JRC Technical Notes

Report on
LPIS Quality Assessment feasibility trial

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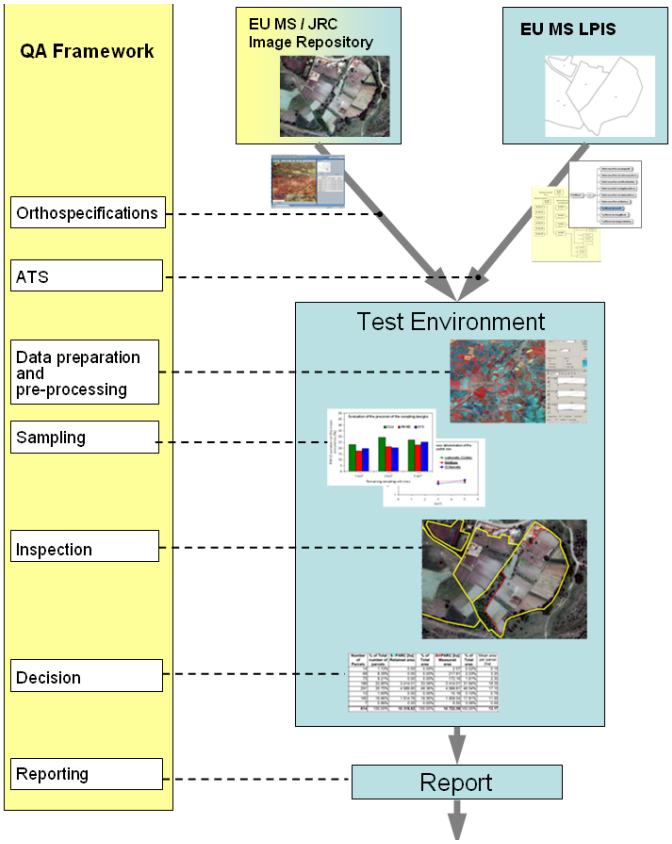

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1. Executive summary

1.1.1. This report presents the findings and conclusions of the feasibility trial on a proposed methodology for the assessment of LPIS quality by individual member states. The methodology distinguishes two major parts or phases: an Abstract Test Suite (ATS) to test data model conformance and an Executive Test Suite (ETS) to verify actual data value conformance. The trial was organised in the second half of 2009 and involved 5 anonymous member states for the ATS and 4 anonymous member states for the ETS.

1.1.2. ISO 19105:2000(E) Geographic information — Conformance and testing, specifies the framework, concepts and methodology for testing and criteria to be achieved to claim conformance.

1.1.3. The process of quality assessment involves three activities:

- **at the start**, to produce a Feature Catalogue of the Implementation Under Test (IUT). This defines and clarifies data types and the relationships amongst them.
- to perform an **initial Abstract Test Suite (ATS)**. The ATS allows for the verification of the LPIS model conformance of the implementation under test through a set of abstract tests.
- to run an **Executable Test Suite (ETS) annually** to inspect the continued ability of the LPIS data to unambiguously geographic locate agriculture fields and to quantify the area of eligible land. The ETS operates on measures for the seven prime quality elements.

1.1.4. An **Annual Report** has to be produced and delivered to the Commission upon completion of the ATS and ETS inspections. The report allows the MS to convey its findings to the European Commission. It holds a predefined mandatory data part and a conditional textual part.

1.1.5. The successful trial, described in this document, demonstrated that the quality findings were relevant and that methodology was both technically and practically feasible.

1.1.6. The results were integrated into a revision of the supporting documentation and in, February 2010, the revised methodology was imbedded in Regulation 2010R146, amending the CAP regulation 2010R1122.

2. Initial ATS conformance testing

2.1. Objectives and scope

2.1.1. The main aim of the LPIS-ATS is to provide a comprehensive test suite that enables conformity testing of the various LPIS implementations developed to address the common requirements laid down in the CAP regulations EC 73R2009 and EC 1122R2009 and their supporting working documents. The **LPIS Core Conceptual Model** has been designed to accommodate these regulatory requirements on the LPIS. The LCM specification can be found at http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Core-Conceptual-Model-for-Land-Parcel-Identification-System-LCM.

2.1.2. The **Abstract Test Suite (ATS)** is the set of abstract tests covering all the specific requirements to be satisfied for the conformance of the implementation under test. [ISO 19105]. In general **Abstract test** is a generalized test for a particular requirement. Abstract tests are independent of the actual implementation values, and their positional, temporal or classification accuracy. An ATS deals with data base structure logical and conceptual consistency, and how database design is 'fit-for-purpose'. Conformity of the model is a pre-requisite for a meaningful testing of the data values in the ETS.

2.1.3. In the overall conformance testing procedure the ATS represents the preparation phase for database testing (Figure 1):The part A 'Model Conformance Test', together with the Implementation Conformance Statement. ATS deals with data base structure logical and conceptual consistency, and with answering how the database design is 'fit-for-purpose'. The ATS shall be performed before starting the part B: Data Conformance (quality) Test – Executable Tests Suite (ETS).

The Conformance Test Report can be drawn up directly from the ATS or through part B.

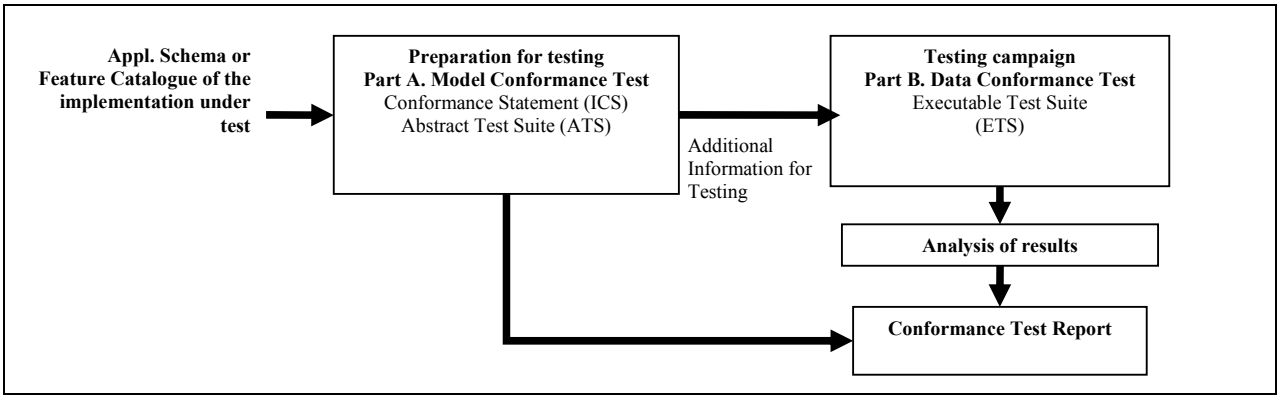

Figure 1. The LPIS inspection method (elaboration after ISO:19105)

2.1.4. The ATS feasibility study scope was:

- to provide methodology for testing and feasible set of tests;
- to test methodology by implementing ATS on real LPIS databases;
- to evaluate methodology, collect feedback and improve the ATS.

2.2. Methodology overview

2.2.1. The ATS implementation has the following three steps:

1. Preparation
2. Testing
3. Reporting

2.2.2. During step 1 the ATS input documentation is collected and compiled. This formal description of the LPIS under test should be an input to the remainder of the test. There are two options for this task: an Application Schema or a Feature Catalogue (FC) of the implementation under test. An **Application Schema** is a description of the LPIS implementation under test in a formal schema language and main data source for the ATS (preferable). According to ISO 19101, an application schema is a conceptual schema for data required for one or more applications (implementation). It provides the formal description of the data structure and content required by the application in a particular domain. An application schema specifies the spatial and non-spatial objects–features types- within domain-relevant view of the real world. An application schema is a conceptual **schema** for data required by one or more applications [ISO 19101:2002]. The feature types describe the core concepts by means of meaningful names, properties (attributes), possible constraints, etc. An application schema is documented in Conceptual Schema Language (e.g. UML). The XML/GML schema is another way to represent application schema. Both representation ways of application schema – UML diagrams and GML encoding – were used for the LCM specification (at http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Core-Conceptual-Model-for-Land-Parcel-Identification-System-LCM).

2.2.3. A **Feature Catalogue (FC)** is a formal description of the LPIS implementation under test and an alternative main data source for the ATS in case no application schema available. According to ISO 19101 it is a catalogue containing definitions and descriptions of the feature types, feature attributes, and feature associations occurring in one or more sets of geographic data, together with any feature operations that may be applied.

2.2.4. The **Implementation Conformance Statement (ICS)** is a description of the options, which have been implemented in the LPIS under test. The ICS accompanies the primary data source: application schema and feature catalogue. The ICS may be presented in form of plane text document or be generated by a structured questionnaire which documents the capabilities of the implementation under test. The ICS is to be provided by the authority claiming conformance with the LCM. This statement can include (non-exclusive list):

- type of payment scheme (SPS/SAPS) and presence of other CNDP schemas and coupled payments (title IV);
- type of Reference Parcel, including national definition translated in to English, history of LPIS system development and upgrades, evolution of parcel definition and reason for changing of type of reference parcel (if applicable);
- rules for producing the Reference Parcel identifier;
- 'eligibility profile' – how different land cover types, which are necessary for different payment schemes, are mapped in the database (see also ETS annex III, table 2);
- process of determination of maximum eligible area for Reference Parcel;

- flowcharts for operations;
- findings of recent audit and mitigation actions, etc.

2.2.5. The second step is an actual '**testing**' or inspection procedure. During this step the equivalence of features and attributes of the LCM is established with the help of the schema/feature catalogue of the LPIS under test. The implementation under test can have more data sets, features and attributes than the LCM, but only those, which are conceptually corresponding to the elements of the LCM shall be tested. Testing can be done by either simple comparing of member state schema/feature catalogue description against the LCM technical specification or via application schema mapping. The former approach was applied during this feasibility study. Tests findings are documented in the **ATS-log report**, one record per each test.

2.2.6. The **ATS-log** report forms the basis for **ATS-scoreboard and conformance statement report**, which are produced during step 3: **reporting**. Finally, the ATS reporting package shall consist of:

- input documentation (application schema OR feature catalogue)
- the ATS-log report
- ATS-'scoreboard' and conformance statement report.

2.3. Preparation phase

2.3.1. The preparation of the input documentation is the most time-consuming step of the ATS. It can trigger several iterations and involves experts dealing with different parts of the IT system.

2.3.2. How to create a database specification from UML model / application schema specification document?

For creating and editing the UML model /application schema, special modelling software shall be used (e.g. Enterprise Architect, Altova UModel). This software allows to export the implementation model/application schema into a database/ system specification document. The documentation shall contain:

- the UML diagrams illustrating overall model and its logical parts,
- the description of each feature type (spatial and non spatial object)
- the description of feature type properties such as attributes (definitions, data type, allowed values, constrains)
- the description of association dependencies (generalisation, aggregation, composition etc.)

An example of such documentation is the LCM technical specification.

2.3.3. How to create a Feature Catalogue?

The template for Feature Catalogue used was adopted from ISO19110 (2003) standard, it can be downloaded from: ftp://mars.jrc.ec.europa.eu/LPIS/Templates/FC_template_v0.xls.

The methodology behind is explained in:

http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/LPIS-Core-Conceptual-Model.

This template of the feature catalogue retains the original structure of the ISO standard. However, for the sake of further clarity in feature type semantics, additional, non-ISO fields were included in the the feature type and feature attribute tables. These, following, entries are specific to the LPIS domain.:

- LCM_discussion: clarification of the definition.
- LCM_example: exemplary values from a MS implementation (not necessarily a "best practice" example)
- LCM_reference: reference to the Regulation
- LCM_comment: various comments

2.3.4. The first worksheet contains two tables: FC_metadata and FC_summary. The FC metadata table contains information necessary for FC identification such as name, scope, responsible organisation /person etc. The table of FC summary contains information on content of the catalogue:

- feature types (usually corresponds to spatial or non spatial data set/layer/table);
- the classification of feature type such as core data –for determination of area of reference parcel-, data for SMR or GAEC, spatial data on rural development or cartographic reference, etc..
- geometry types - such as polygon, line, point, buffer, no geometry (for tables)
- source types - such as maintained by LPIS custodian, external - integrated into LPIS from different sources, shared - on-line link/harvesting/web service to other system(s).

2.3.5. For each feature type in the catalogue one separate .xls worksheet was created. The feature_name_X should correspond to the name of the .xls worksheet where the feature is documented in the FC. The list of the features in the metadata FC_summary table corresponded to the number and the names of features described in catalogue. The template contains one example feature spreadsheet.

2.3.6. The feature type's worksheet (Figure 2) contains two types of table: one for describing the feature type itself, another for describing attribute(s) -one table per each attribute. The list of attributes in the feature table l corresponds to the names and number of attribute tables.

