Interoperability Case Study for Landscape Features in Frame of IACS-INSPIRE Data Sharing Initiative

Technical report

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Executive summary

In the frame of the CAP, Lithuania operates its IACS, which comprises different IACS [1] elements governed by two core stakeholders. Lithuanian Agricultural Information and Rural Business Centre (AIRBC) accredited to manage identification system of agricultural parcels (LPIS) and aid application and payment claims (GSA) while National Paying Agency (NPA) performs controls (OTSC, CWRS etc.), administer aid applications and deal with payment transactions. Lithuanian IACS system is designed for storing EU CAP-relevant geospatial information (incl. but not limited to GSA).

The horizontal regulation of CAP introduces measures to underpin EU policies in domain of environmental and combating climate change. These objectives addressed in Lithuanian strategic plan. There is a need of specific indicators for monitoring and evaluating the implementation of the policy. The link between these indicators and LF is within the context of this case study.

The aim of this study to deliver local national scale generic findings for interoperability of IACS data with INSPIRE. The overall aim of this report is to provide local, large spatial scale (Lithuanian use case) input to Part 2 (Interoperability) of the IACS-INSPIRE Data Sharing Technical Guideline (TG).

Project activities, meetings and reporting

Table 1. List of activities

Activity performed:	**Delivery date**
Identification of test areas and suitable datasets. Semantic mapping of relevant feature types.	15.01.2022
Compiling datasets (layers - feature classes) of the four functional LF classes.	31.01.2022
Comparison of the LF dataset created with third party data with that produced by orthoimagery.	15.03.2022
Area monitoring system insights for the analysis of LF (optional).	31.03.2022
Activity supported:	**Delivery date**
Delivery of draft final report (methodology and results of implementation).	31.03.2022
Delivery of final report (considering the review of the JRC).	15.04.2022
Meetings attended:	**Delivery date**
Identification of test areas and suitable datasets. Semantic mapping of relevant features.	15.01.2022
Mid-term review. Work done and challenges.	15.02.2022
Comparison of the LF dataset created with third party data with that produced by orthoimagery.	15.03.2022
Delivery of draft final report (methodology and results of implementation).	31.03.2022
Delivery of final report (considering the review of the JRC).	15.04.2022
Conclusive remarks on work done. Contract closure.	31.05.2022

Definitions and abbreviations

Table 2. Definitions

Definition	Description
Land cover	Physical and biological cover of the earth's surface including artificial surfaces, agricultural areas, forests, (semi-)natural areas, wetlands, water bodies (INSPIRE).
Agricultural area	Means any area taken up by arable land, permanent grassland and permanent pasture, or permanent crops.
Arable land	Means land cultivated for crop production or areas available for crop production.
Permanent crops	Means non-rotational crops other than permanent grassland and permanent pasture that occupy the land for five years or more and yield repeated harvests, including nurseries and short rotation coppice.
Permanent grassland	Permanent grassland and permanent pasture (together referred to as "permanent grassland") means land used to grow grasses or other herbaceous forage naturally (self-seeded) or through cultivation (sown) and that has not been included in the crop rotation of the holding for five years or more; it may include other species such as shrubs and/or trees which can be grazed provided that the grasses and other herbaceous forage remain predominant as well as, where Member States so decide, land which can be grazed and which forms part of established local practices where grasses and other herbaceous forage are traditionally not predominant in grazing areas.
Landscape feature	Elements of the agricultural area that are traditionally part of good agriculture cropping or utilization practices.
Ecological focus area	An area of land upon which you carry out agricultural practices that are beneficial for the climate and the environment.
Feature type	A class that specifies set of spatial objects sharing common properties and operations applicable to the objects.
Feature class	A ESRI geodatabase Feature class that specifies set of spatial objects sharing common properties and operations applicable to the objects.
Feature	Abstraction of real world phenomena. A feature may occur as a type or an instance. (ISO 19101:2002).
Feature attribute	Characteristic of a feature (ISO19101).
Identifier	Linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated (ISO 19135:2005 – adapted from ISO/IEC 11179-3:2003).
Interoperability	The ability of software and hardware on different machines from different vendors to share data.
Data	Reinterpretable representation of information in a formalised manner suitable for communication, interpretation, or processing (ISO/IEC 2382-1). Data can be any form of information whether on paper or in electronic form. Data may refer to any electronic file no matter what the format: e.g. a database or binary data, text, images. Everything read and written by a computer can be considered data except for instructions in a program that are executed (software).

