Peer Review of the LPIS QA Framework

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Introduction

Located in Ispra (Northern Italy), the Institute for Environment and Sustainability (IES) is one of seven institutes that constitute the Joint Research Centre (JRC), a Directorate-General of the European Commission. The mission of the IES is to provide scientific-technical support to the European Union's policies for the protection and sustainable development of the European and global environment.

Within the Institute itself, the GeoCAP Action, part of the Monitoring Agricultural ResourceS Unit, provides long-term support to the European Commission services and Member States' administrations for the effective implementation of Common Agricultural Policy (CAP) legislation. It addresses new information needs for European Policies related to Agriculture and Regional Development, such as Cross Compliance, Farm Advisory System, food quality and product origin traceability. Furthermore, the Action supports future reforms by the definition, development and testing of standardized and sustainable control methods in a variety of agriculture-related areas across the Union and in Candidate Countries.

To support and perform an administrative control of farmers' declarations, Members States had set up an identification system of agricultural parcels and perform an annual assessment of their Land Parcel identification System (LPIS) implementation. Art.6(2) of E.C. Regulation 1122/2009 provides the legal basis on seven quality elements to be assessed and reported.

The GeoCAP action has developed extensive technical guidance to ensure reliability and comparability of the test results that come from this annual assessment. This framework has generally been well received by the Member States but there was also a call for an independent technical assessment of the various technical elements in the LPIS Quality Assessment (QA) framework. Two experts were asked to perform a systematic meta-evaluation (i.e. evaluation of the evaluation) of the procedures and quality measures included in the LPIS QA documentation. The first expert focuses on "data quality aspects", while the second one focuses on "CAP-LPIS" assessment.

This joint report is produced by two experts, responding to the call and contract of DG Joint Research Centre, IES, MARS Unit. The two complementary reports address two different aspects of the Land Parcel Identification Systems' Quality Assurance Framework (LPIS QA), therefore they can be used as separate ones:

a/ the data quality in the LPIS QA plus its relation to the ISO standard and

b/ the quality system, its elements, the clarity and completeness of the documentation for the Member States (technical) administration.

Both authors have been active experts in spatial data acquisition and spatial data quality for over a decade.

Part I - A review of the data quality aspects of the LPIS QA framework

Sytze de Bruin

Arnold Bregt is acknowledged for his contribution to this part of the review. His contribution particularly involved verifying compatibility with the ISO19157 standard and for proposing modifications related to this compatibility.

1 Assessment questions data quality aspects

The following assessment questions needed to be addressed by the data quality expert:

- Assess the technical and scientific **validity** of the observations and derived values from the **LPIS QA** inspection by confrontation with comparable inspection procedures **in other GI domains**;
- Assess **compatibility** of the inspection procedure **with the ISO191xx standards**;
- **Propose**, where appropriate, **possible modifications** that would improve the reliability and robustness of the applied QA methods, as well as enhance cost-effectiveness of the inspection procedure.

The sections below first describe the procedure used and next address scientific validity and compatibility with the ISO 19157 standard. Potential modifications are suggested within the respective sections. Our findings are summarised in a SWOT table and in the conclusions at the end of the report.

2 Documents and approach

The assessment was done using the following LPIS QA v5.1 documents (frozen on October 7, 2011):

- LPIS quality inspection: EU requirements and methodology;
- ANNEX I: LPIS data quality measures;
- ANNEX II: ETS inspection procedure – Description of the workflow;
- ANNEX III: The concept of land cover and "eligible hectares".

Assessment of the compatibility of the inspection procedure with the ISO191xx standards is based on:

- ISO/CD 19157 Geographic information – Data quality October 2010, which cancels and replaces ISO 19113:2002, ISO 19114:2003 and ISO/TS 19138:2006.

Literature consulted for assessing the technical and scientific **validity** of the observations and derived values from the **LPIS QA** inspection includes:

- Anonymus, 2011. Member State feedback Q&A, version 5.1 from Wikicap: http://marswiki.jrc.ec.europa.eu/wikicap/index.php/Member_State_feedback_and_Q%26A.
- Bogaert, P., Delincé, J., Kay, S., 2005. Assessing the error of polygonal area measurements: A general formulation with applications to agriculture. Measurement Science and Technology, 16 (5), pp. 1170-1178.
- Cochran, W.G., 1977. Sampling techniques. Third edition. John Wiley & sons New York.
- De Bruin, S., 2008. Modelling positional uncertainty of line features by accounting for stochastic deviations from straight line segments. Transactions in GIS, 12 (2), pp. 165-177.
- De Bruin, S., Hunter, G.J., 2003. Making the trade-off between decision quality and information cost. Photogrammetric Engineering and Remote Sensing, 69 (1), pp. 91-98
- De Bruin, S., Heuvelink, G.B.M., Brown, J.D., 2008. Propagation of positional measurement errors to agricultural field boundaries and associated costs. Computers and Electronics in Agriculture, 63 (2), pp. 245-256.
- Goodchild, M.F., Clarke, K.C., 2002. Data quality in massive data sets. In: Abello et al. (eds.) Handbook of massive data sets. Kluwer Academic Publishers, Dordrecht, pp. 643-659.
- Gorokhovich, Y., Voustianiouk A., 2006. Accuracy assessment of the processed SRTM-based elevation data by CGIAR using field data from USA and Thailand and its relation to the terrain characteristics. Remote sensing of Environment, 104, pp. 409-415.