FEATURE TYPE	
Name:	***ReferenceParcel***
Definition:	unit for identification and geographical localisation of agricultural parcels.
Code:	RP1000
Feature Operation Names:	'caps area of AP(s)' – RP area is equal or more than sum of areas of declared AP(s) inside of RP'spatial overlap' – AP is inside of RP+ gets digitized area' – gets area from geometry'gets farmer's area' – gets sum area claimed by framer(s) from aid application database
Feature Attribute Names*:	M- uniqueID; referenceArea; effectiveDate; + C – digitizedArea; farmedArea
Feature Association:	RefrenceAP + UpdateDocument+ ParcelHistory;

Subtype of:	[Abstract Feature type]
LCM_discussion	May contain one or more agricultural parcels and may be cultivated by one or more farmers (or producers association). Does not necessarily cover a territory nationwide, but overlaps are not allowed.
LCM_reference	2004R0796 Art 2. (26)
LCM_example	
LCM_comment	Generalisation of reference parcels: Cadastral parcel, Agricultural parcel, Farmer's block, Physical block

Figure 2. Example describing 'reference parcel' feature type in feature catalogue. (* M – mandatory; O – optional; C – conditional)

2.4. Testing

2.4.1. During the ATS testing phase, equivalence of feature types and attributes of the LCM was established in the schema/FC of the LPIS under test. The implementation under test could have more data sets, features and attributes than the LCM, but only those which are conceptually corresponding to the elements of the LCM were tested. Testing can be done by simply comparing the member state schema/feature catalogue description with the LCM technical specification or via application schema mapping. Tests findings shall be documented in the **ATS-log** report, one record per each test.

2.4.2. The ATS has a hierarchical structure. Tests are combined into the modules (sub-modules). Conformance statement 'Conformant/nonConformant' was assigned to each test and aggregated to the module level. The ATS assigned the LPIS implementation as 'Conformant', if all modules are 'Conformant'.

2.4.3. The current version of the ATS contains three main modules of the tests:

A_11 Module: Definition of Reference parcel

A_12 Module: Eligibility and Land cover type

A_13 Module: Attributes of Reference parcel

- A_131 Mandatory attributes of Reference parcel
- A_132 Attributes for Cross-Compliance
- A_133 Attributes specific for reference parcel type

The content of the tests and modules is explained in the http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Conformance-test-for-LPIS-Core-Model

2.4.4. The tests of Module A_11 examine the definition of Reference Parcel in use. It requires the exhaustive definition of the reference parcel with all possible options, given in native language AND translated in English. Following all steps of the module leads to ONLY ONE conformant test. Module A_11 can be assigned 'Conformant', if one of the tests A_1113; A_1114; A_1115; A_1122; A_1123 is 'Conformant'. See also results aggregation table in 'reporting' chapter 1.5.2. The information on dataset(s) where geometry of reference parcels is stored in the LPIS database are also included in the ATS-log report. It is necessary to indicate ALL datasets/layers/tables with original names which they have in the MS database (e.g. layer of 'active' claimed parcel for SPS/SAPS, layer of inactive parcels, layer of parcel for afforestation etc. if applicable in the member state system).

2.4.5. The tests of module A_12 verified **how**, and most importantly, **where** in the database the area of eligible land was recorded. Tests of this module helps to establish connection between database and country 'eligibility profile', which is necessary for the ETS (see also annex III for ETS). Presumably, test A_121 describes in more details datasets/layers mentioned in module A_11. The tests A_122-124 define other spatial data for establishing 'maximum eligible area' for the parcels. Descriptive text on how the procedures of establishing of 'maximum eligible area' from all spatial layers concerned in this module can be added to the ICS (see 1.2.4).

2.4.6. The module A_131 tested how information about reference parcel associated with polygons geometry - parcels' attributes and their possible values. Module A_133 deals with specific attributes specific of reference parcel type.

2.4.7. In module A_132, the representation of information relevant to the cross compliance (CC) was tested. In general, there are two approaches how this CC relevant data can be integrated in the system:

- All these data are assigned to reference parcel via attributes. In this approach, at the time of the reference parcel creation/update, specific database operations are activated in order to re-calculate and record all required attributes.
- The data are not recorded in attributes of reference parcel or separate related table, and calculations are produced 'on-the-fly', when they are needed for administrative checks.

2.4.8. For each particular test of the modules A_12 and A_13 is assigned "Conformant', if for each element of the LCM, a corresponding feature from LPIS under testing is found. Following information for these feature types shall be documented:

- data set / table
- layer
- attribute
- format
- value
- definition (eng.) – feature type definition translated in English, in order to prove semantic equivalence to the element in the LCM.

2.4.9. The records for all tests findings (data set name/ attribute name, format, values and definition) were stored in the ATS-log report. If needed, additional description was added in the column behind definition column

See template: ftp://mars.jrc.ec.europa.eu/LPIS/Templates/ATS_template_v0.xls

2.5. Reporting

2.5.1. The ATS-scoreboard represents a summary of the ATS-log report. For each test in the ATS, it specifies a conformity element that can take one of the following values:

- Conformant (conformant) - the implementation is fully conformant with the LCM specification.
- Not Conformant (notConformant) - the implementation does not conform to the LCM specification.
- Not evaluated (notEvaluated) - conformance has not been evaluated.

See template: ftp://mars.jrc.ec.europa.eu/LPIS/Templates/ATS_scoreboard_v0.doc

2.5.2. The ATS Scoreboard differs from the ATS-log report, which contains detailed information on where in the LPIS database elements of the LCM can be found.

2.5.3. Aggregation of results at the modules level as follows (Table 1):

Module A_11	can be assigned 'Conformant' value if one of the tests A_1113 OR A_1114 OR A_1115 OR A_1122 OR A_1123 is 'Conformant' AND A_113 are 'Conformant'
Module A_12	is 'Conformant' if test ALL applicable tests (not optional) are 'Conformant'
Module A_13	can be assigned 'Conformant' if: sub-module A_131 is conformant '"AND"' sub-module A_132 is conformant '"AND"' sub-module A_133 is conformant
Sub-Module A_131	is 'CONFORMANT' if ALL tests are 'Conformant'
Sub-Module A_132	is 'CONFORMANT' if ALL tests are 'Conformant'
Sub-Module A_133	is 'CONFORMANT' if ALL tests are 'Conformant'

Table 1. Aggregation of the ATS results.

2.5.4. An aggregation of results **at the LPIS** level is presented in the 'Conclusions' section of the ATS-scoreboard report, which either:

states "All modules are Conformant" **OR**

defines those module(s) which are nonConformant, and explains the reason for this statement(s). In case the alternative solution does/does not exist for non-conformant module/test, the explanation is given in order to arrive at the assessment, if the existing implementation is appropriate/ not appropriate. Three Member States carried over mitigation measures in order to deal with non-conformance after the trial.

The final statement on LPIS conformance /non-conformance closes this section of the report.

2.5.5. **The ATS reporting package** consists of:

- the input documentation (application schema OR feature catalogue);

- the ATS-log report;
- the ATS-scoreboard and conformance statement report;
- the Implementation Conformance Statement (ICS) is an additional supportive document.

2.5.6. The ATS was to be performed as a preparation of the annual data quality assessment (ETS). It is envisaged that the ETS will be an annual procedure. In case if, there were not any structural changes in the database due to e.g. mitigation actions or changes in the requirements, there is no need to repeat the ATS each year. In the annual ETS report, it should be mentioned when the last ATS was done and what is/was the conformance statement. If any mitigation measures for non-conformance were proposed by last ATS, the testing procedure shall be repeated. In the annual LPIS assessment report, it should be mentioned when the last ATS was done and what was the conformance statement.

3. The ATS pilot exercise 2009

3.1. Exercise set-up

3.1.1. For the pilot trial, we have tested 4 member states with different types of reference parcel. One member state had done an ATS pre-test in 2008 with slightly different set of abstract tests. Three member states participated in both – ATS and ETS - testing, and two of MS took part only in the ATS testing.. In the current report they are presented as follows (Table 2):

Member state identification	Nominal Reference Parcel Type
Member state A	-Agricultural parcel/SPS
Member state B	-Physical block/SAPS
Member state C	-Physical (topographical block)/SAPS
Member state D	-Cadastral parcel/SPS
Member state E	-Farmer's block/SPS

Table 2. Member States and respective Reference Parcel Types

3.2. Member state A

3.2.1. The type of the reference parcel is an agricultural parcel, type of support scheme is SPS. One of the particularities of the system is that the same piece of land – agricultural parcel, can be used, and declared (not claimed for SPS) by different farmers, but within different time spans of the year. E.g. one farmer can use parcel for growing crop, then later another farmer can store manure at the same parcel – the manure handling information system is closely integrated with LPIS system.

3.2.2. All parcels have an attribute for land cover/land use classification; values are given to the parcels based on farmer's declaration. But this classification is using mixture of both two (land cover/land use) phenomena, and the same table stores also different kinds of ancillary data values, which makes it difficult to create 'eligibility profile' needed for ETS.

3.2.3. The database is stored in Oracle Spatial, where all geometry is in one table. This geometry table contains several layers (over 120 layers) for representing parcels, data for cross-compliance and environmental regulations, CwRS, etc. The annual procedure starts with the layer of the declared parcels. The crosscheck procedure is based on the intersection of the variuls layers stored in the LPIS.

Each insersection result is stored as a separate layer that enables quantification of the extent. The result is used in specific procedures to crosscheck the farmer's claim. In case of a critilcal value, the reference parcel layer is flagged for further manual inspection by the operator. At the end, after solving critical inconsistencies, the consolidated layer of parcels is created. The description of this consolidated layer was taken for performing the ATS.

3.2.4. Information for testing was provided in Visio diagrams and .xls table description for data layers.

3.2.5. Scoreboard for Member State A looks as following (Table 3):

Module/Test	Quality topic	Conformance Statement
Module A.1.1.	**Definition of Reference parcel**	**Conformant**
Module A.1.2.	**Eligible Land Type (land cover)**	**Conformant**
A.1.2.1	Eligible land types	Conformant
A.1.2.2.	Historical eligibility (referred to yr 2003)	NA
A.1.2.3 (optional)	In-eligible land types	Conformant
A.1.2.4 (optional)	Landscape Features	Conformant
Module A.1.3	**RP_Attributes**	**Conformant**
Module A.1.3.1	**Obligatory attributes**	**Conformant**
A. 1.3.1.1	Reference parcel identifier	Conformant
A. 1.3.1.2	Reference area	Conformant
A.1.3.1.3	Effective date	Conformant
A.1.3.1.4	GIS area	Conformant
A. 1.3.1.5	Area claimed inside parcel	
A. 1.3.1.6	Validity status	Conformant
Module A.1.3.2	**Attributes for cross- complance**	**Conformant**
A. 1.3.2.1	LFA	Not Evaluated*
A. 1.3.2.2	Bird protection	Conformant
A. 1.3.2.3	Nitrate directive	Conformant
A. 1.3.2.4	NATURA & Habitat	Conformant
A. 1.3.2.5	soil protection	Conformant
Module A.1.3.3	**Specific attributes of RParcel**	**Conformant**
A. 1.3.3.1	farmID or farmerID;	Conformant
A. 1.3.3.2	crop group (land use)	Conformant
A. 1.3.3.3	crop (land use)	Not Evaluated
A. 1.3.3.4	land cover	Not Evaluated
A. 1.3.3.5	payment type	Conformant
A. 1.3.3.6	perimeter	Conformant

Table 3. ATS Scoreboard, Member State A

*MS –A does not apply less favourite areas for agriculture

3.2.6. Conclusions: No particular comments on any of the tests. Member state LPIS is Conformant.

3.3. Member state B

3.3.1. The type of reference parcel is Physical block, payment scheme - SAPS. At the time of LPIS creation, the physical block type of parcel had been chosen. Recently, the system is gradually moving towards the farmer's block type: and the original blocks are subdivided on the bases of the farmer's application maps and, sometimes, using cadastre information where appropriate. The main reasons for subdivision are:

- the rule of 75/90. In the situation when agricultural land is partly abandoned, it was decided to create a layer of blocks that are in active use - inactive blocks are kept on a separate layer
- better identification of double-declared areas.

The member state LPIS is a desktop GIS application, based on MapX and uses Oracle 10g database with Spatial extension. All spatial information is stored in one table, all together over 150 layers for:

- field blocks, energy crop parcels and semi-natural habitats parcels;
- cross-compliance data
- CwRS areas and measurements
- Cartographic reference data
- Orthophoto and satellite imagery

The results of all cross checks (overlays) on different layers are combined into one consolidated table - database view-, which is exposed to the IACS. Also administrative part of the IACS provides a database view to LPIS system, which make it possible to track on parcel level data on e.g. claimed area per block.

Information for testing was provided in Visio diagrams and in an.xls table description for the data layers. A textual summary (ICS) describing the implementation under testi was completed during the ATS test.