Table 3. Abbreviations

Abbreviation	Description
MS	European Union (EU) Member State.
AIRBC	Lithuanian Agricultural Information and Rural Business Centre.
NPA	Lithuanian National Paying Agency.
JRC	European Commission (EC), Joint Research Centre.
INSPIRE	Infrastructure for Spatial Information in Europe.
CAP	Common Agricultural Policy.
IACS	Integrated Administration and Control System.
LPIS	Land Parcel Identification System.
AM	Aerial Monitoring.
OTSC	On-the-spot Checks.
CWRS	Controls With Remote Sensing.
GSA	Geospatial Application.
LF	Landscape Feature.
EFA	Ecological Focus Area.
TG	Technical Guidance.
WF	Woody Features.

Introduction

The concept of landscape features (LF) comprises the fragments of permanent non-productive areas embedded in agricultural landscapes. These small fragments have a key role in maintaining biodiversity and ecosystem services in the European agriculture, so they have become a priority focus of several EU policies.

As the concept of LF is relatively abstract, which has only been recently endorsed by mainstream policy and science, there are no established quantification methods and indicators available yet. Such well-defined indicators, however, are critical for context and impact indicators laid out in the new CAP.

LF vector and raster data representation, data completeness, semantic definition and classification of the relevant feature types of these datasets as well as the level of details (spatial resolution and the granularity of thematic information) may not be sufficient and thus, may not be fully compatible with the concepts recognized in the CAP. As the concept of LF is strongly connected to agricultural land, as well as the ecological and policy motivation to quantify them, the exercise is restricted to the agricultural areas and the areas adjacent to them.

Problem definition

In terms of semantics, the new CAP requires a simple, yet comprehensive typology LF, which encompasses the various definition of these features and reflects their functionality (support for biodiversity and ecosystem services in the agricultural landscapes). In context of the strategic plans, the broad categories of LF are foreseen. The EFA layer of LPIS, if it includes "stable" LF as defined by the MS, is very detailed and accurate. However, it is limited, by definition, to arable land and features adjacent to it. Currently the LF on other types of agricultural area (permanent grassland, permanent crop, agroforestry) are not included in LPIS.

Furthermore, the adjacency is defined by complex rules that exclude some elements that contribute to the diversification of rural landscape, support biodiversity and provide ecosystem services. The EFA mapping rules also allow simplified representation geometries. This means that instead of delineating the surfaces (polygons), curves (centre lines) or points could have been also used.

Large spatial scale topographic maps (databases) might be valuable sources of LF, as all the phenomena that are visible on the surface of the Earth are subjects of surveying. Apart of semantics, the other issue might be the scale of the survey, i.e. which is the minimum mapping unit (MMU).

Nevertheless, prominent objects that are important for orientation or for characteristics of the terrain might be included, even when they are smaller than the MMU. Environmental thematic databases, frequently published under the “Hydrography”, “Habitats and biotopes” or “Protected sites” INSPIRE data themes can be also regarded as source of certain LF types. The level of details and the spatial representation might be the most critical issues, especially when the datasets are presented as coverage (most frequently gridded) data.

Lithuanian case study

Lithuania already produced and using comprehensive datasets. Such datasets include the EFA (Ecological Focus Area) layer of the Land Parcel Identification System (LPIS) with inserted LF types in EFA. This case study include exploratory analysis of potential new LF. For production of potential LF layer, several national third party datasets (e.g., various environmental thematic maps) with a reliable coverage of specific LF types will be considered.

The thematic objective of this case study is to assess the usability of existing datasets (IACS and third party datasets) in terms of LF in Lithuania and evaluate interoperability options. This pilot use case study performed for selected test area (see study area description section) within the territory of the Lithuania.

Material and methods

The study involves the following high-level tasks:

1. Resolution of the semantic differences between the functional LF classes;
2. Compiling a dataset (layers) for the four functional LF classes within the agricultural area mask;
3. Assessing the efficiency of using the EFA layer and third party information to create a comprehensive LF dataset through comparison with orthoimagery.
4. Support in quantifying resources needed to perform the tasks listed above, in terms of workload, software, etc. (TG level).