- ISO 2859-2 Sampling procedures for inspection by attributes -- Part 2: Sampling plans indexed by limiting quality (LQ) for isolated lot inspection.
- Jessen, L., 2010. Kwaliteit van de basisregistraties adressen en gebouwen (versie 2010). Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Den Haag: http://bag.vrom.nl/ufc/file2/bag_sites/krista/33a1615472210766daaa060093348e12/pu/Kwaliteit_van_de_BAG_2010.pdf.
- Land Information New Zealand, 2009. Standard for the geospatial accuracy framework. LINZS25005, 21 September 2009: http://www.linz.govt.nz/sites/default/files/document/25005-Standard%20for%20the%20geospatial%20accuracy%20framework%20-%20LINZS25005_4.pdf.
- Milcinski, G., Kadunc, M., Vidmar, M., Cerovski, T., Okorn, A., Petkovsek, T., Rotter, A., and Vitas, D., 2010. Uncertainty of LPIS data or how to interpret ETS results. Proceedings of the 16th GeoCAP Annual Conference. Including the supplementary material available via: http://www.sinergise.com/docs/articles/2010-Uncertainty_of_LPIS_Data_or_How_to_Interpret_ETS_Results-Supplementary_material.pdf.
- Stombaugh, T.S., Sama, m.p., Zandonadi, R.S., Shearer, S.A., Koostra, B.K., 2008. Standardized evaluation of dynamic GPS performance. ASABE paper 084728, ASABE Annual International Meeting, Rhode Island, June 29-July 2.
- USGS, 2007. Network, Cumberland Piedmont , USGS/CSS/BIP/Center for Biological Informatics, 200705, Guilford Courthouse National Military Park Vegetation Mapping Project - Field Plot and Accuracy Assessment Points: http://biology.usgs.gov/npsveg/guco/metagucofield.faq.html
- Van Buren, J., Westerik, A., Olink, E.J.H., 2003. Kwaliteit TOP10vector - De geometrische kwaliteit van het bestand TOP10vector van de Topografische Dienst, Kadaster - Concernstaf Vastgoedinformatie en Geodesie.

3 Validity of LPIS QA with comparable inspection procedures in other GI domains

The following items were addressed in a comparison of the LPIS quality assessment with similar assessments elsewhere:

- Acquisition of reference data;
- Use of quality measures and quality elements;
- Internal consistency of the documentation;
- Thresholds;
- Sampling.

Each of those items is addressed in a separate subsection.

Note that so far I have not come across a comparable effort of operational spatial quality assessment that also thoroughly applies the ISO 191xx standards. Therefore most of the references used in this chapter have an academic background. Examples of practical procedures are: Jessen (2010), Land Information New Zealand, (2009), USGS (2007), Stombaugh et al. (2008) and Van Buren et al. (2003).

3.1 Acquisition of standard data

In contrast to several other quality control systems (e.g. Jessen, 2010,) the LPIS QA framework strictly addresses product quality rather than process quality. This implies that (after a model conformance test; see section 5.1) the LPIS implementation of a member state is to be compared against an *independent* dataset that is accepted as a *standard* (e.g. Goodchild and Clarke, 2002; Land Information New Zealand, 2009; Gorokhovich and Voustianiouk, 2006; Stombaugh et al., 2008; USGS, 2007; Van Buren et al., 2003). For example, Stombaugh et al use a fixed and precisely measured trajectory that is traversed by a GPS receiver mounted on a cart, while Van Buren et al. (2003) used an independent topographic dataset acquired by terrestrial measurements and aerial verification. Below the latter type of data is referred to as the "standard data set".

In the LPIS QA, the standard data set is obtained by interpretation of ortho-imagery, i.e. a similar procedure by which LPIS itself is being developed. However, for practical reasons (lack of resent fine resolution imagery), the used imagery may be of lower quality than the imagery used for creating the

LPIS. Therefore, like any data set, the standard data set is not free from error and one may even wonder how to obtain a standard data set is more accurate than the LPIS implementation that is being tested.

Recommendation: *Investigate alternatives for obtaining a good quality standard data set, for example using finer resolution ortho-imagery coming available later in the season. Data recentness as well as image resolution and image quality should be considered in decision making about the data used for creating the LPIS QA standard data set.*

Annex II of the LPIS QA gives instructions on the visual scale (between 1:1000 and 1:5000) at which imagery is to be interpreted and image contrast enhancement that may lead to a better accuracy than that of the product that is being evaluated. Nevertheless, as shown by de Bruin et al. (2008) agricultural fields digitised at a scale of 1:4300, i.e. within the recommended range, are vulnerable to considerable digitising error leading to errors in the overlap with true geometry as well as errors in the measured area. The test reported in that work was done on a rather large field (approx. 15 ha) having a simple shape.