3.3.2. Scoreboard for member state B looks as following (Table 4):

Module/Test	Quality topic	Conformance Statement
Module A.1.1.	**Definition of Reference parcel**	**Conformant**
Module A.1.2.	**Eligible Land Type (land cover)**	**nonConformant**
A.1.2.1	Eligible land types	Conformant
A.1.2.2.	Historical eligibility (referred to yr 2003)	nonConformant
A.1.2.3 (optional)	In-eligible land types	Conformant
A.1.2.4 (optional)	Landscape Features	nonConformant
Module A.1.3	**RP_Attributes**	**Conformant**
Module A.1.3.1	**Obligatory attributes**	**Conformant**
A. 1.3.1.1	Reference parcel identifier	Conformant
A. 1.3.1.2	Reference area	Conformant

A.1.3.1.3	Effective date	Conformant
A.1.3.1.4	GIS area	Conformant
A. 1.3.1.5	Area claimed inside parcel	
A. 1.3.1.6	Validity status	Conformant
Module A.1.3.2	**Attributes for cross -compliance**	**Conformant**
A. 1.3.2.1	LFA	Conformant
A. 1.3.2.2	Bird protection	Conformant
A. 1.3.2.3	Nitrate directive	Conformant
A. 1.3.2.4	NATURA & Habitat	Conformant
A. 1.3.2.5	soil protection	Conformant
Module A.1.3.3	**Specific attributes of Reference Parcel**	Not Evaluated
A. 1.3.3.1	farmID or farmerID;	Not Evaluated
A. 1.3.3.2	crop group (land use)	Not Evaluated
A. 1.3.3.3	crop (land use)	Not Evaluated
A. 1.3.3.4	land cover	Not Evaluated
A. 1.3.3.5	payment type	Not Evaluated
A. 1.3.3.6	perimeter	Not Evaluated

Table 4. ATS Scoreboard, Member State B

3.3.3. Conclusions: MS LPIS is 'nonConformant'

Module A.1.2 can not be assessed as 'Conformant', since the member state doesn't have a layer of eligible land on the date of 30.06.2003. This layer is important to ensure that no claims are made outside of this area. We have indeed discussed the alternative solution, which is implemented in the member state B: the solution allows going back in the DB history of each particular parcel to the status at 30.06.2003. But, as this fragmentized solution can not give all functionalities of a separate layer, the MS LPIS was assessed as 'not Conformant'. The MS-B was advised to create a layer of historical eligibility for the date 30.06.2003. Recommendation was accepted and this layer will be created.

3.4. Member state C

3.4.1. The type of reference parcel is Physical (topographic) block, payment scheme - SAPS. No specific issues on reference parcel type evolution. Data provided in the form of feature catalogue. No specific description on the system architecture provided.

3.4.2. The scoreboard for member state C looks as follows (Table 5):

Module/Test	**Quality topic**	**Conformance Statement**
Module A.1.1.	**Definition of Reference parcel**	**Conformant**
Module A.1.2.	**Eligible Land Type (land cover)**	**Conformant**
A.1.2.1	Eligible land types	Conformant
A.1.2.2.	Historical eligibility (referred to yr 2003)	Conformant
A.1.2.3 (optional)	In-eligible land types	Conformant

A.1.2.4 (optional)	Landscape Features	nonConformant
Module A.1.3	**RP_Attributes**	
Module A.1.3.1	**Obligatory attributes**	
A. 1.3.1.1	Reference parcel identifier	Conformant
A. 1.3.1.2	Reference area	Conformant
A.1.3.1.3	Effective date	Conformant
A.1.3.1.4	GIS area	Conformant
A. 1.3.1.5	Area claimed inside parcel	(not found in FC)
A. 1.3.1.6	Validity status	(not found in FC)
Module A.1.3.2	**Attributes for cross -complance**	**Conformant**
A. 1.3.2.1	LFA	Conformant
A. 1.3.2.2	Bird protection	Conformant
A. 1.3.2.3	Nitrate directive	Conformant
A. 1.3.2.4	NATURA & Habitat	Conformant
A. 1.3.2.5	soil protection	Conformant
Module A.1.3.3	**Specific attributes of Reference Parcel**	**Conformant**
A. 1.3.3.1	farmID or farmerID;	Not Evaluated
A. 1.3.3.2	crop group (land use)	Not Evaluated
A. 1.3.3.3	crop (land use)	Not Evaluated
A. 1.3.3.4	land cover	Not Evaluated
A. 1.3.3.5	payment type	Not Evaluated
A. 1.3.3.6	perimeter	Conformant

Table 5. ATS Scoreboard, Member State C

3.4.3. Conclusions: there are two tests still not clarified, therefore it is impossible to judge conformance of the module A.1.3 and A.1.3.1.

3.4.4. Member State LPIS is 'Conformant'/'nonConformant'

3.5. Member state D- Cadastral parcel

3.5.1. The member state D uses as reference parcel a subdivision of a cadastral parcel with homogenous land cover/land use. The payment scheme is SPS. The IS for managing payments is organized on two levels; the central office manages LPIS data and regional offices manage the farmers' applications. Cross-checks are performed at both levels.

3.5.2. The reference parcel identifier re-uses the identifier of cadastral parcel, which is a composite key compiled from province, municipality etc. identifiers down to cadastral parcel and sub-parcel. The last component of the key is a sequential integer number of sub-parcel inside of cadastral parcel.

3.5.3. Information for the ATS was provided in the form of a feature catalogue. Textual documentation on the database structure in the regional offices was also provided.

3.5.4. Scoreboard for member state D looks as following (Table 6):

Module/Test	Quality topic	Conformance Statement
Module A.1.1.	**Definition of Reference parcel**	**Conformant**
Module A.1.2.	**Eligible Land Type (land cover)**	**Conformant**
A.1.2.1	Eligible land types	Conformant
A.1.2.2.	Historical eligibility (referred to yr 2003)	N/A
A.1.2.3 (optional)	In-eligible land types	<Conformant/non Conformant>
A.1.2.4 (optional)	Landscape Features	<Conformant/non Conformant>
Module A.1.3	**RP_Attributes**	**<Conformant/non Conformant>**
Module A.1.3.1	**Obligatory attributes**	**Conformant**
A. 1.3.1.1	Reference parcel identifier	Conformant, multi-key
A. 1.3.1.2	Reference area	Conformant
A.1.3.1.3	Effective date	Conformant
A.1.3.1.4	GIS area	Conformant
A. 1.3.1.5	Area claimed inside parcel	Not Evaluated -regional office
A. 1.3.1.6	Validity status	Conformant
Module A.1.3.2	**Attributes for cross -complance**	**<Conformant/non Conformant>**
A. 1.3.2.1	LFA	Not Evaluated
A. 1.3.2.2	Bird protection	Not Evaluated
A. 1.3.2.3	Nitrate directive	Not Evaluated
A. 1.3.2.4	NATURA & Habitat	Not Evaluated
A. 1.3.2.5	soil protection	Not Evaluated
Module A.1.3.3	**Specific attributes of Reference Parcel**	Not Evaluated
A. 1.3.3.1	farmID or farmerID;	Not Evaluated
A. 1.3.3.2	crop group (land use)	Not Evaluated
A. 1.3.3.3	crop (land use)	Conformant
A. 1.3.3.4	land cover	Conformant
A. 1.3.3.5	payment type	Not Evaluated
A. 1.3.3.6	perimeter	Not Evaluated

Table 6. ATS Scoreboard, Member State D

3.5.5. Conclusions: additional evaluation on attributes/spatial layer on cross –compliance is needed

3.6. Member state E - Farmer's block

3.6.1. The member state is using particular type of farmer's block delimited by homogenous land use/land cover. The payment scheme is SPS. A pre-trial ATS testing was performed one year before, using an earlier version of the ATS. Therefore, some tests were not evaluated. The documentation was provided in the form of a FC.

3.6.2. The scoreboard for member state E is presented as follows (Table 7):

Module/Test	Quality topic	Conformance Statement
Module A.1.1.	**Definition of Reference parcel**	**Conformant**
Module A.1.2.	**Eligible Land Type (land cover)**	**non Conformant**
A.1.2.1	Eligible land types	Conformant
A.1.2.2.	Historical eligibility (referred to yr 2003)	N/A
A.1.2.3 (optional)	*In-eligible land types*	*Not evaluated*
A.1.2.4 (optional)	*Landscape Features*	*Not evaluated*
Module A.1.3	**RP_Attributes**	**Conformant**
Module A.1.3.1	**Obligatory attributes**	**Conformant**
A. 1.3.1.1	Reference parcel identifier	Conformant
A. 1.3.1.2	Reference area *	Conformant
A.1.3.1.3	Effective date	Conformant
A.1.3.1.4	GIS area	Conformant
A. 1.3.1.5	Area claimed inside parcel	Conformant
A. 1.3.1.6	Validity status	Conformant
Module A.1.3.2	**Attributes for cross -complance**	**Conformant**
A. 1.3.2.1	LFA	Conformant
A. 1.3.2.2	Bird protection	Conformant
A. 1.3.2.3	Nitrate directive	Conformant
A. 1.3.2.4	NATURA & Habitat	Conformant
A. 1.3.2.5	soil protection	Conformant
Module A.1.3.3	**Specific attributes of Reference Parcel**	**Conformant**
A. 1.3.3.1	farmID or farmerID;	Conformant
A. 1.3.3.2	crop group (land use)	Conformant
A. 1.3.3.3	crop (land use)	Conformant
A. 1.3.3.4	*land cover*	*Not Evaluated*
A. 1.3.3.5	*payment type*	*Not Evaluated*
A. 1.3.3.6	perimeter	Conformant

Table 7. ATS Scoreboard, Member State E

3.6.1. Conclusions: All modules are 'Comformant', therefore Member State-E LPIS can be assessed as 'Conformant'.

Remark: The module A 1.3.1 is 'conformant', but the member state claims that the reference area and GIS area are equal, which is ensured by very precise mapping criterion. This statement is not possible to verify at the ATS phase, consequently, special attention should be given to this aspect during the ETS.

4. Conclusions on ATS-pilot

4.1.1. The results from the ATS pilot show that, the implementation of the ATS is feasible in the expected timeframe (2-3 weeks), with the existing resources available in the member state administration. The workload required for the ATS, as have been reported, keeps the IT system administrator busy for 2 to 3 weeks. Depending of her/his knowledge of particularities of the processes in the LPIS workflow, database administrator had to consult other key expert persons on the different stages of the test.

4.1.2. The methodology was in general accepted by the member state administrations participating in the pilot. The common reflection was, that provided methodology offers a possibility to report the information on how the design of the LPIS systems conforms to the regulation requirements.

4.1.3. However, several iterations in order to clarify different elements of the tests and documentation were needed. This confirms that there are still semantic gaps on the both sides; some 'loss-in-translation' still exist. It has turned out that the definition of the actual scope of the ATS- spatial features, layers and attributes to be included – is not a trivial task when LPIS implementation accounts for hundreds of datasets and layers.

4.1.4. The 'manual' nature of the work should be abandoned in the feature, member states should be able to 'map' their solution against the common schema independently. This will exclude possible misinterpretations by screening authority (whoever it will be, the JRC or DG AGRI).

4.1.5. There are also several feedbacks from the ETS can be mentioned. The importance of the 'Eligibility profile' is crucial to make the right decisions in the ETS, therefore right datasets and layers should be used/requested for screening the results of the ETS. The information on these additional datasets and layers can be derived from ATS. Special attention should be paid to the implementations under test, which declared that the GIS area of the parcel is equal to the maximum eligible area.

References and source materials

LCM Specification and FC

http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/LPIS-Core-Conceptual-Model.

http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Core-Conceptual-Model-for-Land-Parcel-Identification-System-LCM

ATS methodology

http://mars.jrc.ec.europa.eu/mars/Bulletins-Publications/Conformance-test-for-LPIS-Core-Model

Templates

Feature catalogue	ftp://mars.jrc.ec.europa.eu/LPIS/Templates/FC_template_v0.xls
ATS log report	ftp://mars.jrc.ec.europa.eu/LPIS/Templates/ATS_template_v0.xls
ATS scoreboard report	ftp://mars.jrc.ec.europa.eu/LPIS/Templates/ATS_scoreboard_v0.doc

5. Introduction to ETS-pilot

5.1. Report objectives

5.1.1. The objective of this chapter is to present the results of the so-called “ETS pilot”. Its aim is to provide a feedback on the performance and suitability of the parcel inspection procedure, developed as part of the Executable Test Suite (ETS) in the frame of the LPIS QA framework. The “ETS pilot” comprises a number of pilot tests with selected EU Member States, simulating a full inspection on a sample of reference parcels.

5.1.2. Although the ETS pilot is acts as a “feasibility trial” of the methodology for the LPIS Quality Assurance and uses real LPIS data, the test should be regarded as a “simulation” of a real ETS inspection procedure, with the main objective to check the feasibility of the methodology and to validate the inspection procedure in a real or “pseudo-real” environment. It cannot be considered, in any case, as evaluation or quality check of a particular LPIS.

5.1.3. The work on the pilot tests is conducted on the base of the methodology, developed in the following documents:

- Data quality measures, applied in the LPIS QA Framework (based on ISO 19138) – Annex I (version 3)
- Description of the workflow, related to the inspection of the Reference Parcel – Annex II (version 3)
- Application of the land cover concept to describe eligibility of land – Annex III (version 3)

5.1.4. Data from the selected datasets, representing four real Land Parcel Identification Systems, has been selected using a pre-defined ISO-based sampling scheme. The test inspection was complete for all tested sample datasets.