Study area description

Lithuanian territory represents a surface of 65,286 square kilometres, mostly characterised as a plain. Lithuania's terrain is an alternation of moderate lowlands and highlands. The highest elevation is 297.84 meters above sea level. 2,833 lakes larger than 1 hectare and 1,600 smaller ponds punctuate the landscape. The majority of the lakes are in the eastern part of the country. Lithuania also has 758 rivers longer than 10 kilometres.

The land cover development (0.48% change rate per year) in the country is getting slower mainly because of the rapid decrease of the intensity of forest conversions. The artificial land occupation is concentrated mostly around the core urban areas and cities. In 2012, 33% of the surface was occupied by arable land and permanent crops, 27% semi-natural vegetation, 33% by forested land, 3% by artificial areas and 4% by water bodies and other land [2]. The human population density is constantly declining and was approximately 31 inhabitants per square kilometre in 2011 [3].

The case study performed for one selected test area within the territory of the Lithuania. This area is situation close to the main road A9, which connects cities of Šiauliai and Panevėžys (Figure 1). One test site[1] selected because all agricultural landscape typologies in terms of terrain elevation, hydrography and agricultural cultivation patterns in Lithuania are very similar (Table 5). The selected rectangular area (total test area) cover 260 sq.km (Figure 2).

The selected test area covered by the following input materials (as listed in Table 5):

1. EFA layer from LPIS (Table 5, DT id: 1);
2. Parcels from LPIS with information on the types of agricultural area (Table 5, DT id: 2, 3);
3. "Related farmers" declarations on EFA and LPIS (Table 5, DT id: 4);
4. Third party datasets (Table 5, DT id: 6–9, 11);
5. Recent high-resolution orthoimagery (Table 5, DT id: 5);
6. LF mapping data. LF and potential LF areas (Table 5, DT id: 10).

[1] in the methodological note it was suggested to use 4-5 test sites, however, one test site was selected. LUCAS 2022 survey was not used for targeted selection of test area.