In contrast to earlier work by Bogaert et al. (2005), Milcinski et al. (2010) showed that not only the field size influences uncertainty about the area of fields, but also their shape. Possibly, differences between the results obtained by the latter groups of authors were caused by the field shapes considered in their work as well as by differences in (not) accounting for serial correlations between vertices. Note that such correlation can be easily incorporated in error models (Bogaert et al., 2005; de Bruin et al., 2008) while failure to represent shapes properly can also be modelled (de Bruin, 2008). However, to avoid dependence on models (which are disputable), a tailored digitising experiment could be conducted to assess the effects of field shape and size on geometrical uncertainty. Field shape and size can affect both the fields in LPIS and those in the standard data set. Resulting uncertainty should be acknowledged when applying thresholds on differences between areas recorded in the LPIS and those in the standard data set. Note that field size is already taken into account in table 8 of annex I and that JRC is aware of discussions about the importance of field shape.

Recommendation: *Further investigate the need and feasibility of accounting for field shape and digitising error in the definition of thresholds on differences in eligible area (area purity).*

According to the ETS workflow in annex II, the operator should re-delineate the land cover from scratch. Nevertheless, this is done after a first feasibility inspection. Digitising of the standard data set is therefore not performed independently from the inspection of the reference parcels. This may lead to bias in the interpretation results. In the worst case and violating instructions, there is a risk that the standard data will be derived from the LPIS, which would --of course-- invalidate the QA.

Recommendation: *Feasibility inspection and re-delineation of fields should be done by different operators to ensure that an independent standard dataset is acquired.*

3.2 Use of quality measures and quality elements

JRC has chosen to avoid direct reference to spatial accuracy and uses derived thematic accuracy measures instead. This is a perfectly valid approach: both the LPIS and the standard dataset are a tessellation of the terrain into eligible land, non-eligible land, landscape features and non-agriculture landscape features. Positional errors will thus translate into thematic errors (cf. Goodchild and Clarke, 2002) which are assessed.

The recorded measures are however spread over a multitude of tables (2, 3, 4, 5, 6, 8, 10, 11) in annex I of the QA, where some tables refer to measures that are aggregates of data used in other tables. I found this rather confusing. It is also not fully clear to me by which methods area estimated are obtained (apart from the small elements whose areas are visually assessed (table 2)). Identification of fields appears to be done by spatial overlay. Overlay operations also allow determination of the areas used in the different tables, but I do not know if this is suggested or recommended.

Whether performed in a GIS or by other means, overlay of LPIS and the standard data set will produce polygons that are correctly classified, others representing false inclusions and yet others representing false exclusions of the different thematic categories. The derived alpha-numerical data are currently

scattered over at least eight tables, which partly address recognition of spatial elements, assessment of areas (parameters) and comparison of parameters against conformance levels. Regrouping the information may lead to a clearer documentation.

Recommendation: (see also section 4.2) *Make a clear difference in the documentation between description of the data quality measures, their assessment, their evaluation and the presentation of results.*

3.3 Internal consistency of the documentation

It occurs to me that DQ_ConformanceLevel in table 8 of annex I and section 3.2.3 of the document "LPIS quality inspection: EU requirements and methodology" should refer to the to the same conformance level. This is not the case, however.

Note that the link < LPIS QA technical documentation section > on the LPIS page of WikiCAP leads by default to out-dated 4.3 documentation.

Recommendation: *Check and if necessary correct the conformance level stated in section 3.2.1 of the document "LPIS quality inspection: EU requirements and methodology".* Check and if necessary correct links to the LPIS QA documentation in the WikiCAP.

Recommendation: The recommendations listed under 3.2 and 4.2 also provide means for improving internal consistency of the documentation.

3.4 Thresholds

Thresholds on quality measures should ideally be defined taking into account the intended use of the data set (e.g. de Bruin and Hunter, 2003). This link to *usability* is not explicitly made in the QA documentation assessed for this review. The origin of thresholds remains unclear and occasionally confusing terminology is used. For example, it is clear to me how the hypergeometric distribution (ISO 2859-2) can be used to find acceptance numbers. However, the relation between a proportion of 5% incorrectly recorded areas and a limiting quality of 12.5 is not clear from the examples provided.

Recommendation: *Where possible, provide explanation or motivation for the thresholds which are linked to the use of LPIS. Avoid confusing terminology referring to thresholds on the same quality measure . As noted elsewhere, Thresholds are best presented in a separate section since they may be subject to change without needing to change other parts of the QA.*

3.5 Sampling

Estimation of lot statistics can benefit from stratified sampling or alternative sampling strategies, which may lead to a higher precision. For example, simple random sampling from a full population that includes subareas that are known to be internally homogeneous but mutually contrasting will give a larger sampling variance than when stratified random sampling would be used. Of course, inference needs to be adjusted according to the sampling design. For example, calculation of the sample mean from a stratified random sample needs to account for the stratum weights (Cochran, 1977).

Recommendation: *Previous QA results (once available) and known issues in regional LPIS implementations may provide a basis for stratified random sampling, with which a higher precision can be achieved. If alternative sampling designs are adopted, inference from the sample should be modified accordingly.*

4 Compatibility with the ISO 19157 standard

The key standard for data quality is the ISO/CD 19157. This standard was prepared by Technical Committee ISO/TC 211, Geographic information/Geomatics. This standard cancels and replaces old ISO data quality standards: 19113:2002, ISO 19114:2003 and ISO/TS 19138:2006. The standard is currently in its inquiry stage (step 40.20), which means that currently this draft standard is under ballot. It is not accepted as a formal international ISO standard yet, small changes are still possible. Notwithstanding its draft status, we propose to use this standard for the compatibility assessment. The main reasons are 1) the standard is almost finished and no major changes are to be expected and 2) this standard will be the data quality standard for the coming 5 years and 3) LPIS quality assessment (QA) should keep up with the development in QA.