6. Key elements of the methodology

6.1.1. As a major instrument for the implementation of the first pillar of the Common Agriculture Policy (CAP), the Land Parcel Identification System (LPIS) has two major objectives at operational level:

- To enable the unambiguous geographic location of agriculture fields, claimed for aid by the farmer (identification and position of parcels)
- To quantify the area of eligible land at a parcel level in order to cap any undue payments

6.1.2. In this respect, the ETS inspection is targeting those key measures on the LPIS objects, which observation and quantification during the inspection process, is expected to provide the necessary information for the prime quality elements, essential for the LPIS to be able to perform its role. These quality elements are listed and explained in JRC IPSC/G03/P/WDE/wde D(2009)(10999).

6.1.3. The ETS comprises three key processes (Figure 3):

- Sampling - sampling of the reference parcels for inspection, based on ISO2859-2

- Parcel Inspection - inspection of the selected reference parcels, on the base of a up-to-date background data
- Data Analysis - subsequent analysis of the observations made during the inspection and aggregation of the results at the level of the LPIS sample.

6.1.4. The ETS observations require, a land cover interpretation and delineation of the land represented by the reference parcels, either by photo-interpretation of recent orthoimagery (1st approach) or by direct field measurements (2nd approach). The current version of the ETS methodology covers the 1st approach only, which was also the basis for the current ETS pilot.

6.1.5. As if is performed in the office – the reference parcels are not inspected on the field – the ETS inspection requires the availability of two principle input datasets:

- the sample reference parcel data and
- an up-to-date reference orthoimage.

6.1.6. The EU Member State Administration could use any available orthoimagery in the country, if acquired in the calendar year of the inspection. Alternatively, the Commission could provide a very-high resolution (VHR) satellite data, acquired in the frame of the CwRS campaign. For the ETS pilot, the VHR data acquired in the 2009 CwRS program, has been used.

6.1.7. In an appropriate GIS environment, the inspected reference parcels are overlaid on the available orthoimagery and the specific set of data quality measures for each relevant quality element is derived, following a strict sequence of actions. As most of the process is related to photointepretation and land cover delineation, certain general mapping rules are defined in advance, however they are not too restrictive in order to give some flexibility to the inspectors to adjust their particular LPIS environment.

6.1.8. All land cover features on the land represented by the reference parcel are subject of delineation. At that stage, no “a priori” information on the use of the land or ancillary data is used. Features are delineated purely based on the physiognomic (biotic or abiotic) aspect of the land cover: vegetated area, bare surface, water body, artificial sealed surface, etc.

6.1.9. A country specific eligibility map is applied to the land cover features recorded in order to correctly separate the eligible from ineligible land cover features. The MS Administration is supposed to have an eligibility profile, which can tell if a particular land cover, can be considered as eligible or not (and at what extend), according to the rules and schemes applied in the EU Member State. The resulted observations' database is then processed (by cross-checking with the eligibility profile) and the relevant statistics and analyses at LPIS sample level are generated through simple SQL statements. Finally, the scores for the relevant "prime" quality elements are derived for the LPIS under test. An overview of the ETS workflow is given on the diagram below:

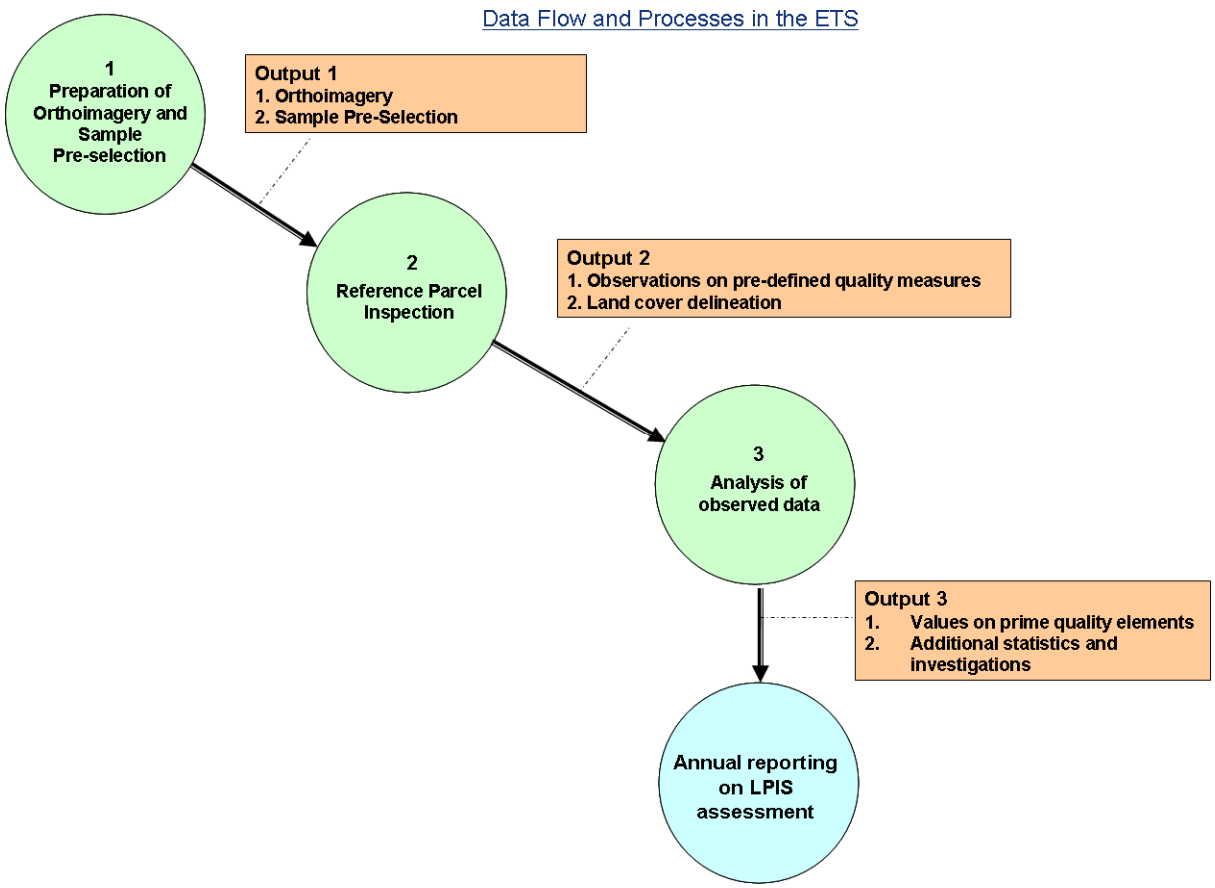

Figure 3. General diagram of the ETS

6.1.10. At this point, it should be noted that ETS parcel inspection delineation, obtained in the frame of the LPIS Quality Assurance, is not the same "thing" as the boundary surveyed for the LPIS update. The polygons derived from the ETS inspection are used to calculate the values of the quality measures, which needs to be performed at reference parcel level. The results from the ETS observations, aggregated at LPIS sample level, should provide the necessary information to the decision-makers on the relevant actions on LPIS level. The update of a parcel is subject of separate specifications and workflow cycles. An individual parcel update might be triggered by a particular inspection result on the parcel

7. Introduction to the sampling methodology

7.1. Objective

7.1.1. This section presents findings of the trial application of the methodology for sample pre-selection, used for Executable Tests Suite for LPIS data quality inspection. It summarizes also the first experiences of its application between the EC JRC and 4 participating Member States.

7.2. Terms and definitions

7.2.1. Lot of reference parcels: a homogeneous population of reference parcels within each country/region (or LPIS),

7.2.2. Sample size: prescribed number of reference parcels to be inspected based on ISO 2859/2-1985 (Procedure A, Limiting Quality = 2%),

7.2.3. Sample pre-selection: sequential list of reference parcels to be inspected, roughly exceeding the sample size by a factor 3, The final sample is constructed from this ordered list.

7.2.4. LPIS Control Zone: zone used for the ETS inspection, where up-to-date national orthophoto or VHR data, acquired in the frame of the CwRS, is available and considered random with respect of the underlying parcels.

8. Methodology

8.1.1. The general workflow is presented in Figure 4. The pilot consisted of three distinct activities: the reception of reference parcel point-data and the analysis of their structure. Then, the clipping process, based on the appropriate VHR zones was applied, when necessary. Finally, a minimum sample size for the ETS procedures was determined (based on the quantity of RP in the LPIS) and a sample pre-selection was randomly generated. The sample pre-selection was then sent to the MS in the XML format.

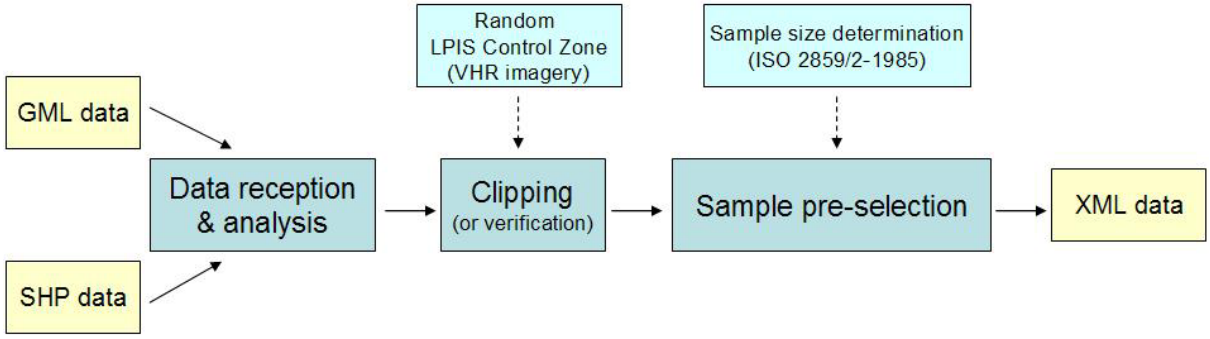

Figure 4. Workflow for the first phase of the ETS feasibility study.

8.1.2. According to Figure 1, creating the sample pre-selection involved:

- creation of a point representation from the reference parcel polygons (by MS); The point coordinates should lay INSIDE the parcel's perimeter.

- conversion of reference parcels' point data into a harmonized data structure and exchange of reference parcel data (by MS),
- reception and analysis of reference parcel data (by EC),
- clipping of reference parcel data with the extend of the LPIS control zones (by EC),
- determination of the sample size for the ETS inspection, based ISO 2859/2-1985, procedure A (by EC),
- generation of a sequential list of randomly selected reference parcels to be sent to the MS in the XML format (by EC).

8.2. Input data format(s)

8.2.1. In a European SDI, the communication must be performed in the GML*[1] format (*see Annexes I & II*). The GML that an LPIS custodian creates should contain for each of the parcels from the LPIS system:

- A point representation of the reference parcel “X” and “Y”
- Information on coordinate system used, i.e. EPSG: 4326
- The unique identification of the reference parcel: “rpID”
- The “maximum eligible” area of the reference parcel, as recorded in the system “referenceArea”

8.2.2. In practice, however, we have received data in different formats, as indicated for each participant, Due to that inconvenience, the data had to be analysed and transformed for any further use on a common platform.

8.3. Clip/verification with the VHR imagery

8.3.1. First, to select reference parcels to be inspected, a clip of reference parcels with the extend of the (programmed) LPIS control zones was performed. This process provided the reference parcels covered by Very High Resolution imagery (VHR), required for the ETS inspection procedures.

8.4. Sample size determination

8.4.1. In parallel, applying the ISO 2859/2-1985, procedure A, indexed for a limiting quality LQ (2%), yielded a sample size (n) according to the LPIS reference parcel numbers (Table 8). This sample size (n) indicated how many reference parcels from the complete LPIS should be inspected in order to draw valid conclusions on the LPIS quality.

[1] *Because of a possible large size of the GML files created, the Commission will try to allow some processes to be executed at the MS side, in order to reduce the amount of data that has to be transmitted over network.*

Lot size		Limiting quality in percent (LQ) 2,0
10 000 to 35 000	*n*	315
	Ac	3
35 001 to 150 000	*n*	500
	Ac	5
150 000 to 500 000	*n*	800
	Ac	10
>500 000	*n*	1250
	Ac	18

Table 8. Single sampling plan indexed by limiting quality (LQ)(Procedure A). Source: ISO 2859/2-1985, where (n) - sample size, (Ac) - acceptance number specified in the plan.

8.5. Sample pre-selection

8.5.1. Some limitations related to the use of VHR imagery may render it impossible to inspect one or more pre-selected reference parcels. For instance, it is impossible to inspect a parcel covered by cloud on the orthoimage or parcels partially outside the LPIS control zone. To accommodate this potential "fall-out" of parcels, the randomly generated sample pre-selection is 3 times larger than the required sample size. Parcels, impossible to inspect, could than be skipped in favour of another random parcel.

8.6. Sample pre-selection sending

8.6.1. Eventually, a sample pre-selection was sent in the XML format to the Member States, according to the following schema: LPIS_SamplePreselection.xsd (ftp://mars.jrc.ec.europa.eu/LPIS/Schemas/*LPIS_SamplePreselection.xsd*). Moreover, the process of XML file creation was automated, which significantly accelerated the ETS sample pre-selection sending (SQL and scripting).