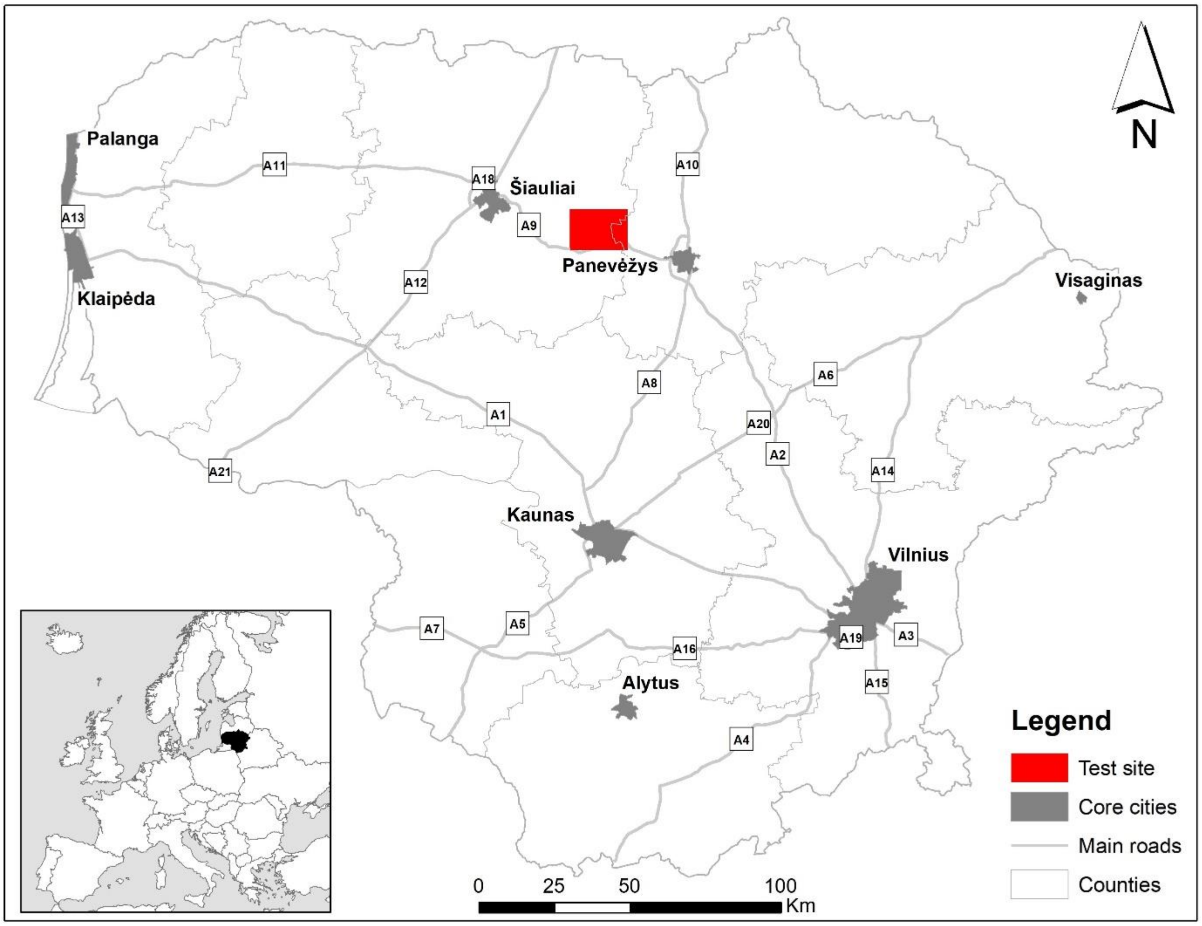

Figure 1. Case study area (see Figure 2) location in Lithuania.

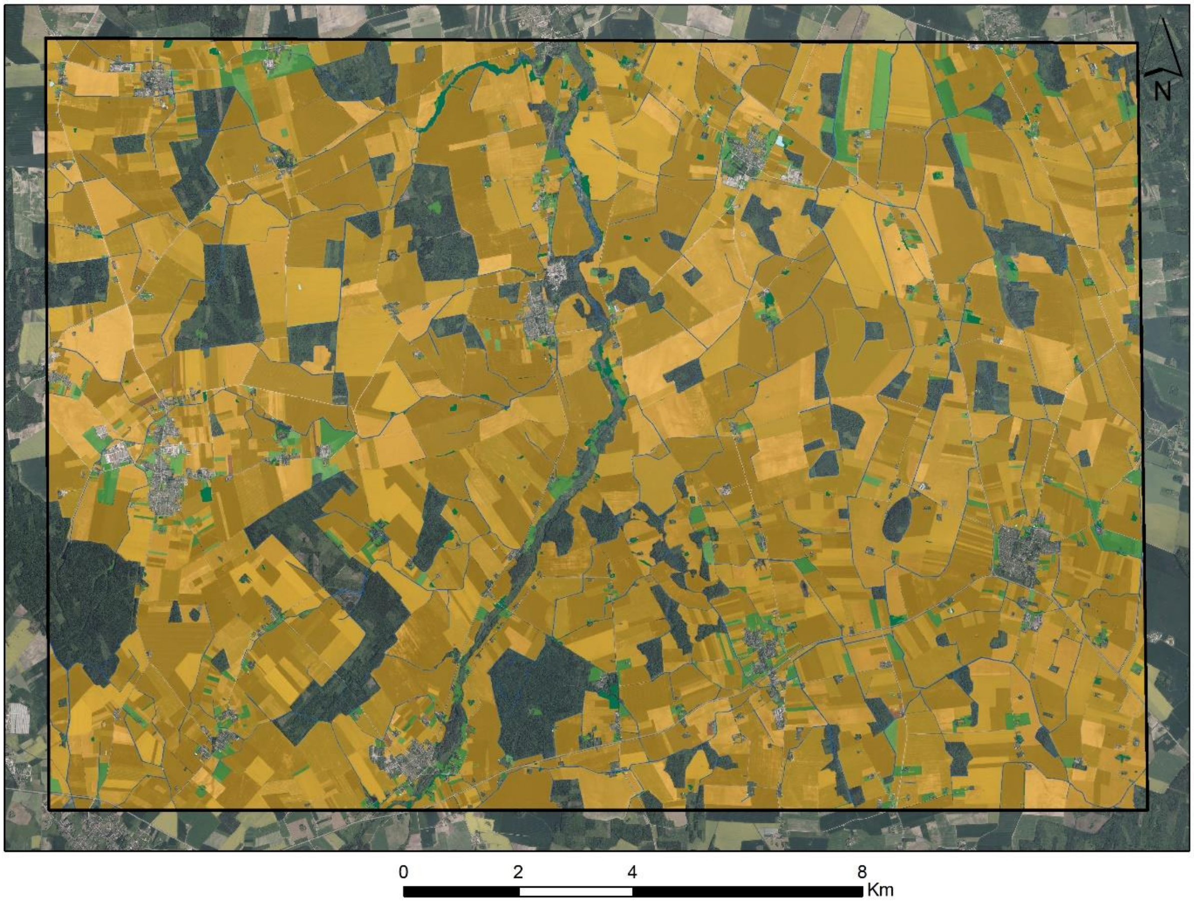

Figure 2. Case study area and selected study/test site. Map legend provided in (Figure 3).