As a starting point for the assessment of the compatibility of LPIS QA with the ISO 19157 standard the latter is taken as point of departure. The main aspects of the ISO 19157 are compared with the current LPIS QA implementation. Separate attention is paid to LPIS-ATS and LPIS-ETS. Recommendations for improvement of the LPIS QA system and documentation are given.

4.1 ATS and ISO 19157

In Table 1 the relation between the LPIS-Abstract Test Suite (ATS) and the and the ISO 19157 quality elements is presented.

Table 1. Relation ATS and ISO 19157

Quality element ISO 19157	**LPIS-Abstract Test Suite (ATS)**
Completeness	X
Logical consistency	X
Spatial accuracy	-
Thematic accuracy	-
Temporal quality	-
Usability	-

X: LPIS data quality element present in ISO 19157, -: Quality element of ISO 19157 not present in LPIS.

The role of LPIS-ATS is the test of model conformity, i.e. is the proposed model in line with intended model. In the documentation an explicit link is made with two data quality elements. This link seems obvious, but the test if a model is in line with the intended model is not the real scope of the ISO 19157. The focus of the standard is "to describe, evaluate and report data quality". It is applicable "to assess how well a dataset conforms to its product specification". The term abstract test suite is used in ISO 19157, but in a different meaning. It specifies the conformance of a data quality testing procedure with ISO 19157.

Quote from ISO 19157:

> *Any product claiming conformance to this International Standard shall pass all the requirements described in the abstract test suite presented in Annex A as follows:*
> *1) A data quality specification shall pass the tests outlined in Clause A.1;*
> *2) A data quality measure shall pass the tests outlined in Clause A.2;*
> *3) A quality evaluation process shall pass the tests outlined in Clause A.3;*
> *4) Data quality metadata shall pass the tests outlined in Clause A.4;*
> *5) A data quality report shall pass the tests outlined in Clause A.5.*

Recommendation: *Change the term ATS in the LPIS documentation (suggestion: change it to "Model Conformance Test"). Do not link the ATS in the LPIS documentation with the ISO 19157 standard, it does not really fit.*

4.2 ETS and ISO 19157

In Table 1 the relation between the LPIS-Executable Test Suite (ETS) and the and the ISO 19157 quality elements is presented.

Table 2. Relation ETS and ISO 19157

Quality element ISO 19157	**LPIS-Executable Test Suite (ETS)**
Completeness	X
Logical consistency	-
Spatial accuracy	-
Thematic accuracy	X
Temporal quality	X (called temporal accuracy)
Usability	-

X: LPIS data quality element present in ISO 19157, -: Quality element of ISO 19157 not present in LPIS.

LPIS uses three out of the six data quality elements of the ISO 19157. In the LPIS documentation the term temporal accuracy is used and also a LPIS quality measure on logical consistency is presented.

Recommendation: *Change the term "temporal accuracy" in the LPIS QA documentation to "temporal quality".*

According to ISO 19157 date quality measures are used to evaluate data quality elements. In the ISO 10157 standard (ANNEX C) a set of commonly used data quality measures are specified. Data quality measures are described using technical components. The following are specified within the ISO 10157 standard:

Quote from ISO 19157:

- *measure identifier (7.4.1)*
- *name (7.4.2);*
- *alias (7.4.3);*
- *element name(7.4.4);*
- *basic measure (7.4.5);*
- *definition (7.4.6);*

– *description (7.4.7);*

– *parameter (7.4.8);*

– *value type (7.4.9);*

– *value structure (7.4.10);*

– *source reference (7.4.11);*

– *example (7.4.12);*

Within the LPIS documentation also data quality measures are used. They are described in ANNEX I. The format used for describing LPIS data quality measures is derived earlier ISO 191xx reporting data quality format for meta data, with as a result a too complicated description of the LPIS data quality measures.

Recommendation: *Describe the LPIS data quality measures with the components presented in ISO 19157.*

Recommendation: *Perform an mapping of the LPIS data quality measures against the common set of data quality measures provided in the ISO 19157.*

In the ISO 19157 standard a clear division is made between:

1) *measure;*
2) *evaluation;*
3) *result.*

In the LPIS documentation this division is also visible, but less clearly divided in modular blocks. A sharper division of these three aspects is recommended. This provides much flexibility development of the LPIS Quality Assurance framework and clearer set-up of its documentation and instructions.

Recommendation: *Make a clear difference in the documentation between data quality measures, its evaluation and the reporting of results.*

In the ISO 19157 standard ample attention is given to metaquality elements. In short it is defined at assessment of the quality assessment.

Quote from ISO 19157:

Metaquality elements may be used to provide a set of indications which allows qualifying a quality evaluation result. The knowledge about the quality of a given result is indeed often of the same importance as the result itself.

EXAMPLE: a reported positional accuracy based on a very small sample is less reliable than the same figure based on the whole population.

Metaquality may be described using the following elements:

– *Confidence;*

– *Representativity;*

– *Homogeneity.*

The issue of metaquality is in the LPIS quality assurance system mentioned, but not systematically addressed. The use of metaquality evaluation is an attractive instrument for the EU and the member states, because it provides insight in the quality of the values of the quality measures, identifies weak spots in the quality assurance system and is easy communication and debate.