9. Input data: reference parcels

9.1.1. The feasibility LPIS trial data were received from 4 countries: LPIS 1, LPIS 2, LPIS 3 and LPIS 4.

9.2. LPIS 1

9.2.1. The data received from LPIS 1 country was stored in GML format (one .gml and one .xsd file). The GML file itself contained 63.832 points representing reference parcels which have been clipped with the available VHR imagery for 2009. The total number of reference parcels for LPIS 1 is between 150.000 and 500.000 (in use on the 21/04/2009).

9.2.2. The GML file received was conformant to the proposed template. Still, three relevant observations were made.

9.2.3. First of all, as the the proposed framework foresees usage of common XML schemas for validating the content of XML/GML files sent by MS and/or EC, the received files needed to be validated. The test was run and performing minor modifications of the schemaLocation, the GML validates with the proposed XSD schema (ftp://mars.jrc.ec.europa.eu/LPIS/Schemas/LPIS_GML_state.xsd).

9.2.4. Secondly, after an in-depth analysis of the XSD and GML files some specification elements need also to be updated:

- Schema:
  - rpID element should have longer length – currenlty it is set to 1,
  - rpID element should have minOccurs and maxOccurs equal to 1,
  - a correct referenceArea value. According to the schema provided from LPIS 1, it is only possible to store a rounded value… (totalDigits=10 but fractionDigits=0),
- GML
  - in order to be consistent and informative, Spatial Reference System information is required.
  - some duplicate elements were founded, with the following rpIDs:

9.2.5. ATS considerations : duplication of rpIDs is one of the major issues that should be solved during the ATS. One can automatically prevent the presence of duplicates in the GML files received, but their generation should be controlled at the LPIS system level directly.

9.3. LPIS 2

9.3.1. The LPIS 2 data were in the File Geodatabase format, comparable to a SHP format. There were around 200.000 reference parcels, represented by their entire geometry. As the LPIS 2 is under upgrade, we have only received a subset of the total lot, the latter being composed of less then 500.000 reference parcels.

9.4. LPIS 3

9.4.1. The LPIS 3 data consisted in points transferred in .dbf format. The received dataset was already clipped to the CwRS control zones: 16.058 points. In the whole LPIS 3 dataset there are between 150.001 and 500.000 physical blocks.

9.5. LPIS 4

9.5.1. The LPIS 4 data were in the SHP format and required a lot of preparation, as they have not followed a proposed convention yet (naming, fields presence, presented in Annex I and Annex II.). The shapefile contains more then 500.000 points representing reference parcels for the whole country. The following observations were made on the file structure.

9.5.2. There are 7 fields, namely: FID, SHAPE, ID, REFERENCE, UNIQUE_PAR, XI and YI. The unique identifier of a reference parcel is the UNIQUE_PAR field, which data type is “double”.

9.5.3. ATS considerations : the data format of the reference parcel ID (UNIQUE_PAR) is set to float, which is not convenient for further processing. In order to avoid problems of comparisons between field values, it is better to transform it to the “string” type in the original source of data.

10. Sample size determination and sample pre-selection

10.1. LPIS 1

10.1.1. The GML file contained 63.832 clipped parcels. Following explanations given in the previous section, a sample of 800 parcels should be inspected (Table 9). Therefore, for a first test, 2000 reference parcels were selected as a sample pre-selection and then sent in the XML format.

LPIS 1			
Lot	**Clipped**	**Pre-selection**	**Sample**
<500.000	63.832	2.000	800

Table 9. LPIS 1 reference parcels and final sample size.

10.2. LPIS 2

10.2.1. The shapefile contained a partial lot of reference parcels, based solely on a priority parameter relating to the farmer.. It was assumed that it counts between 150.001 and 500.000 parcels, so under these conditions the minimum sample size was composed of 800 parcels (Table 10). A sample pre-selection (2400 reference parcel points) was produced in the XML format.

LPIS 2			
Lot	**Clipped**	**Pre-selection**	**Sample**
<500.000	-	2.400	800

Table 10. LPIS 2 reference parcels and final sample size.

10.3. LPIS 3

10.3.1. The .dbf file contained 16.058 clipped parcel points. For the total lot of LPIS 3 physical blocks, a minimum sample size is of 800 parcels to be inspected (Table 11). A sample pre-selection was produced and sent in the XML format.

LPIS 3			
Lot	**Clipped**	**Pre-selection**	**Sample**
<500.000	16.058	2.400	800

Table 11. LPIS 3 physical blocks and final sample size.

10.4. LPIS 4

10.4.1. The shapefile contained a total lot of reference parcels points and has been clipped to produce 80.049 points. For that lot, a minimum sample size is of 1250 parcels to be inspected (Table 12). A sample pre-selection was produce (3750 reference parcel points) and sent in the XML format.

LPIS 4			
Lot	**Clipped**	**Pre-selection**	**Sample**
>500.000	80.049	3.750	1250

Table 12. LPIS 4 reference parcels and final sample size

11. Conclusions on sampling pre-selection

11.1. First observations and achievements

11.1.1. The “sample size” is a direct result of applying ISO 2859/2-1985, procedure A, indexed on Limiting Quality at 2% for an LPIS lot of a given size. This ISO standard ensures a sufficient and the most cost-effective sample plan to make a statistically reasonable verdict on the total population.

11.1.2. The sample pre-selection process can be considered as appropriate. It is random and it enables proportionally distributed sampling: every reference parcel from the selected image zone has the same probability, greater then 0, to be in the sample pre-selection.

11.1.3. It was observed that applying a random selection process from clipped reference parcels, yielded a random and proportionally distributed (geographically over the CwRS zones) sample pre-selection.

11.1.4. An automated mechanism of random sample pre-selection from the lot of reference parcels (SQL and scripting) has been created and successfully applied.

11.1.5. A sample pre-selection was sent in the XML format, according to the following schema (ftp://mars.jrc.ec.europa.eu/LPIS/Schemas/*LPIS_SamplePreselection.xsd*) to the Member States (Annex 3).

11.2. XML sample pre-selection output

11.2.1. An XSD schema was created for the sample pre-selection file.

11.2.2. The process of XML file creation was automated, which significantly accelerated the ETS sample pre-selection sending (SQL and scripting).

12. GML template

The newest version of the *LPIS_GML_state.xsd* should be found at the following remote location: ftp://mars.jrc.ec.europa.eu/LPIS/Schemas/LPIS_GML_state.xsd

13. GML instance document

Example of a GML instance (i.e. one parcel representation) of the LPIS list file:

```
<?xml version="1.0" encoding="utf-8" ?>
<cap:FeatureCollection
  xmlns:xsi=http://www.w3.org/2001/XMLSchema-instance
  xsi:schemaLocation="http://ec.europa.eu/dgagri/cap
ftp://mars.jrc.ec.europa.eu/LPIS/Schemas/LPIS_GML_state.xsd"
  xmlns:cap="http://ec.europa.eu/dgagri/cap"
  xmlns:gml="http://www.opengis.net/gml">
  <gml:boundedBy>
    <gml:Box>
      <gml:coord>
        <gml:X>-120.824787</gml:X>
        <gml:Y>30.26769069085526</gml:Y>
      </gml:coord>
      <gml:coord>
        <gml:X>-69.02891949999997</gml:X>
        <gml:Y>47.47070784386273</gml:Y>
      </gml:coord>
    </gml:Box>
  </gml:boundedBy>
  <gml:featureMember>
    <cap:ReferenceParcel fid="F0">
      <cap:geometryProperty>
        <gml:Point srsName="EPSG:4326">
          <gml:coordinates>-89.51200899999992,37.29161997773667</gml:coordinates>
        </gml:Point>
      </cap:geometryProperty>
      <cap:rfID>MS1Parcel1</cap:rfID>
      <cap:referenceArea>14.610000000</cap:referenceArea>
    </cap:ReferenceParcel>
  </gml:featureMember>
  <gml:featureMember>
    <cap:ReferenceParcel fid="F1">
      <cap:geometryProperty>
        <gml:Point srsName="EPSG:4326">
          <gml:coordinates>-77.01691799999991,38.89158055322644</gml:coordinates>
        </gml:Point>
      </cap:geometryProperty>
      <cap:rfID>MS1Parcel2</cap:rfID>
      <cap:referenceArea>159.055000000</cap:referenceArea>
    </cap:ReferenceParcel>
  </gml:featureMember>
  <gml:featureMember>
    <cap:ReferenceParcel fid="F2">
      <cap:geometryProperty>
        <gml:Point srsName="EPSG:4326">
          <gml:coordinates>-75.4187164999999,38.86503976958772</gml:coordinates>
        </gml:Point>
      </cap:geometryProperty>
      <cap:rfID>MS1Parcel3</cap:rfID>
      <cap:referenceArea>62.456000000</cap:referenceArea>
    </cap:ReferenceParcel>
  </gml:featureMember>
</cap:FeatureCollection>
```