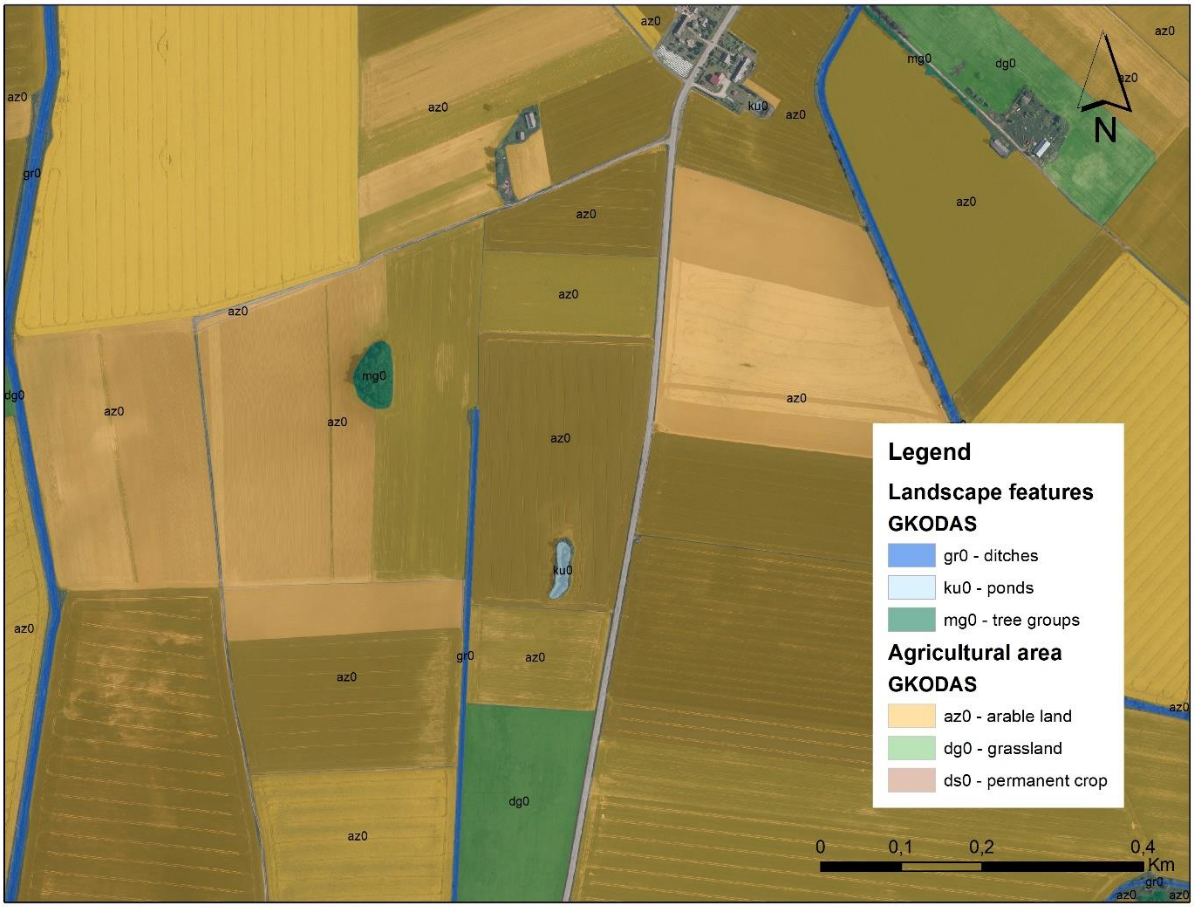

Figure 3. Study/test site example with existing LF and agricultural area (Table 5, DT id: 1).