Recommendation: *Include the ISO 19157 descriptors of metaquality in the LPIS quality assurance system.*

In the LPIS quality assurance system also conformance levels are specified for the LPIS quality measures. These conformance levels define acceptable levels for a particular use, e.g. EU regulations. These levels are not part of the quality description as such, but are external thresholds for the evaluation of the results of quality measures. They are user, context and application specific. Within the LPIS quality assurance system is advisable to make this clear separation between the measuring of data quality and the judging of the results of the quality measures. The latter, being quite often subject to political debate and disputes.

Recommendation: *Make in the LPIS QA system a clear difference between the description, evaluation and reporting of data quality (the scope of ISO 19157) and the judging of the results (the role of users, policy makers).*

5 Strengths, Weaknesses, Opportunities and Threats (SWOT) related to data quality aspects

Below our findings are summarised in a SWOT table, where:

- strengths are helpful to achieving the objectives of the LPIS QA and are of internal origin;
- weaknesses are internal attributes of the QA that are harmful to achieving the objectives;
- opportunities are external attributes (of the environment) that help achieving the objectives;
- threats are external attributes harmful to achieving the objectives.

Swot table quality aspects

	Helpful	Harmful
Internal	**Strengths:** • The LPIS QA is a unique effort implementing a comprehensive quality assessment using ISO standards. • The LPIS is dynamic rather than static and JRC uses feedback from member states to improve the system. • JRC plays a central role in the implementation of the LPIS QA (no *ad hoc* organisation).	**Weaknesses:** • Acquisition of standard data suffers from weaknesses: (1) limited quality; (2) there is a risk that the data are not independent; (3) potentially variable quality in space. • Origin of thresholds is unclear; should be science and policy-based. • Documentation should be clearer and better structured, with a clear distinction between the description of the quality measure, its evaluation and the presentation of results This also applies to the WikiCAP.
External	**Opportunities:** • The LPIS QA deals with an important subject (also under the new CAP) involving a substantial part of the EU budget. • Improved readability can be achieved by adopting ISO 19157, which makes a clear distinction between: (1) quality measure; (2) evaluation of the measure; (3) result. • Presentation of the result should specifically target operational, strategic and tactical levels of decision making.	**Threats:** • The LPIS QA is complex and quality assessment in general is often poorly understood, which may lead to resistance when implemented in the member states. • Only in case of acute problems management is prepared to invest in quality assessment; otherwise there is limited energy.

Part II - A review of the LPIS QA framework from the CAP-LPIS aspects

Gábor Csornai

Linda Grácia Tóth is acknowledged for her contribution to this review. Her contribution was very important particularly because of her direct involvement in the implementation of the LPIS QA elements in a member state technical administration. She shared her experience in the real QA process, its easy and difficult areas as well.

1 Importance of the new LPIS QA system

The role of an LPIS/IACS is to prevent, control the potential risk for undue payments and help the farmers in the declaration and the control officers in their activity. Therefore the objective of the LPIS Quality Assessment system is accordingly to reliably indicate and measure the extent, the given LPIS system meets these requirements.

In the previous years, there was only one quantitative requirement in the quality assessment of LPISs, the 75/95% rule (previous Art.6(2) of EC Regulation 1122/2009). It was clear that the EC became not satisfied by the controlling value of this rule. In other words, they found problems at MSs LPIS when this criterion was definitely met. Because of the given necessarily short time of EC audit missions, it was quite general that they selected a very biased sample, to show the shortcomings and problems to the MSs. Then the audit reports expressed concerns on the quality of the LPIS referring to the findings of this many times biased sample. It was then the task of the MSs to justify, that those reported bad examples refer only to a small subset of the RPs. The justification was sometimes hard or impossible, so the final consequences, sanctions also depended from it. This situation called for a reinforced quality assessment framework for the LPISs that ended up in the present one.

The renewed LPIS QAF is a major development and a very important step forward to a relevant, accurate characterization of the quality of an LPIS for its compliance capability to the basic objectives. Its basic idea is that the proper sampling of the RPs, definite, unambiguous quality measures and their computation rules/methods and the threshold values provide a very good, useful basis, evidence, a ground This ground is good either to the MS self-assessment and the references when inherent disputes take place between the EC and the MS.

Even if there are some little problems, shortcomings to improve in items of the QAF its main objective to put the QA to an objective, measurable, relevant, and common platform, succeeded to achieve. There is a need for further refinement and development of the system! The way as it has been done with DG JRC organization and the active participation of MSs should follow in the future, too.

The CAP-LPIS viewpoint in mind during this part of the review is very wide. It necessarily should have used a focus or a main viewpoint to apply. In this review I decided to use ***the importance of the LPIS quality assessment and easier, more objective and established conclusion over its findings.*** This is the common most important and determining viewpoint of the EC and Member State administration who to operate CAP and one of its pillars in the IACSs: the LPISs. This is why I found irrelevant to list little problems, temporary or inherent difficulties or resources investment that had been needed. The difficulties were present certainly also in the former quality assessment system, yet this renewed QAF may have a lot more potential in use.

The common abbreviations used are collected at the end.

