commons and detailed instructions (exactly the same as used for creation of reference parcels – LPIS if parcel based LPIS available) have to be given to the photo interpreters.

For field parcels, pegs are provided to clearly identify parcel borders. For ortho-images it is not possible to provide the equivalent of pegs otherwise there will be a risk that photo interpreters digitize these vertices/lines not doing interpretation of the image. So as guide for interpretation, a shape surrounding the parcel to be measured, has to be created in advance for all parcel in the sample, and shown on the screen during the measurement.



As for the GNSS validation protocol, the reference area and perimeter of the test parcels should be established (from LPIS if available or performing field measurement using surveying tools or GPS RTK measurements).

B. Statistical analysis

- Collected data

The results of the area measurements performed in validation process should be collected like in Table A of ISO 5725. In each cell there is measured parcel area (in this case in square meters). Each 4 repetitions define one set, or used in ISO 5725 one laboratory, or sometimes called one run. So one operator delivers 3 sets (in GNSS validation, see diagram above and table below). Level in ISO 5725 means in our validation procedure - parcel (6 parcels: A, B, C, D, E and F - 6 levels).

Table A

Observation results (9 sets per parcel, 4 repetitions per set)

Operator - i	Lab - L	Repetition k	A	B	C	D	E	F
			Level - j parcel					
			y_i					
set, run laboratory	1	1	5386	2981	14123	4372	9647	1877
		2	5319	3020	14135	4362	10288	2308
		3	5344	2944	14136	4380	10028	1890
		4	5295	3021	14123	4399	10223	2168
1	2	1	5341	2968	14122	4321	9277	1936
		2	5366	3133	14130	4423	10333	2282
		3	5377	2971	14102	4379	9541	1850
		4	5341	3036	14104	4390	10291	2245
	3	1	5367	2972	14129	4362	9913	1875
		2	5362	2979	14128	4399	10321	2337
		3	5366	2952	14135	4335	10027	1979
		4	5371	2979	14120	4017	10374	2264
2	4	5	5327	3040	14137	4408	9683	1824
		6	5358	3064	14151	4384	10539	2242
		7	5322	3054	14131	4389	9786	1847
		8	5352	3042	14186	4316	10460	2253
	5	5	5398	3032	14135	4367	9815	1890
		6	5382	2908	14134	4342	10416	2287
		7	5328	3020	14112	4422	9904	1890
		8	5367	3023	14148	4420	10299	2220
	6	5	5350	3022	14106	4356	9876	1859
		6	5386	3013	14103	4392	10303	2278
		7	5340	2661	14103	4363	9975	1890
		8	5342	3044	14105	4359	10189	2281
3	7	9	5394	2947	14073	4302	10044	1971
		10	5345	3014	14060	4350	10165	2191
		11	5341	2856	14088	4372	10077	1955
		12	5381	3064	14054	5180	10242	2192
	8	9	5337	3020	14125	4428	9940	1962
		10	5354	2966	14126	4383	10221	2100
		11	5372	3038	14118	4405	10063	2024
		12	5393	2952	14139	4396	10188	2153
	9	9	5365	3018	14110	4467	9972	1923
		10	5361	2956	14115	4378	10234	2460
		11	5390	3025	14180	4457	10079	1875
		12	5369	3039	14112	4399	10355	2460

- Basic statistics

Next for each parcel mean area and standard deviation for each set is calculated (Table B and C in ISO 5725-2).

Table B - Recommended form for the collation of the means

A	B	C	D	E	F
5335,9	2991,7	14129,4	4378,1	10046,5	2060,8
5356,5	3027,0	14114,4	4378,3	9860,5	2078,3
5366,3	2970,6	14127,8	4278,5	10158,8	2113,8
5339,4	3049,9	14151,0	4374,0	10117,0	2041,5
5368,9	2995,5	14132,2	4388,0	10108,5	2071,8
5354,5	2935,0	14104,3	4367,6	10085,8	2077,0
5365,3	2970,3	14068,7	4551,1	10132,0	2077,3
5364,0	2994,2	14127,2	4403,0	10103,0	2059,8
5371,2	3009,7	14129,3	4425,4	10160,0	2179,5