Table 4. LULC, Agricultural area and LF statistical indicators for study site and Lithuania.

No.	Type	Name	Coverage			
			Study site		Lithuania	
			ha	%	ha	%
1.	Corine Land Cover 2018 (LULC) with MMU of 5 ha.	Artificial surfaces (1)	697.23	2.72	220,833.00	3.38
		Agricultural areas (2)	22,008.83	85.94	3,818,947.88	58.48
		Forest and semi natural areas (3)	2,903.93	11.34	2,264,293.55	34.68
		Wetlands (4)	0.00	0.00	56,698.73	0.87
		Inland water bodies (5)	0.00	0.00	169,077.89	2.59
2.	Agricultural area (LPIS)*	Arable land (az0)	219.38	95.73	2,266,256.26	78.38
		Grassland (dg0)	9.46	4.13	604,274.27	20.90
		Permanent crop (ds0)	0.32	0.14	20,943.87	0.72
3.	Landscape features (LF)*	Ponds (ku0)	0.08	1.57	51.52	4.23
		Ditches (gr0)	3.34	69.50	49.58	4.07
		Tree groups (mg0)	1.39	28.93	1,116.71	91.70

* - declared in 2021.

Resources used

The descriptions of officially accessible spatial data (http://www.geoportal.lt) covering study area, provided in the Table 5.

Table 5. List of datasets used in the Lithuanian case study*

DT Id	Dataset name (FC: feature class** name)	Source Database	Provider	Spatial scale	Decription	INSPIRE data theme
1	Landscape features (in EFA layer) (FC: LandscapeFeatures)	LPIS	SE AIRBC	5,000	Direct mapping from aerial and VHR orthoimagery, auxiliary spatial data	Land use
2.	Reference parcels (physical blocks) (FC: ReferenceParcels)	LPIS	SE AIRBC	5,000	Direct mapping from aerial and VHR orthoimagery, auxiliary spatial data	Land use
3.	Agricultural area types (FC: AgriculturalAreas)	LPIS	SE AIRBC	5,000	Direct mapping from aerial and VHR orthoimagery, auxiliary spatial data	Land use
4.	Declared agricultural parcels (FC: DeclaredParcels)	IACS	NPA		Direct mapping from aerial orthoimagery	Land cover
5.	Aerial orthoimagery (dir: IACSINSPIRELT_ort)	ORT10LT	National Land Service		GSD – 0,2 m	Orthoimagery
6.	Georeferential Base Map (FC: GeoreferencialPolygons, GeoreferencialPolylines)	GRPK map (GDB10LT)	SE GIS-Centras	10,000	Direct mapping from aerial orthoimagery	Administrative units, Transport networks, Protected sites, Land cover, Buildings, Height, Agriculture and Aquaculture infrastructure, Hydrography

7.	Cadastre of river, lakes and ponds (FC: WaterwaysPondsDitches, WaterbodiesLakes Ditches)	UETK	Environmental protection agency	10,000	Included in EFA layer delineation	Hydrography
8.	Cadaster of protected areas*** (FC: StateReserveArea, HabitatsDirectiveSites, BotanicalNaturalHeritage)	STK	State service of protected territories	10,000		Protected sites; Habitats and biotopes
9.	Cadaster of forest areas (FC: ForestParcels)	VMT	Lithuanian State Forest Service	10,000		Land cover
10.	Potential areas for landscape features (FC: LandscapeFeatures Polygon) LandscapeFeaturesPoint) LandscapeFeatures Polyline)	Own development	IACSINSPIRELT	5,000	LF data harvesting (direct mapping/extraction/conversion/intersection) from 3 rd party dataset	Land cover
11.	Small woody features (FC: WoodyFeatures)	SWF	European Environmental Agency	5,000	Automatic classification, photointerpretation (auxiliary, because temporal extent 2014-2016)	Land cover

* - all data in IACSINSPIRELT.gdb database is in LKS-94/Lithuania TM, coordinate system EPSG:3346.
** - database IACSINSPIRELT.gdb feature class names as described in Annex I.
*** - included but not limited to NATURA 2000 (i) Birds Directive Sites (SPA), (ii) Habitats Directive Sites (pSCI, SCI, SAC); Sites - or parts of sites - belonging to both directives and State Reserve Areas.