14. Sample pre-selection schema

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns="http://www.jrc.it/mars/geocap/LPIS_SamplePreselection.xsd" xmlns:xs="http://www.w3.org/2001/XMLSchema"
    <xs:element name="samplePreselection">
        <xs:complexType>
            <xs:sequence maxOccurs="unbounded">
                <xs:element name="referenceParcel">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="id" type="xs:string" nillable="false"/>
                            <xs:element name="ordinalNumber" type="xs:integer" nillable="false"/>
                            <xs:element name="status">
                                <xs:simpleType>
                                    <xs:restriction base="xs:string">
                                        <xs:enumeration value="tested"/>
                                        <xs:enumeration value="notTested"/>
                                        <xs:enumeration value=""/>
                                    </xs:restriction>
                                </xs:simpleType>
                            </xs:element>
                            <xs:element name="reasonForSkipping" type="xs:string"/>
                        </xs:sequence>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
            <xs:attribute name="country" type="xs:string" use="required" />
            <xs:attribute name="region" type="xs:string" use="required" />
            <xs:attribute name="samplePreselectionCreationDate" type="xs:date" use="required" />
        </xs:complexType>
        <xs:unique name="unique_id">
            <xs:selector xpath="./samplePreselection/referenceParcel"/>
            <xs:field xpath="id"/>
        </xs:unique>
    </xs:element>
</xs:schema>

```

Figure 5. Sample pre-selection XSD file structure.

15. Status of the work

15.1.1. The ETS pilot was organized in a way that, all four test LPIS dataset were inspected in parallel – 3 of them done by the LPIS custodians themselves, and one done by JRC. The pilot implementation followed the sequential structure given below:

- Sampling – LPIS data exchange for the sample pre-selection, between the EU Member States and JRC, has been done in the late summer of 2009. The sample pre-selection datasets have been created by JRC staff and have been sent to the MS Administration in the August-September 2009. During the sample pre-selection, the availability and quality of the VHR satellite data has been checked for all CwRS zone and has been taken into account. In case of existence of CwRS zones covered with available aerial imagery, these zones were included in the sample selection. More details were presented in the previous chapter: Sample pre-selection methodology.

- Parcel Inspection – Once the parcel pre-selection has been derived and the operational environment for the ETS has been set, it took from 1.5 to 2.5 months to complete the inspection, depending on the complexity of the LPIS model, the minimum number of parcels to check, and the local manpower available. It should be noted that the EU Member States are participating on voluntary basis for this ETS test, and are performing the work according their availability and free operational resource. Once the inspection has been completed, the following items has been delivered by the EU MS participating in the ETS pilot:
  - All observation made during the inspection, according to ETS Annex I "LPIS data quality measures" – reported in XML (based on schema template), MBD or Excel.
  - All mapped features during the inspection – ESRI shape format
  - Additional notes, comments and suggestions, regarding the feasibility of the ETS inspection
  - Scores for the relevant "prime" quality elements, derived for the LPIS under test

  The ETS test done by JRC, was completed on a later date than the others, as it required a specific GIS environment to be set for the inspection procedure. In addition, all necessary imagery from the CwRS contractor, need to be downloaded, reviewed and processed.

- Data Analysis – It included follow-up screening of the observations made, in order to validate the results and further investigate some particular findings or problematic cases for interpretation. For that reason, JRC requested the orthoimagery used in the ETS inspection and reproduced (as close as possible) the inspection GIS environment used by the MS Administration. The results of the data analysis made by JRC have been discussed bilaterally with the MS Administrations involved in the ETS pilot

15.1.2. Table 13 (given below) shows the number of reference parcels inspected for each LPIS under test, and the timeframe for the conduction of the ETS inspection.

LPIS sample	Work done by	Date of the pre-selection sample sent from JRC	Minimum number of Reference parcels to check	Reference parcels inspected	Date of delivery of the final ETS observations
LPIS 1	MS	25.08.2009	800	850	01.10.2009
LPIS 2	JRC	22.09.2009	800	800	11.11.2009
LPIS 3	MS	18.09.2009	800	800	04.11.2009
LPIS 4	MS	26.08.2009	1250	1228	13.11.2009

Table 13. ETS pilot for the 4 LPIS selected

16. Performance Issues

16.1.1. By default, the quality and the level of performance of a certain system, cannot be better than the quality and performance of its worst component (or weakest link). This means that regardless the design of the ETS workflow (and its components), the output will always be heavily dependent on some external (to the methodology) factors, most important of which were the:

- Design of the LPIS conceptual model (data structure, feature content)
- Quality of the input orthoimagery
- Skills of the operator, performing the inspection

16.1.2. The conformity of the LPIS model, in respect to the data structure and content is checked and analysed in the frame of the ATS (Abstract Test Suite), developed in the scope of the current LPIS QA framework. The results of the ATS are expected to provide the necessary information in order to decide, if the LPIS data model is complete and unambiguous enough to guarantee reliable outcome of the ETS. The orthoimagery, in other hand, should comply (at minimum) with the technical specifications for the CwRS campaign, developed by JRC and included in the annual Common Technical Specification, as well as with the orthoimage specifications published in the WikiCAP Knowledgebase System. Finally, the operator should have sufficient experience in land cover mapping, with at least some basic knowledge on EU CAP rules and principles. As the LC mapping at that large scale is not a as standard and straightforward task, some specific training and on-the-job guidance needs to be envisaged.

16.1.3. From the components listed above, the input orthoimagery is the key element, having huge influence on the final results, due to the following main reasons:

- It is the primary source of information for the parcel inspection and subsequent decisions
- It cannot be easily corrected or adjusted during the ETS process, if necessary.

16.1.4. Therefore the proper evaluation of the quality of the orthoimagery, is a crucial point, which needs to be done before the parcel inspection, in order to assess suitability of the imagery for the ETS purposes.

16.1.5. The quality measures, from which the key LPIS quality elements are derived, are defined in a way to comprise all possible types of LPIS systems. It is evident that some of the measures will be either redundant or meaningless for a particular type of reference parcels and national rules. Therefore, it is difficult to give clear estimates of the time needed for the ETS, as it depends on the type of the LPIS

and the corresponding work involved. Anyway, if enough human and system resources are available, performing the ETS should not take more than 10-15 working days, considering the fact that in most of the cases less than 1000 reference parcels will be inspected.

17. Results

17.1. Calculation methods

17.1.1. The final results obtained at LPIS sample level, are compiled and presented in a Table 2 (given below). They provide the necessary data in relation to those key LPIS quality elements (except one), which values are derived solely by inspecting the sampled reference parcels. These are (as defined in version 3 of the ETS):

- Total eligible area – the maximum quantity of land that can be claimed by farmers (SAPS) or eligible hectares upon which entitlements can be activated (SPS). It is expressed by quality measure 10201 (LPIS eligible area) as the percentage of eligible area observed during the ETS in respect to the eligible area recorded. The expectation is that the total area of the observed agriculture land cover, should be >98% and <102% of the eligible area recorded.
- Proportion of reference parcels allowing undue payment on ineligible land. It is expressed by quality measure 10202 (LPIS non-conformant RP). Calculated as the percentage of reference parcels, which have more than 3% negative difference between the eligible area observed and eligible area recorded. The expectation is for less than 5% of such non-conformant parcels.
- Distribution of reference parcels allowing undue payment on ineligible land. It is expressed by quality measure 10203 (LPIS eligibility rates).
- Critical defects - Occurrence of non-compliances that could obstruct the use of the parcel. It is expressed by quality measure 10205 (LPIS potential critical defects). This mostly refers to either parcels which doesn't contain any eligible land, or parcel which continuity is disrupted by ineligible features, in a way that the parcel is actually a multitude of separate parcels. The expectation is less than 1% RP with potential defects unexplained.

NOTE: The key element "Categorization of the reference parcels allowing payment undue on ineligible land", expressed by quality measure 10204 (LPIS number of anomaly causes) was not reported in the scope of this pilot.

17.1.2. The values for the remaining key elements (from Discussion Paper 11164), which can be calculated on the basis of information, retrieved from the IACS registers, were not yet provided (except one case).

17.2. Findings per measure

17.2.1. **Total eligible area:** In 2 of the 4 LPIS cases the expectation for Area observed minus Area recorded to be in the range of 98%-102% is met. The results for LPIS 1 show 99.76%, while in the case of LPIS 4, there is in fact an increase of the eligible land (101.2%). LPIS 3 is performing just above the threshold, having 97.2%. Worst results were obtained for LPIS 2, with a total eligible area observed being 91.8% of the eligible area recorded.

17.2.2. **Proportion of RP allowing payment on ineligible land:** The expectation for less than 5% non-conformant reference parcels was met only by LPIS 1 (1.65%). LPIS 4 is just above the threshold with 5.5% of non-conformant reference parcels, while LPIS 3 has 21.75%. Finally, for LPIS 2 the rate of the non-conformant reference parcels was surprisingly high - 60.5%. At first glance, the high rate of non-conformant reference parcels seems to be in contradiction with the values for the total eligible area found. It could be explain with the fact that during the ETS many reference parcels have changed their reference area in both direction - some of them “increased” and other “decreased” their eligible land , leading to a compensation after the summing up.

17.2.3. **Distribution of RP allowing payment on ineligible land**: Although the resulted histogram of the reference parcels allowing payment on ineligible land to be considered as informative (no threshold is set), is shows that 3 of the 4 LPIS sets comply with the “old” 75/%90% rule (Art.6.2, Comm. Reg 796/2004), which requires that 75% of the reference parcels should contain 90% eligible land. The only exception might be LPIS 2, which seems to be on the limit, however it is not absolutely clear from the histogram, due to the ranges currently defined (72% of RPs have up to 8% ineligible land inside, and 81.9% of RPs have up to 12% ineligible land).

17.2.4. **Critical defects:** For 3 of the 4 LPIS sets, the expectation of less than 1% of potential defects unexplained, is met: for LPIS 1 is 0.12%; for LPIS 3 and 4 is 0%. This results can be a good indication that in those MS, the administrative workflow applied is such that potentially “defect” parcels are corrected at the time when the declaration starts (efficient update cycle). LPIS 2 shows quite high amount of parcels with critical defects - 25%.

17.2.5. The findings per measure described above are summarized in Table 14.

11164. doc	Quality topic	Measures	Expectation	Result for LPIS 1 850 reference parcels checked			Result for LPIS 2 800 reference parcels checked			Result for LPIS 3 800 reference parcels checked			Result for LPIS 4 1228 reference parcels checked		
3.1	Total eligible area: maximum quantity of land that can be claimed by farmers (SAPS) or eligible hectares upon which entitlements can be activated (SPS)	10201– LPIS eligible area	The total area observed of the agriculture land cover, should be >98% and <102% of the eligible area recorded	99.76%			91.70%			97.24%			101.2%		
3.2	Proportion of RP allowing payment on ineligible land[1]	10202 – LPIS non-conformant RP	< 5% RP contaminated	1.65%			60.50%			21.75%			5.5%		
3.2	Distribution of RP allowing payment on ineligible land	10203 - LPIS eligibility rates	N/A	Rate ineligible land in RP	Number of RP	% of RP	Rate ineligible land in RP	Number of RP	% of RP	Rate ineligible land in RP	Number of RP	% of RP	Rate ineligible land in RP	Number of RP	% of RP
				0-2%	828	97.41	0-2%	234	29.25	0-2%	486	60.79	0-2%	1107	90.15
				2-4%	11	1.29	2-4%	163	20.36	2-4%	117	14.68	2-4%	64	5.21
				4-8%	4	0.47	4-8%	181	22.63	4-8%	90	11.23	4-8%	33	2.69
				8-12%	1	0.12	8-12%	77	9.63	8-12%	30	3.80	8-12%	12	0.98
				12-20%	4	0.47	12-20%	55	6.88	12-20%	33	4.15	12-20%	6	0.49
				20-50%	1	0.12	20-50%	36	4.50	20-50%	32	3.97	20-50%	6	0.48
				>50%	1	0.12	>50%	54	6.75	>50%	11	1.38	>50%	0	0
				Total	850	100	Total	800	100	Total	800	Total	Total	1228	100
3.4	Occurrence of critical defects	10205 - LPIS critical defects	< 1% RP with potential defects unexplained	0.12%			25.0%			0%			0%		

Table 14. ETS scoreboard

18. Analysis of the Results and User Feedback

18.1.1. This section presents the subsequent analysis of the results obtained, together with the user feedback on the feasibility of the ETS. Findings are presented for each of the LPIS datasets separately.

18.2. LPIS 1

18.2.1. As the type of reference parcel for LPIS 1 is “agriculture parcel”, it might be assumed that the inspection would be quite simple and straightforward. Indeed, it is expected that such type of reference parcel will be less “contaminated” with ineligible land and will have relatively simple shape and structure. The almost “perfect” results obtained and the fast performance (40 parcels/hour inspected) of the test seem to confirm that expectation.

18.2.2. In any case, it was reported that the operator required additional guidance and training, as the mapping rules of the ETS inspection differed from the mapping rules implemented in the MS Administration for the LPIS update. One particular difference was the fact that according to the MS definition, the reference parcel should enclose not only single type of land cover, but also a single type of crop – thus, in the LPIS update cycle, the parcels needs to be split, if more than one crop is found. Contrary to that, the ETS approach maps the surface in broadly defined land cover classes – for example, all crops are represented by one single class “arable land”.

18.2.3. In order to achieve best results, the operator used the VHR data (pan-sharpened, true colour and colour infrared) collected in the frame of the CwRS, in combination with the orthophoto, acquired in the period 2006-2008 (having resolution of 25 cm). In any case, the operator mainly and maximally used the VHR satellite images because they were up-to-date. The orthophoto was only used to have a clearer view for checking some details along the parcel boundary (next to a stream, a road, a fence,..). However, it became evident that when a parcel cannot be properly evaluated on the base of the VHR data, due to a presence of clouds, the operator used the orthophoto as supplementary information. (See also 6.1.6)