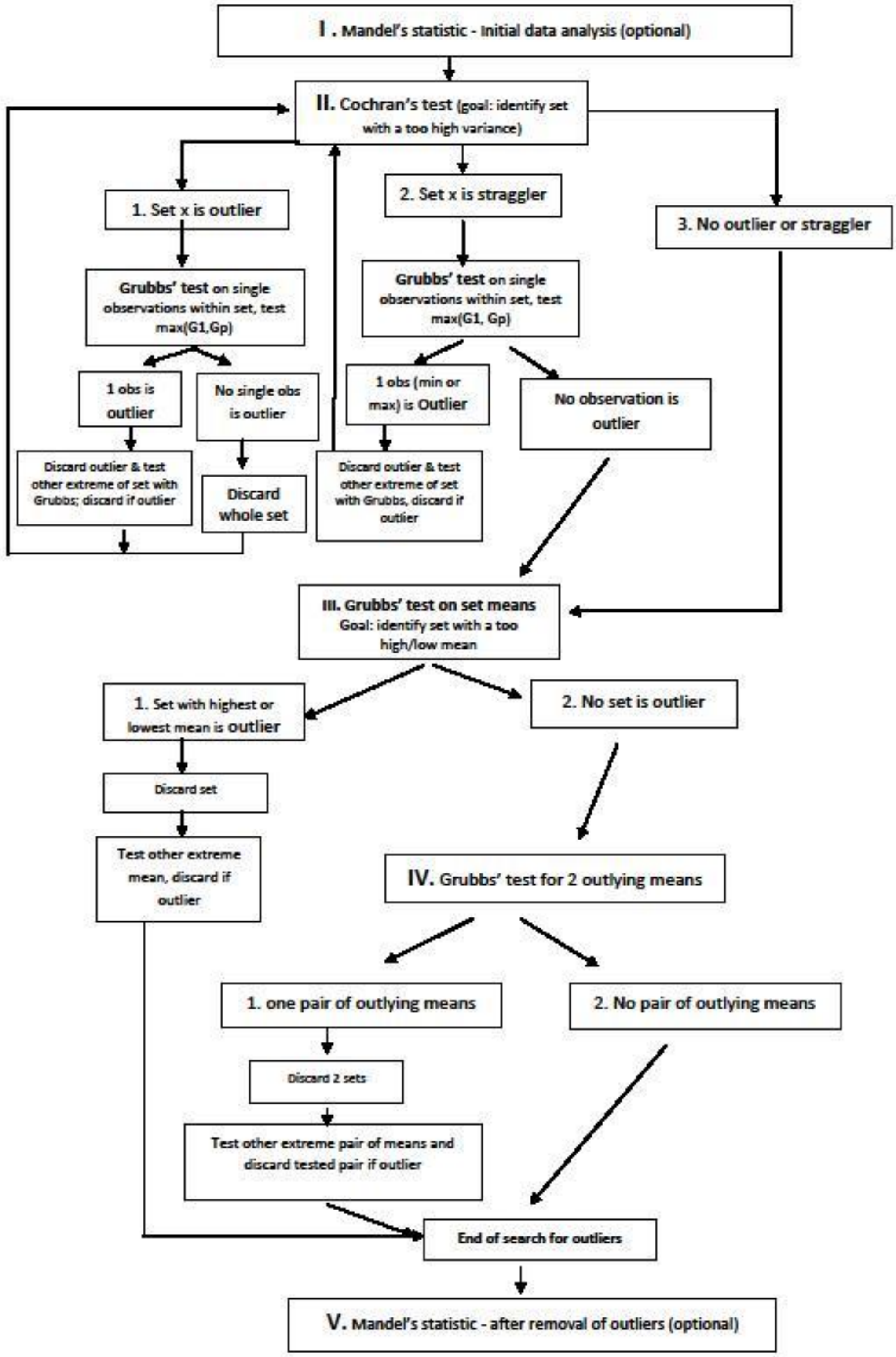
Table C - Recommended form for the standard deviation

A	B	C	D	E	F
18,27	77,29	13,93	42,38	532,65	217,30
3,80	12,80	6,04	176,14	223,91	221,79
17,82	11,17	24,68	40,05	444,84	238,10
29,84	58,53	15,03	39,81	293,72	211,64
21,62	182,91	1,50	16,53	195,04	234,17
26,43	90,13	15,13	420,42	89,36	132,09
23,86	41,70	8,76	18,87	128,22	83,96
12,92	36,68	33,90	43,58	168,73	324,49

- Outliers detection

The statistical parameters concerning the buffer tolerance value should be calculated only for the dataset free of outliers. Therefore the collected data need to be tested for outliers see flowchart below. Cohran's test is described in chapter 7.3.3 and Grubss' test in chapter 7.3.4 of ISO 5725-2.