In addition, large scale topographic maps dataset were considered as a potential resource for landscape feature identification. Environtmental thematic databases under INSPIRE data themes „Hydorgraphy“, „Habitats and biotopes“, „Protected sites“ reviewed and listed in Table 5.

Methodology used

Based on the input data the following steps are performed:

1. Analysis of the semantic definition and mapping specifications of LF in the EFA layer, third party datasets;
2. Documentation of the rules of semantic mapping between EFA, third party data and the functional LF classes and identification of the information gaps (LF types for which there is no, or just partial information available, Table 8).
3. Production of a LF dataset and map (LF layer) by integrating the relevant elements after the

semantic mapping (Annex I).

4. Overlay of LF datasets produced by merging available data. Analysis of results in terms of matching instances;

5. Comparison of the results and discussion of the discrepancies found and their possible implications on indicators, their assessment and validation.

Results

Semantic mapping

Semantic mapping between the broad categories of LF (Table 6) and the corresponding feature types (Table 7) of the EFA layer and the selected third party datasets provided in the Table 8 with mapping example in Figure 4.

The mapping presented in tabular form. The documentation also include the mapping rules and information gaps (Table 8).

Table 6. Functional Landscape Feature Classes (as provided in the contract Table 1)

FLF id	Functional LF (FLF) class	Examples from GAEC/EFA	Proposed geometric specifications
1	Woody features	Isolated trees, tree lines and avenues, hedges, woody strips, trees in group, field coppices and riparian woody vegetation	width >= 1m AND (width<= 20 m OR area <=0.5ha)
2	Grassy features	Grassy strips, field margins, embankments, buffer strips, grassed ‚thalweg‘	width >= 1m AND (width<= 20 m OR area <=0.5ha)
3	Wet features	Inland channels of fresh water, standing small water bodies such as natural or man-made ponds, ditches.	width >= 1m AND (width<= 20 * m OR area <=0.5ha)
4	Stony Features*	Dry stonewalls, terrace elements, rock outcrops, natural or artificial stacks of stones.	(width OR height) >= 1m AND (width<= 20 m OR area <=0.5ha)

*- does not exist but foreseen in new legislation in Lithuania.

Table 7. Lithuanian Landscape feature classes and coded values (Table 5, DT id: 1).

<table>
<tr><th>FLF_LT id</th><th>Functional LF (FLF) class</th><th>Description</th><th>Gkodas</th><th>Feature class delineation conditions</th><th>Geometric specifications</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Woody features</td><td>Trees in group</td><td>mg0</td><td rowspan="3">The element must be interspersed with or limited to the arable land.
It is also permissible to limit to:
- ineligible areas;
- declared areas of permanent grassland and / or permanent crops.</td><td rowspan="2">0.01 ha >= area <= 0.3 ha</td></tr>
<tr><td>Woody vegetation</td><td>mg0</td></tr>
<tr><td>2</td><td>Wet features</td><td>Ponds with riparian vegetation</td><td>ku0</td><td>0.005 ha >= area <= 0.3 ha</td></tr>
</table>

		Ditches	gr0	Not more than 5 m from the arable land	width >= 10 m
		Inland channels of fresh water from 1 m wide	gr0		
3	Grassy features	Grassy strips (field margins) those area and configuration unchanged for 3 years or more	az0	Areas adjacent to arable land, woodlands, roads, ditches, other bodies of water	1m >= width <= 20m OR area >=0,1 ha