18.2.4. Once the operator decided that the boundary (extend) of the reference parcel correctly encloses the agriculture land cover (with no internal non-agriculture features to be extracted), he reported the area observed the same as the area recorded and pass to the next parcel. The polygon of the "measured" reference parcel remains the same (a copy/paste) as the original one. If the reference parcel was found to include ineligible land cover feature, those are mapped and excluded from the parcel. The operator has mapped and excluded all identifiable ineligible land cover features, even smaller than 0.01ha. If the reference parcel was found to exclude eligible agriculture land, the parcel was enlarged only to compensate for losses occurring in the same parcel. Latter, after the completion of the inspection, it was decided that all reference parcels excluding agriculture land should be a subject of such adjustment.

18.2.5. The check for positional accuracy (quality measure 10101 –not required for 2010R146-) of the border has been found to be complex and time consuming, without a very clear purpose and use. In order to provide the values for that measure the MS Administration introduced a specific procedure, based on 4-meter perimeter buffer around the boundary of the reference parcel.

18.2.6. A special attention was given to the sequential inspection of the parcels from the pre-selection list, and especially to the reasons of skipping a certain parcel. The user feedback was that it is not very clear in which cases parcels should be skipped, and that better guidelines are necessary. Additional concern was the fact that the parcels skipped (parcel delineation is difficult/unclear on orthophoto) are exactly the typical ones with risk of error. Their systematic omission could lead to underrepresentation of the LPIS sample. An introduction in the procedure of a possibility for rapid field visits has been suggested.

18.2.7. Good correspondence between the results of the “maximum eligible area observed” from the ETS inspection and the “maximum eligible area observed” from the internal quality assurance done in the MS Administration, has been found (even when both procedure were not absolutely equal).

18.3. LPIS 2

18.3.1. Due to the high rate of non-conformant reference parcels (480 out of 800), and high number of parcels with (potential) critical defects (200 out of 800), LPIS 2 needs a special attention. First of all, it should be clarified, that the results and conclusion regarding LPIS 2 can be considered premature, as the LPIS 2 sample is processed by JRC on the base of pure land cover delineation, without a priori knowledge of the local agriculture practices and not applying any national eligibility profile.[2] The land cover on the area represented by each reference parcel was completely remapped, even if the visual interpretation revealed a good fit between the inspected reference parcel and the orthoimagery. A proper analysis of the raw observations might explain a considerable amount of the exclusions found and thus improve the rate of anomalies.

18.3.2. The follow-up bilateral discussion with the MS Administration is aiming to clarify the nature of the raw observation made and is trying to find a reasonable explanation of the problems found. The preliminary outcomes of this analysis revealed some weaknesses in the inspection procedure, which had to be resolved. However, there are clear indications for a problem with the conceptual design of this LPIS, triggering the commission and propagation of the observed systematic errors during the initial LPIS creation and subsequent update.

18.3.3. The type of the reference parcel for LPIS 2 is a “physical block”, which is supposed to enclose agriculture land only. This type is expected to be the most complex one from the “production block” type of reference parcels, as it can enclose the production area of more than one farmer. However, the parcel inspection, revealed a considerable number of reference parcels with a complex shape and structure, beyond the acceptable common practices. Such reference parcels, even enclosing correctly only eligible land, makes the location of the particular agriculture parcel considerably difficult – thus, preventing the farmer to submit correct declaration and increasing the risk for commission of obvious errors. These parcels are in fact a multitude of adjacent reference parcels, which have to be split and assigned with its own unique identifier. There were also cases of reference parcels completely defined on land, which cannot be considered agricultural (and eligible for direct payments), such as golf courses, marshland, park-like patches of grass in urban areas, etc. These findings suggested that the origin of the reference parcels in the LPIS is from an external dataset (as topographic block or cadastral parcel), which doesn’t match the typology of production block, enclosing purely agriculture land cover.

18.3.4. Another important point, regarding the parcel inspection of LPIS 2, is the up-to-date orthoimagery used in the photointerpretation. Contrary from LPIS 1, where two orthoimage datasets have been used (VHR and orthophoto), the inspection of the parcels from LPIS 2 has been done solely with the VHR orthoimagery from the CwRS campaign, which in this case was acquired by IKONOS. Although inside the LPIS specification, the coarser spatial resolution of this sensors (GSD of 1 meter) and the relatively low elevation angle of acquisition (up to 52 degrees), made the proper interpretation (using 1:2000

[2] In the other 3 LPIS cases, the inspection was performed by the MS Administrations themselves, applying their national eligibility rules implicitly

visual scale without ancillary information) of some land cover features quite difficult. The most common problems for the photointerpretation were:

- Invisible parcel boundary due to the occlusion of trees (forest, tree balts) of urban structures)
- Unclear distinction between some eligible land cover type such as arable land and grassland
- Unclear distinction between grassland and fallow land
- Unclear boundaries within mixed land cover (grassland with trees and shrubs)
- Presence of internal features, which might disrupt the continuity of the reference parcel, but could be considered also as part of the parcel (narrow channels, ditches, paths)

18.3.5. The use of additional imagery acquired during the same year, but in different season has been suggested. It has been also found that the true-colour composite offers in some cases better background than the colour infrared one for interpretation, probably due to the effect of saturation in the near infrared in those area where the reflectance of the vegetation is strong in that range of the wavelength.

18.4. LPIS 3

18.4.1. As in the previous case, the type of the reference parcel for this LPIS is “physical block”, defined by stable geographic - physical boundaries, enclosing homogenous land cover under agricultural use. Eligible land cover can be arable land, permanent crop or grassland, however areas are eligible for payment only if maintained in good agricultural condition at certain reference date. However, there is an important difference in the definition valid for LPIS 3 – the boundary of the reference parcel is not required to enclose eligible land only. In this respect, the maximum eligible area for the parcel doesn’t equal its geometry area. Its value is derived from the spatial intersection of the contour of the reference parcel with various information layers (eligible land cover, exclusions, protected areas). In fact LPIS 3 has a multi-layer data model with the basic unit (the reference parcel) being a “topographic block” with permanent boundaries, sable in time, rather than “production block”, which limit can be a subject of change each year.

18.4.2. Results show that the distribution of the reference parcels “contaminated” with ineligible land is fully compliant with the 75%/90% rule (Art. 6.2 from Reg 796/2004). The difference between the total eligible area observed and the total eligible area recorded is in the range of 2.8%. A comparison of this value with a previous LPIS revision (2048 parcels checked against the backdrop orthophoto, acquired in 2005-2008), revealed an increase of the difference between area observed and area recorded with 1.6%. This negative trend shown clearly the impact of time on the measures – the more recent orthoimagery indicates changes in the land (from 2005 to 2009), which probably has not been reported in the LPIS.

18.4.3. Due to current LPIS model, applied in the EU Member State (LPIS 3) and the national rules in force, the operater considered some quality measures listed in ANNEX I, irrelevant (for example, the landscape features) and ignored them during the inspection. Also no critical anomalies such as the ones listed in

Annex I (inability to identify RP boundaries, discontinuity or total absence of eligible features in the QC sample), have been found. It has been reported that due to the design of the LPIS model and nature of the reference parcel type, the list of critical defects (if considered exhaustive) is not relevant to LPIS 3.

18.4.4. Finally, the check for positional accuracy (measure 10101 – not required for 2010R146- , revealed 333 out of 741 reference parcels with inaccurately positioned nodes. It should be noted, that only 75 of them had more than quarter of their boundary segment misplaced. However, considering the fact that the type of the reference parcel is "topographic block", the misplacement of the parcel boundary might not be a big issue, if the value of the maximum eligible area is correct and the locations of the parcel doesn't hamper the farmer to provide correct declaration.

18.5. LPIS 4

18.5.1. Due to the larger sample size needed, the completion of the ETS for LPIS 4 took longer than in the other cases. Although in name the type of the reference parcel is "agriculture parcel", in practice it is much more like "farmer block". The specific landscape conditions, the type of agriculture and the agronomic practices applied in this EU Member State, imply the use of reference parcel with relatively large size (the average size of the parcels in the sample is 5 ha). The complexity of the landscape morphology (having a direct influence on water movements, soil, and on the productivity of the vegetation cover), had a direct impact on the land cover, which is diverse, with abundance of various landscape elements, which are difficult to interpret and map. This was a particular challenge for the ETS inspection, considering that the VHR orthoimagery from the CwRS was the sole source of information for land cover identification.

18.5.2. During the inspection, the operator re-digitised (at scale of 1:2000) a new parcel against the VHR orthoimagery, excluding any ineligible land cover and reported this net area as the new eligible area observed. The variation of the eligible area observed in respect to area recorded was in both directions – negative difference, when more ineligible land was excluded, and positive difference, when more agriculture land was included. The final sum up at sample level, resulted in an increase of the total eligible area found in respect to the eligible area recorded with 1.2%, which was a particular finding for that LPIS.

18.5.3. During the inspection, the operator initially marked 30 of the original reference parcels that have been divided into sub-parcels by exclusion polygons, as having potential critical defect. However, according to the business rules applied in the MS Administration, the original parcel is archived and a new parcel is created every time a modification is made. This means, that such multi-parcels or parcels with discontinuity are handled and resolved prior to the farmer application and cross-checks – thus, the 30 reference parcels initially identified, are not having "real" defects. That was the reason for reporting 0% occurrence of critical defects after the analysis of the findings.

18.6. General User Feedback

18.6.1. During the pilot implementation and after, the participating MS Administrations (as well as the photo-interpreters in JRC) have been asked to provide their overall comments on the ETS workflow, as well as to the feasibility of the entire methodology. Some more specific comments and suggestions were already presented in the sections above. In the following paragraphs, the user feedback on the most critical issues, has been summed-up:

- In general, the ETS methodology and procedure is feasible and can be done in a relatively short timeframe. Quality measures are found to be appropriate, meaningful and scientifically sound. However, the ETS technical documentation needs improvement in terms of structure, practical guidance and simplification, as some documents and sections were too "ISO-structured" and difficult to understand by the common user.
- Some measures (as boundary accuracy (10101) and landscape elements (10104)) seem to be very complex, and difficult to apply without additional clarification. They also required more efforts than expected. There was a suggestion to drop entirely the quality measure 10101 (boundary accuracy), as its implementation is very difficult and its use in the follow-up analysis and decision is not well justified.
- There was a request for more detailed mapping rules, especially in respect to the landscape elements (working scale, minimum mappable unit). The calculation of their area is also not clarified enough in the documentation. In any case, it was suggested that these rules should not be too restrictive and should have certain flexibility to be applied in any local context.
- The quality measure on critical defects, although important, can be sometimes subjective, as it depends on operator's decision during the photointerpretation. The type and design of the reference parcel plays major role as well. Parcels initially marked as "having critical defect", should be further investigated in order to check how they are handled in the administrative process.
- Although accepted in principle, the XML approach for data exchange and reporting was found difficult for some of the participants. Instead of using the pre-defined templates, data has been delivered and reported using other industry standard formats, as ERSI shape, MDB or MS Excel.
- The quality of some orthoimagery using in the CwRS might not be sufficient for the proper identification and delineation of certain land cover features, without supplementary information. The use of ancillary data (other recent orthoimagery, high-resolution satellite data, cadastral data) or the conduction of rapid field visits in case of doubt has been suggested.
- A common convention on reporting statistics and measuring units was proposed.

19. Reproducibility of the results

19.1.1. In order to roughly evaluate the robustness of the ETS methodology and the reproducibility of the results from the ETS, part of the sampled reference parcels of LPIS 2 have been inspected once again with a different reference orthoimage dataset, keeping all other conditions equal (environment, procedure, operator, visual scale). As the national orthophoto has been acquired in different time during the year (April to August 2009), a screening on the two orthoimage datasets has been made to select only those parcels for which the land cover remains unchanged in both cases. This action was important to guarantee that the difference in the interpretation and mapping is influenced at minimum by factual changes in the landscape. As a result, 66 reference parcels were initially processed both with the VHR data from the CwRS 2009 and the national orthoimagery. Results obtained have been analysed and compared.

19.1.2. The specification of the two image datasets were as follows:

- VHR data from CwRS 2009:
  - IKONOS, spatial resolution of 1 meter, pansharpened (natural colour or colour infrared)
  - Digital orthoptoto, spatial resolution of 0.5 meters, colour infrared, compressed to ECW
- National orthophoto
  - Aerial orthophoto, spatial resolution of 0.25 meters, natural colour, compressed to ECW

19.1.3. The average difference between the eligible land cover mapped using the national orthophoto and the eligible land cover mapped using the CwRS data at parcel level for all 66 observed parcels, is 0.092 ha. The median of the area differences 0.0076 ha These positive values show that the eligible land cover observed on the national orthophoto is slightly more than the one observed on the CwRS data. This is also evident from the statistics on Figure 6 given below.

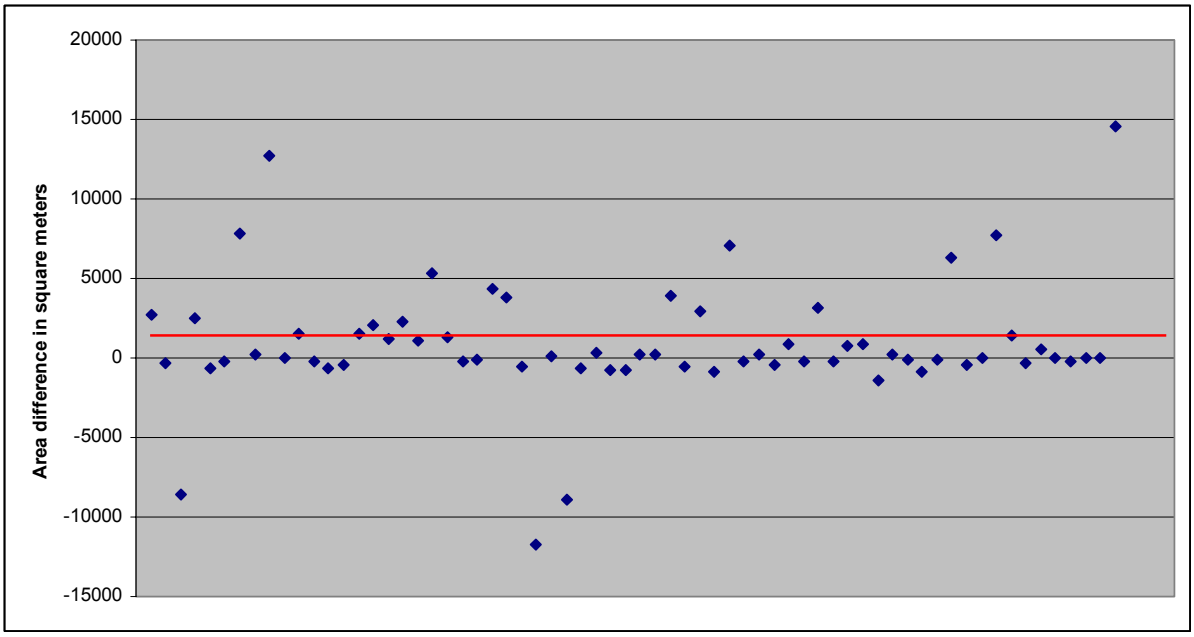

Figure 6. Histogram of the area difference for the selected (66) reference parcels. The red line shows the average.