2 Assessment of the meta-evaluation criteria of all quality elements

The LPIS quality is assessed through specific measures that are to characterize the capabilities of an LPIS. The group of quality elements can characterize the problems of the given LPIS, and can also help to create and execute a remedial action plan. This way the MS should eliminate revealed threatening

factors from the system. It is a good tool for self-assessment and to map all the LPIS system's anomalies. It can also serve as a common, objective reference basis in the disputed issues between the Commission and the MS.

The QA should be done in a common, regulated, transparent, quantified and objective way. Member States want to comply the rules in general and also avoid penalties for their irregularities. DG JRC has obviously invested vast efforts to make technical guidelines easy to understand and interpret by introducing many references to relevant parts of the documentation and by giving a very detailed instruction for execution and evaluation of most of the quality elements. Fusion of ANNEX I and former annexes IV and V also had a very good effect on clarity and simplification in the execution of the test.

For a better understanding the list of prime quality elements and their thresholds are included:

Quality Element	Name	Threshold
QE1	The correct quantification of the maximum eligible area	[98%, 102%]
QE2	The proportion of reference parcels where the maximum eligible area takes ineligible areas into account or where it does not take agricultural area into account	≤ 5%
	The distribution of reference parcels where the maximum eligible area takes ineligible areas into account or where it does not take agricultural area into account	-
QE3	The categorisation of reference parcels where the maximum eligible area takes ineligible areas into account or where it does not take agricultural area into account	≤ 5% each
QE4	The occurrence of reference parcels with critical defects	≤ 1%
QE5	The ratio of declared area in relation to the maximum eligible area inside the reference parcel	-
QE6	The percentage of reference parcels which have been subject to change, accumulated over the years	≤ 25%
QE7	The rate of irregularities determined during on-the-spot-checks	> 0.05

Including non-agricultural land into the eligibility layer evidently involves risk to the Fund. Excluding agricultural land from the system makes it impossible for the farmer to declare that land. An area becoming eligible can be caused by land change or Regulation reforms. Both cases of inclusion and exclusion should be detected and their number reduced to the minimum. QE1 serves as an effective tool to this. Determination of the rate of recorded and observed eligible area in the LPIS QA sample and further analysis of the problem's nature in case of failure is an efficient way to reveal imperfections in the maintenance of an LPIS.

QE2 maps those reference parcels where LPIS includes non-agricultural area or excludes agricultural area. This quality element seems to be reasonable, together with its threshold.

Recommendation: *some definitions (e.g. LUI, contamination) seem to be unclear, therefore they might lead to some ambiguity in interpreting the measures. Thus their refinement might be reasonable.*

QE3 deals with causes of non-compliance, giving the threshold 5% for each category. This categorisation is a very effective tool to draw the MS's attention to specific maintenance processes or defects of administration that might introduce systematic problems. MSs might benefit from further investigation of the cases involved, and by creating an action plan they will have a basis for negotiation with EC if needed.

In version 5.1 quite another approach to QE4 has been introduced by discarding the list of waivers, renaming critical defect entities and rephrasing conditions in one step. A new type of critical defect has also been included. MSs' feedbacks seem to have been taken into account, and conditions for critical defects appear to be reasonable, although the assessment of their fitness for purpose, as well as the thresholds', are quite hard and might only be properly done after first year's evaluation.

Recommendation: *a more detailed definition for "multi-parcel" critical defect to avoid ambiguity and misinterpretation seems to be needed.*

In the past, many Member States claimed IACS data quality not to have an effect or relation to LPIS quality and therefore objected its inclusion into LPIS QAF. In version 5.1 scope of quality elements 5-7 has been modified and focused to reference parcels involved in current year's quality assessment which is an acceptable compromise.

The most disputed measurement, the QE5 'ratio of declared/maximum eligible area' has no longer a conformance threshold. The reason, cause of under-declarations should be a study topic for further investigation. For a MS to get a better understanding of its IACS processes and the attitude of the farmers, and it should be proven that there is no relationship between under-declaration and the undue payments.

LPIS cumulative land changes (QE 6) has also been brought to an LPIS QA level. It is also linked to the measure and the non-compliance "Changes of underlying land were not applied". An annual rate of non-conforming reference parcels per zone is calculated. This suggests an assumption that every zone has been updated the same year as a whole.

Recommendation: *Since a control zone's entire area is not necessarily updated in the same year, subdivision of the set of reference parcels for this quality element might be more effective and meaningful only according to the number of years since the reference parcels were last updated.*

Recommendation: *Rules for accumulation of the annual rate should be further refined in respect to those cases where update is done rotationally. Those MSs that do their update in one step, can start from zero after the process, but other MSs have no such option to eliminate irrelevant elements.*

Note: *measures calculated by completely different QA rules (2010: changes identified by administrators or indicated by farmers, 2011: some non-conforming RPs, rules of non-compliances still change), for completely different areas (2010: whole country, from 2011 on: zones that change every year) are accumulated*

Recommendation: *Start over the accumulation from 2011, as completely new rules have taken place.*

Such a tool as an annual change rate might be applicable for many different goals, assessing update cycle's fitness for purpose in terms of length, or to find certain areas or time intervals where/when more changes can be observed than in others, if any. Methodology – use of aggregation, just to mention one viewpoint – and thresholds should be chosen with respect to the desired aim.