- **Cochran's test** checks variation of standard deviation between classes.
- **Grubb's test** checks variation of means between classes, standard deviation is calculated between classes.
- **Grubb's test for single observation** checks variation of observed value in class (standard deviation is calculated within class).


I . Mandel's statistic - Initial data analysis (optional)
II. Cochran's test (goal: identify set with a too high variance)
1. Set x is outlier
2. Set x is straggler
3. No outlier or straggler
Grubbs' test on single observations within set, test max(G1,Gp)
Grubbs' test on single observations within set, test max(G1, Gp)
1 obs is outlier
No single obs is outlier
1 obs (min or max) is Outlier
No observation is outlier
Discard outlier & test other extreme of set with Grubbs; discard if outlier
Discard whole set
Discard outlier & test other extreme of set with Grubbs, discard if outlier
III. Grubbs' test on set means
Goal: identify set with a too high/low mean
1. Set with highest or lowest mean is outlier
2. No set is outlier
Discard set
Test other extreme mean, discard if outlier
IV. Grubbs' test for 2 outlying means
1. one pair of outlying means
2. No pair of outlying means
Discard 2 sets
Test other extreme pair of means and discard tested pair if outlier
End of search for outliers
V. Mandel's statistic - after removal of outliers (optional)

Cochran's test statistic C

$$C = \frac{s_{max}^2}{\sum_{i=1}^{p} s_i^2}$$

s_i – standard deviation for *i* set

s_{max} – the highest standard deviation of the all sets

Grubbs' test statistic G

$$G_p = (x_p - \bar{x})/s$$

where

$$\bar{x} = \frac{1}{p}\sum_{i=1}^{p} x_i$$

and

$$s = \sqrt{\frac{1}{p-1}\sum_{i=1}^{p}(x_i - \bar{x})^2}$$

p- number of sets

x_i – mean area in *i* set

During the outliers' detection, follow the flowchart above and perform the tests according ISO 5725-2

After the outliers removing tables: A, B and C are modified. It is recommended to put the reason of outliers discarding in table A. Single observations or all sets can be removed.

- Calculation of repeatability and reproducibility

After outliers detection the uncertainty of parcel area measurements is estimated.

ISO 5725-1

- **Repeatability standard deviation**: the standard deviation of test results obtained under repeatability conditions.
- **Repeatability conditions**: conditions where independent test results are obtained with the same method on identical test items in the same laboratory by the same operator using the same equipment within short intervals of time.
- **Reproducibility standard deviation**: the standard deviation of test results obtained under reproducibility conditions.
- **Reproducibility conditions**: conditions where test results are obtained with the same method on identical test items in different laboratories with different operators using different equipment.

$$s_{rj}^2 = \frac{\sum_{i=1}^{p}(n_{ij}-1)s_{ij}^2}{\sum_{i=1}^{p}(n_{ij}-1)}$$

s_{rj} – standard deviation of repeatability
j – level (parcel)
i – set
n_{ij} – number of repetitions for set i and parcel j
s_{ij} – standard deviation for set i and parcel j

$$s_{Rj}^2 = s_{rj}^2 + s_{Lj}^2$$

s_{Rj} – standard deviation of reproducibility
s_{rj} – standard deviation of repeatability
s_{Lj} - between-laboratory standard deviation (ISO 5725 – 2 chapter: 7.4.5.2)
j – level (parcel)

	A	B	C	D	E	F
srj^2	552,8492	2583,9474	164,8867	1124,1431	63545,2292	39031,0833
sLj^2	24,5992	57,3501	504,1034	282,3688	-14463,8653	-9575,2738
sRj^2	577,4484	2641,2975	668,9901	1406,5119	63545,2292	39031,0833

- Verification of bias and influence of pooling factors

According the interlaboratory tests performed in the past and during ongoing projects the significant, repeatable and rigid influence of parcel border quality on the value of reproducibility was observed. Any other factors should not influence the validation results. However we observed in some cases the bias, influence of the operator, walking direction, measurements day, parcel area and size etc. But generally we expect no bias and no influence of any factors presented in the table below. Therefore we recommend performing bias test (basing on the formulas in IS0 5725-2 chapter 7.4.5, ISO 5275-4 chapter 4.7.2 or T-Student test). Influence of the other factors is recommended to verifying using ANOVA analysis.