19.1.4. The histogram on Figure 6 shows also a number of reference parcels with considerable difference in the eligible area observed in both image datasets (StDev of 3.9 ha). There are either very big parcels with complex contours or parcels, which are interpreted completely in different way. The maximum absolute difference between the area measurements from the two image datasets is 1.46 ha (the parcel inspected is more than 75 ha). The maximum relative difference (area difference divided on area observed on national orthophoto) is about 10-12%, except few specific outliers of very strong variations in both measurements. The total area difference for the whole selected set (66 parcels) is 60 ha, which is about 0.8% from the total area recorded in the LPIS for those parcels.

19.1.5. In order to assess the difference observed from the point of view of their impact of the reporting for the LPIS Quality Framework, the values for the key quality elements have been calculated for the 66 inspected parcels (Table 15). They are presented on the scoreboard below:

Key element (quality topic)	Result ETS (national orthophoto)	Result ETS (CwRS imagery)
Total eligible area	96.94%	96.13%
Proportion of RP allowing payment on ineligible land	55%	56%
Occurrence of critical defects	30%	32%

Table 15.Comparison of the ETS scoreboard results from the two image datasets (66 parcels)

19.1.6. From the results given above, it becomes evident that the total eligible area observed on the base of the national orthophoto is closer to the total eligible area recorded in the LPIS, than the total eligible area observed on the base of the CwRS imagery. The values for these key quality elements differ from each other with almost 1%. However, the number of the reference parcels, inspected with both datasets is relatively small in order to draw in particular conclusion. Anyway, it might show a systematic tendency, which needs further analysis. In respect to the rate of non-conformant reference parcels, both values are quite the same (55% and 56%). Further investigation showed that the rates of reference parcels, which have been "converted" from non-conformant to conformant and vice versa, were almost equal. The values for the percentage of reference parcels with potential critical defects are also similar. Further investigation revealed that most of the reference parcels flagged to have critical defects on the base of the CwRS imagery, remained flagged after the inspection with the national orthophoto. This suggests that the critical defects observed, represent a true condition on the ground, and are not related to the information content available on a particular image dataset.

19.1.7. The expected difference of the results obtained in both datasets, can be estimated in terms of the variances in the photointerpretation and delineation, caused by various factors. First, it is assumed that the systematic variation by the repeated manual delineation of the same parcel contour from a single reference dataset, by the same operator in a given scale is negligible. Therefore, any significant variation in the delineation of the reference parcels, using the 2 different datasets, should be explained by the following factors:

- Different dates of acquisition of both image datasets, resulting in difference stage of the vegetation growth and different spectral signatures on the imagery
- Difference in the geometric accuracy of the two image datasets, as well as in the absolute position
- Different information content of the two image datasets: the national reference orthophoto is more detailed (spatial resolution of 0.25 m.), while the CwRS ortohimagery is coarser, (having spatial resolution of 0.5 - 1m meter)
- Different spectral resolution of the two image datasets: the reference orthophoto is natural colour, while the CwRS ortohimagery is mostly colour infrared
- Different perception and subjective opinion of the operator applied in both reference datasets, especially, if different visual scale is used (exceptionally).

19.1.8. The similarity of the final results obtained gives an indication that the ETS methodology is robust and stable enough to provide meaningful results in different operational conditions (in this case, different reference data). However, considering the limited size of the repetition, it is still premature to draw

particular conclusions on how adapted image specifications can reduce the observed variation even further. A follow-up analysis on larger number of parcels, should investigate the nature of the area differences, obtained using different image datasets, and reveal any systematic dependence of the results from the quality of the orthoimagery.

19.1.9. In the meantime, some preliminary suggestions might be made, in respect to the observed trend in the area difference from both image datasets between the measures. The fact that more eligible land has been mapped on the national orthophoto, than on the CwRS imagery, probably can be explained with the following:

- Better spatial resolution of the national orthoptoto, than the CwRS imagery. Using an image with poorer information content, the operator is inclined to exclude more potentially eligible land cover in those cases when he is not certain and confident. For example, single trees inside or tree lines at the border of the parcel, which are perfectly visible on 25 cm orthopfoto, are blurred on the 1 meter satellite data. Such small objects, once pixelized, can give an impression to the operator that they cover larger area.
- Different time of acquisition of both datasets. The national orthophoto, seem to be acquired in a period where the vegetation growth is still limited. This is especially evident when looking at the tree crowns – they are partially leafless. Contrary to that, the CwRS data was acquired at a period where the presence of vegetation is significant. The variations in the vegetation resulted in a different land cover classes mapped (see the example on Figure 7).
- Different spectral resolution of the two image datasets. Sometimes the difference between bare and vegetated surface are more evident on the colour infrared image from the CwRS, than on the natural colour national orthophoto (see the example on Figure 7).
- More or less oblique field of view (FOV) during acquisition between both datasets (more strong on the CwRS data). It doesn't have much adverse effect on the national orthophoto, due to the better details and land of vegetation, which might obscure some features, but has a negative impact on the VHR satellite orthoimagery from CwRS (see Figure 8).

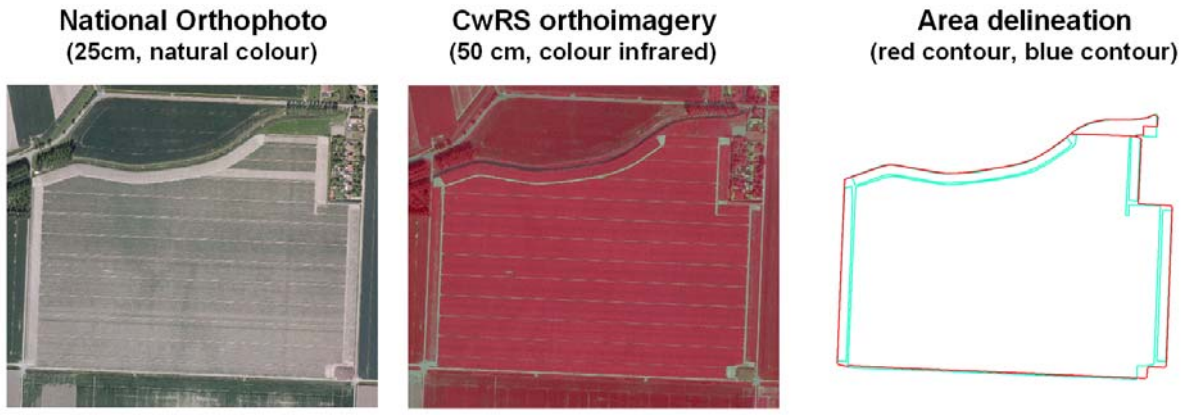

Figure 7. Difference in the image content (land cover) in both image datasets. This results, in different delineation - red contour from the national orthophoto, and blue contour from the CwRS data

Figure 8. Visual appearance of a tree line bordering a parcels in both image datasets. There is a strong shadow presented on national orthophoto, but due to the higher spatial resolution, image can be interpreted correctly (contrary to the VHR satellite data).

19.1.10. As an outcome of this, it can be said that there are various factors, which influence the information content of the imagery and it proper interpretation. It seems that there is a trade-off between the spatial, temporal and spectral resolutions. The "perfect orthoimagery" for the ETS is a fiction – in reality there will be always some compromise with one or few parameters of the image datasets. The most important will be to assess the impact of all this factors on the ETS observation and final decisions taken.

20. Conclusions

20.1. The results from the ETS pilot, show that the implementation of the ETS is feasible in the expected timeframe (2-3 months), with the existing resources available in the MS Administration. The methodology was in general accepted by the MS Administrations, participating in the pilot. It provides, according to the common opinion, objective and comprehensive information of the ability of the LPIS, to perform correctly its role.

20.2. On the other hand, the ETS documentation needs improvement towards more clarity and simplification. Further efforts should be made to provide more guidance and explanation how to inspect and interpret certain measures, together with examples from the practice. A trial year, without compliance thresholds, was request by the MS Administrations involved in the pilot. Also quality compliance thresholds that take into account the local agricultural practices (reference parcel type, fragmented parcels, temporarily flooded lands), have been proposed.

20.3. All MS Administrations participating in the test, stressed on the correct interpretation of quality measure 10106 "Critical Anomalies" - which counts the occurrence of the potential critical defect at parcel level. The word "potential" was considered essential in the definition of that measure, as it clarifies that any observations (made on the area of certain reference parcel), that might obstruct its correct use, should be then analysed in the context of the LPIS management and update workflow. These findings at parcel level, will become an indication of a "real" defect, only when there is an evidence that such anomalies

are not handled and corrected prior to the farmer applicationn process and the subsequent LPIS cross-checks.

20.4. The land cover mapping in that large scale is not a straightforward process, especially at that level of detail. Additional on-the-job training is probably needed. The operator, involved in the ETS inspection should have some basic knowledge of CAP principles and regulatory basis. Specific mapping rules need to be defined for some cases (for example, landscape features).. A better communication on eligibility profile is required.

20.5. A direct copying and pasting of the original polygon, if the visual interpretation doesn't reveal any changes in not recommended by default. The ETS methodology is based on purely new delineation of the land cover of the area, represented by the reference parcel.

20.6. The quality of the orthoimagery is essential for the successful performance of the inspection, as it has significant impact on the final results. The comparative analysis done on LPIS 2, could suggest that the operator is more conservative when using orthoimagery with coarser spatial resolution. Thus the results might be on the safe side in respect to the EU funds, The current requirements for the orthimagery used in the LPIS (based on the specifications applied for the Control with Remote Sensing Campaign), might need some refinement in order to guarantee the minimum information content necessary for the operator to perform the inspection in the office, without the need of systematic field visits. This is relevant, due to a discrepancy between the nominal specifications for the LPIS orthimagery in the Regulations and guidelines (1/10.000 , 2.5m RMSE, 0.1ha MMU), and the ones used for many actual LPIS systems (1/2.500, 25cm resolution, 0.01ha measurement)

20.7. In this respect, the following recommendation, regarding the orthoimagery applied in the ETS are given below:

- Use of orthoimages with spatial resolution higher than 1 meter
- Use of imagery acquired at nadir, as close as possible. If oblique acquisition is not avoidable, the off-nadir angle should be limited to 30 degree (especially for sensors with ground sampling distance larger than 50 cm.)
- Use of the full spectral range of the imagery. If infrared channels are available, they should be used.
- Time of acquisition even not so relevant for the LPIS QA, comparing to the CwRS, has an impact of the interpretation. The operator needs to take it into account during the interpretation. There is no general rule, each MS should assess this aspect for its conditions..
- The use of ancillary image or vector data can be an option, if a proper judgment cannot be drawn on the base of single orthoimage only. The use of the supplementary HR data acquired during the CwRS campaign is encouraged.
- As with any photointepretation, a field inspection might be considered if the available information in the office is not sufficient The correct application of the inspection methodology is crucial to support a general trust in its findings.

20.8. Finally, some additional suggestions have been made for follow-up actions, which are summarized in the list below:

- Elaboration of ISO compliant quality measures for each requirement from the Orthospecifications
- Better use of the information derived during the Abstract Test suite (ATS)
- Better explanation and clarification of Annex III, especially the eligibility profile
- Refinement of the land cover classes, using LCCS (version 3)
- Practical Tips & Tricks for the mapping: MMU, visual scale, image enhancements, etc.

20.9. The findings in the frame of this feasibility pilot, triggered, the following changes in the ETS methodology (incorporated in version 4 of the ETS Annexes):

- Annex I
  - TABLE 1: RP positional accuracy (10101) is DELETED
  - TABLE 7: Critical defects (10106) - The option of "Multi-parcel" is added in the list of potential critical defects.
  - TABLE 8: RP Area purity (10102_2) - Conformance level is updated with additional threshold: "between (or equal to) 97 % and 103 % OR Less (or equal) to 10 000 sq.m." DQ_EvalMethodDesc is revised and updated accordingly.
  - TABLE 9: RP cause of anomaly (10107): DQ_Scope is changed from "All RPs allowing payment on ineligible land" to "All non-conformant reference Parcels (as derived from 10102_2)". The order to the causes in the list is revised.
  - TABLE 12: LPIS eligibility rates (10203): DQ_MeasureDef changed to “Distribution of the reference parcels in LPIS, according to the correctness of the eligible area recorded (in respect to the eligible area observed on the orthoimagery)". In such case, the histogram encompass and represents also the RPs with 0% ineligible land, as well as those RPs which exclude agriculture land.
  - TABLE 13: LPIS number of anomaly causes (10204): DQ_MeasureDef changed to " Categorization of the non-conformant Reference Parcel, based on the potential cause for the occurrence of the contained problem”
- Annex II
  - Diagram in Figure 1 is updated
  - VI.1 and VI.2 - The check for positional accuracy of each reference parcel is DELETED. An overall check for completeness and relative positional accuracy between different datasets is added.
  - VI.5.iii – Quality measure 10106 changed from “Critical Defects” to “Potential Critical Defects”.
  - VI.6.i - The check for conformance of the reference parcel is updated according to the changes in quality measure 10102_2
  - VI.6.ii – The categorization is mode on the reference parcels found to be non-conformant
  - TABLE 1 “List of codes..” is updated
- Annex III
  - Paragraph 3.1.4 on land cover, revised
  - Paragraph 3.1.6 on land use, added in Chapter 3

- The term "tarra/tare" removed. "Pro-rata" is used instead
- Table 1 revised: order of columns changed
- Chapter 6 revised significantly. The purpose of the LCCS concept is explained and introduced better
- Chapter 7 on eligibility profile added, additional Table 2 introduced
- Chapter 8 "Application instructions" revised significantly, separating clearly the process of definition of the land cover classes using LCCS and the subsequent expression of the "maximum eligible area", according to the national - specific eligibility rules (agreed in advance with the Commission).

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Abstract
This report presents the findings and conclusions of the feasibility trial on a proposed methodology for the assessment of LPIS quality by individual member states. The methodology distinguishes two major parts or phases: an Abstract Test Suite (ATS) to test data model conformance and an Executive Test Suite (ETS) to verify actual data value conformance. The trial was organised in the second half of 2009 and involved 5 anonymous member states for the ATS and 4 anonymous member states for the ETS.
The successful trial demonstrated that the quality findings were relevant and that methodology was both technically and practically feasible.
The results were integrated into a revision of the supporting documentation and in, February 2010, the revised methodology was imbedded in Regulation 2010R146, amending the CAP regulation 2010R1122.

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