Recommendation: *Give a motivation to this quality element.*

QE7, "OTSC rate of irregularities" has been transformed into an assessment to find out whether LPIS non-conformities significantly affect the rate of irregular applications, with clear and detailed instructions.

Generally, most quality elements can be stated to be fit for purpose, and their thresholds to be set properly. Thanks to their changes up till now, they became strong tools for the MSs to self-assess themselves, and to the EC to have a set of comparable and objective measurements.

3 Review of the support documentation and online technical guidelines (WikiCAP) in terms of clarity and completeness

The evaluation, assessment of ***clarity and completeness of the documents*** should be done with a special care, taking into account the specific introduction period of an entirely new quality assessment of the LPIS systems. Both the clarity and completeness certainly develop and can be assessed at a certain time, e.g. today, with the LPIS QA version in effect. The clarity and completeness have been remarkably helped by the different related workshops, conferences and bilateral meetings.

The approximate volume of the relevant documentation is around 300 pages. The overlap is fairly little that suggest a strong threaded structure. This can be used and consulted through word searches.

MS experts who have been involved in the LPIS maintenance and also in QA for several years and accumulated remarkable expertise can find their way. The MS most likely would welcome a concise, unified *training package* for their new staff. This effort by the MSs should be minimized in the way that a special team/interest group (DG JRC + MS experts) should produce this revised package.

The system of documents is under continuous update. The many feedbacks, suggestions are taken into consideration and built into the revised text of the document.

WikiCAP has proven to be a very useful TOOL, way of distribution and information base for keeping up and communicating the most up to date community knowledge, skills and requirements through the topics, issues, items! This is quite a radical improvement in the EC information support history of its programs' support and coordination!

The system has inherently some problems, limitations. This can be noticed in the word search and the finding of all the components of a certain issue.

Note: *content of the PDF documentation files – which provide valuable further information – are excluded from the scope of the built-in word search tool.*

Recommendation: *Creators of the online documentation should refer to any further information about the different issues or maintain a 'lookup table' similar to the function of 'index' in a textbook. This would enable the readers to find the relevant information they need, without doubt of its most recentness.*

The skills, experience, devotion and co-operation readiness should also be taken into account when evaluating the ***clarity of the documents***. Therefore the opinions of the MS LPIS experts and administration staff might differ. In general, it can be stated that the ***LPIS QA documents and WikiCAP are clear and their descriptions can be understood and implemented in the LPIS QA procedures, the execution of the tests.***

The completeness e.g. –as well as the clarity- can be measured by the questions of the MSs during the preparation and the execution of the ATS, ETS tests. There is no information available of any MS, where these tests were impossible to accomplish because of the problems. This means that the DG JRC program was successful in fully inform the MSs and also in provision them by tools completely. Very rich illustration materials have been provided to the MSs to refine their understanding in the LPIS QA.

Both the clarity and completeness of the documentation have continuously been improved by the feedbacks of the MSs. The LPIS QAF related events, conferences and workshops, plus the bilateral information exchange with the MARS Unit have clearly contributed to the standardization of the QAF and the interpretation of some elements, execution steps or meaning of the quality elements. The thematic presentations of the workshops have been made continuously and immediately available to the community. The materials of these should be treated as an integrated part of the relevant documentation. ***It can be stated that the documentation and online information on the LPIS QAF is complete***.

4 SWOT table of the LPIS QAF system from the Member State technical administration viewpoint

The focus in this SWOT assessment covers the LPIS QAF system from the definitions up to the production and report of the QAF measures. Primarily summarizes their capabilities to reflect and measure the quality of the LPIS. However the last item in opportunities necessarily steps out of this range, but was thought inevitable to mention because of its importance.

STRENGTHS	**WEAKNESSES**
• the new QAF of LPIS is a big step forward in the assessment of a MS LPIS quality • it provides transparent, consistent sampling and evaluation procedure for the RPs QEs computation to create the system of quality measures • these measurements provide a set of clear findings/measures that characterize the quality of the MS LPIS objectively and comparably • LPIS QAF is a good self-assessment tool that helps to reveal unknown systematic and unique anomalies of the MS's system • LPIS QEs is capable to be a common ground and reference basis to refer to its findings in the disputes (EC-MS) • most of the quality element thresholds have firm and consistent ground	• frozen version for current year's campaign relatively late (e.g. deadline, RFV) • smaller ambiguities in the interpretation and the implementation of the measures' computation
OPPORTUNITIES	**THREATS**
• QE7 might give the opportunity to lower the sample size of OTSC • creating and maintaining an index would enable the reader to find the relevant most recent documents and on line information he needs • definition, motivation, evaluation, threshold and reporting of quality elements should be much more strictly separated • some guidelines, rules, directives should be developed for the application of the quality measures constellation and their evaluation by the European	• the needed effort and time to accommodate to continuous changes (reading, interpreting, training, developing/modifying software) makes hard to report without delay • ambiguity might lead to different interpretations, decreasing comparability

Commission	

Overall conclusions

I - Regarding data quality aspects

The LPIS QA is a unique effort implementing a comprehensive quality assessment using ISO standards. No comparable system was found during the review. The LPIS QA also deals with an important subject involving a substantial part of the EU budget.