No significant, repeatable, rigid influence	
GPS	**orthoimagery**
Parcel size Parcel shape	
No - bias (difference between mean measured parcel area and reference area)	
Skilled/unskilled observer (however training is strongly recommended)	
Direction of walking	
Day, time (satellite constellation)	

Significant influence	
GPS	**orthoimagery**
Mask (i.e. trees on the parcel border)	Quality of the parcel border (good and bad)

- C. Buffer tolerance estimation

Repeatability and reproducibility standard deviations are for each parcels in square meters. Reproducibility limit in area values [m^2] depends on parcels so for the standardization it should be divided by reference perimeter to obtain reproducibility limit in buffer values [m].

According ISO 5725-6 chapter: 4.1.4: when examining two single test results obtained under reproducibility conditions, the comparison shall be made with the reproducibility limit (in our case: buffer limit): RL=2,8 (sRj in buffer).

	A	B	C	D	E	F
sRj^2 [m^4]	577,4484	2641,2975	668,9901	1406,5119	63545,2292	39031,0833
sRj [m^2]	24,0302	51,3936	25,8648	37,5035	252,0818	197,5629
perimeter [m]	296,38	391,59	468,27	269,00	608,13	400,00
sRj in buffer = sRj/perimeter [m]	0,0811	0,1312	0,0552	0,1394	0,4145	0,4939
Buffer limit = 2,8 sRj in buffer	0,2270	0,3675	0,1547	0,3904	1,1607	1,3829

- D. Classification of the buffer width for a measurement tool

Reproducibility limit calculated in validation process allows classifying the area measurement method to the one of the following classes:

- (1) "1.5m" for RL inside (1.25m, 1.5m];
- (2) "1.25m" for RL inside (1.0, 1.25m];
- (3) "1.0m" for RL inside (0.75m, 1.0m];
- (4) "0.75m" for RL inside (0.50m, 0.75m];
- (5) "0.50m" for RL below 0.50m.

Mean value of repeatability in buffer for our example: 0,61 m so the validated method is classified into class (4): buffer limit taken to the control should be: 0,75 m

- E. Report from validation

Report from validation should include following informations:

- (1) Validated equipment: type of GNSS receiver with software (type and version), serial numbers of each entity, metadata about orthoimagery (type, resolution, uncertainty from quality control etc.)
- (2) In the case of GNSS receivers:
    - device settings (elevation mask, max DOP, etc.)
    - details about the validated method: vertex + number of logs per vertex / continuous + logging interval

   - use of differential correction and type of correction
   - measurements with or without external antenna

- (3) reference parcels areas and perimeters, details about the measurements method applied for reference measurement
- (4) design of parcels set
- (5) table A with some explanation if needed (notice about the not normal procedure, applied equipment if changed or shared between operators, gross error etc.)
- (6) basic statistic before outliers discarding: table B and C
- (7) results of outliers testing: table A with the removed single observations and/or all sets
- (8) repeatability and reproducibility standard deviation in [m^2] and in buffer values [m]
- (9) results of bias analysis and ANOVA analysis
- (10) buffer limit and class of the validated method
- Test data

An example of xls file containing the collected data from an area measurement validation test can be found on WikiCAP (http://marswiki.jrc.ec.europa.eu/wikicap/images/4/41/Validation_test_data.xls)

- F. Documentation needed when the statistical analysis is to be made or validated by JRC

1. In case a MS decides to entrust JRC with the statistical analysis after data collection, the following information should be sent to JRC for final analysis:

- Report from validation of the test carried out by MS (points: 1-5). Last four points (6, 7, 8 and 9) will be prepared by JRC (outliers detection, repeatability and reproducibility standard deviation calculation, buffer limit determination and result of method classification).
- Detailed description of validation procedure (protocol) should be delivered.
- Raw measurements data
   - In the case of GNSS - a copy of the measurement protocol indicating parcel id, date and time, set, repetition, operator, direction of measurement, area measured, perimeter measured.
   - In the case of orthoimagery validation all vector files should be delivered.

A technical report and the data will document the whole validation process; they will help JRC to evaluate and analyze the data as well as to draw conclusions on the tolerance

to be used with that device and measurement method. The final statement on the performance of the system will be prepared by the JRC on the basis of the test results.

2. In case a MS decides to perform the validation tests and the statistical analysis by itself a technical report, data and the sheets with the statistical analysis (templates to be asked to JRC) should be sent to the JRC for validation, final assessment and publication of the results on the JRC web page.