The LPIS QA version 5.1 gives a good basis for an operational assessment tool of the LPIS implementations by member states. In its current form it can be used for self-assessment. However, using LPIS QA version 5.1 for justification of LPIS quality to the EC or in disputes involves risks, as expressed in the following conclusion.

Acquisition of the data used for testing the LPIS suffers from weaknesses:

(1) the test data are of limited quality, because they are based on interpretation of imagery that may have a lower resolution than the imagery used for creating the LPIS. Differences between the two data sets may thus point to quality issues of the test data set. Member states are free to purchase or acquire better quality imagery, but at their own expense, which makes it an unlikely solution;
(2) there is a risk that the test data are not independent because the LPIS is visually checked before re-digitizing reference parcels;
(3) the test data potentially have variable quality in space, because field shape and area may influence positional accuracy. The latter point needs further research.

LPIS QA documentation is extensive but rather complex. Improved readability can be achieved by adopting the new ISO 19157 standard for Geographic information data quality, which makes a clear distinction between:

(1) quality measures;
(2) evaluation of the measures;
(3) results.

One reason to make such a distinction is that if the presentation of results changes (e.g. different aggregation owing to a different sampling scheme such as stratified random sampling) may not require updating of the other parts. This conclusion also pertains to the WikiCAP, which can be better structured to allow finding documents without knowing the exact keywords.

To improve usability, presentation of the result should specifically target *operational*, *strategic* and *tactical* levels of decision making.

The origin of thresholds (conformance levels) is not always clear. Useful thresholds should be science and policy-based rather than be at an arbitrary level. The latter was admitted to be the case for some thresholds.

II - From a Member State technical administration viewpoint the given LPIS Quality Assessment Framework -

The developed LPIS QAF is a major step forward in all the components of the MSs LPIS quality assessment: the regulation, the development of the set of prime quality elements, the documentation and the guidance of the MS implementation. It was time for this development -quite a reform- from several viewpoints and has emerged from the immense experience basis and also the need of the community.

The new LPIS QAF has been operational for the 2nd year in 2011, plus these operations were preceded by a voluntary pilot year in 2009, to help preparations. It is widely tested, used and commented by the

Member States. All the operational results and problems were feedback and the experiences shared among the MSs and the Commission.

From the very beginning the development program for the renovation QAF has put a real emphasis onto the electronic documents' dissemination and update. Even with its limitations this was also an improvement for the MSs. The QAF online documentation and interpretation materials, the WikiCAP modules, plus the presentations of the related workshops and conferences together, build up a concise well defined guidance and reference system, helping the Member States to implement their respective LPIS QAF and assess their own LPIS by a common methodology and also share their experiences.

It is very important that the developed prime quality measures together can appropriately show the MS LPIS quality. Given the clear general requirements summarized by the regulations, he QAF system seems to be complete and responding to the former. Beyond the required adequacy that is obviously the main factor of the appropriateness of the new QAF, the steps to implement the annual LPIS quality self-assessment are of central importance. This required procedure is well based, has a firm ground, from the sampling the MS Reference Parcel units through the computation of the primary QEs and the reporting.

I do not see major conflicts referring to the conformance values, thresholds to QEs that are given where possible or applicable.

It was suggested that the combinations of the measures can sufficiently characterize the MS LPIS from different viewpoints (e.g. the risk for undue payment e.t.c.) and show a direction to the remedy if needed.

The new QAF is a good self-assessment tool for the MSs that helps to reveal unknown systematic and unique anomalies in the MS's LPIS.

One of the best results of the new QAF that LPIS QEs are capable to serve as a common ground and reference basis to refer to its measures' values, findings. The disputes are inherent between the European Commission and the Member States over the compliance of the operated systems e.g. the LPIS/IACS. This is more defined and should work more objectively and on a common platform over Europe. There should certainly be further refinements and update of the system by the experiences even in the area of the negotiations over the given QA result of a certain MS. See however the reservations regarding the test data set, above (overall conclusions part I.);

The operation of the renewed LPIS QAF needs substantial investment, continuous attention from the MSs. This is to return in terms of the standard better quality of the LPIS and also in the savings in the MS efforts in the presentation, justification their LPIS quality to the EC and also in the better position of the EC to conclude in

The substantial involvement of the MSs have been fairly wide in the build-up. Similarly, the necessary improvements, revisions, refinements should be made with the co-operation of the MSs. This helps to guarantee that with even the given palette of different environments, the MSs could do their QA task properly.

There is no system where improvements and simplifications could not be needed. These should evidently be done in the QAF as well. One should not assume that these two reports should point out all of them.

The LPIS QAF has different relevance and also relation to different decision or other bodies, responsible to the regulation, technical services, the operation of LPIS and LPIS QA or auditing that is shareholders of the whole system. The QE definitions, together with their evaluation methodology, the compliance thresholds plus the way of the reporting and documentation should be treated and controlled in a carefully separated manner. This can help the easier maintenance and upgrade the requirements of the QAF and still avoid to cause a profound remodelling need to all.

Abbreviations

CwRS	Control with Remote Sensing
EC	European Commission
IACS	Integrated Administration and Control System
DG JRC	DG Joint Research Centre (IPSC, MARS Unit)
LPIS	Land Parcel Identification System
MS	Member State
LUI	Land Under Inspection
OTSC	On-the-Spot Check
QA	Quality Assurance