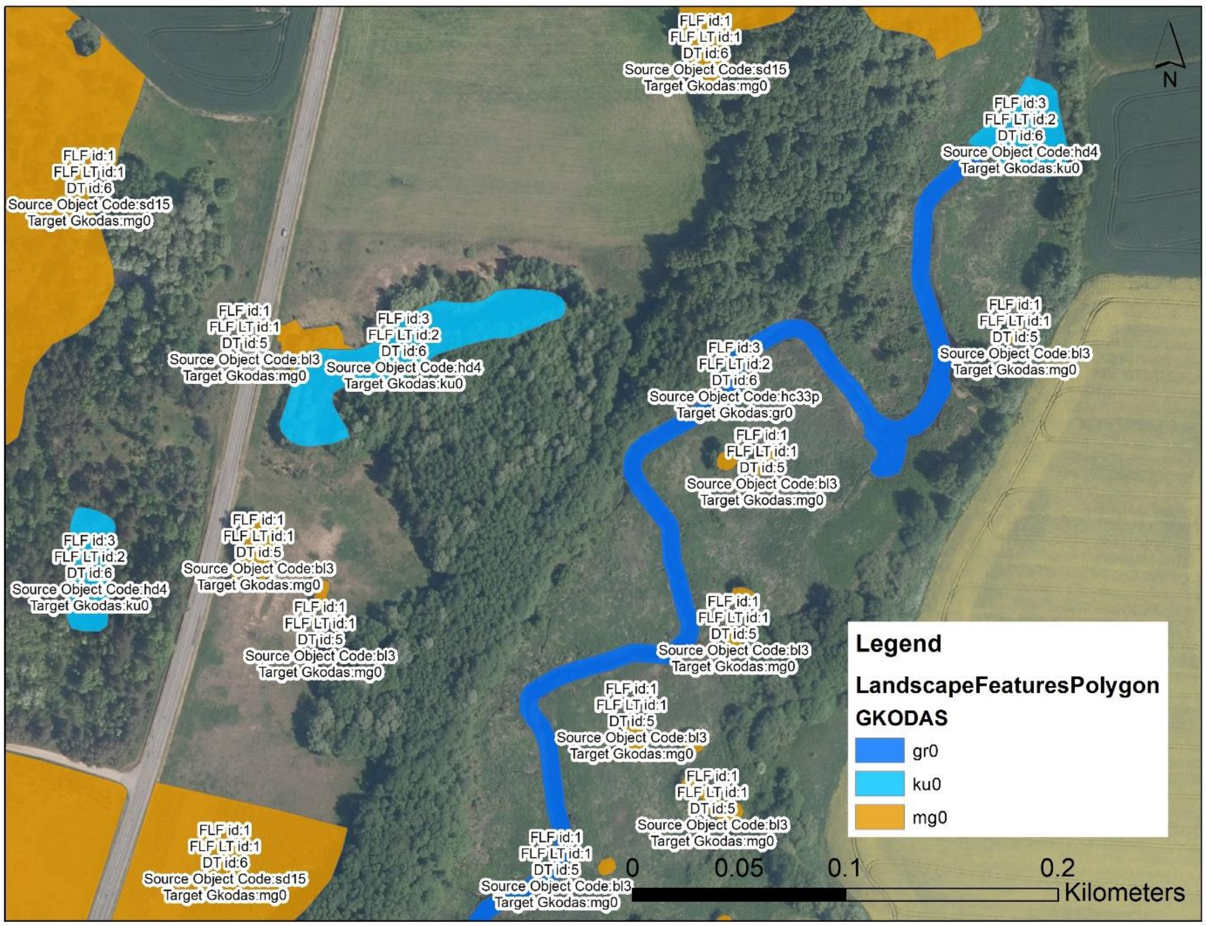

Figure 4. Mapping example LF. Labels show FLF id (Table 6), FLF_LT id (Table 7), DT id (Table 5). Object conversion from third party source (ObjectCode) to target (Gkodas) LF values (Table 7).

Table 8. Semantic mapping between third party data features and potential new LF feature (Table 5, DT id: 10). Mapping example if provided in Figure 4. All LF are on or adjacent to arable land. Potentially new LF are on or adjacent to all agricultural areas.

FLF id*	**FLF_LT id****	**DT id *****	**Object Code*****	***Gkodas****	***Geometry *******	***Link description***	***Information gaps***
1	1	5	bl3	mg0 (trees ingroups, woody vegetation)	polygon	Interactive and semi-automatic vectorisation. According specification in Table 7.	No overlaps with DT id: 1 (Table 5).
3	2	6	hc31p hc32p hc33p	gr0 (ditches)	polygon	Direct replica. Topologically correct.	No overlaps with DT id: 1 (Table 5).
3	2	6	hd4	ku0 (ponds with riparian vegetation)	polygon	Direct replica. Topologically correct.	No overlaps with DT id: 1 (Table 5).
1	1	6	sd15	mg0 (trees in groups, woody vegetation)	polygon	Step 1. mg0 = Table 5, DT id 6 sd15 do not overlay with Table 5, DT id 2, bl3 and bl9 but included in Table 5, bl6 and do not overlay with Table 5, DT id 1. Step 2. mg0 = Table 5, DT id 6, sd15 which is in Table 5, DT id 2, bl9 and do not overlay Table 5, DT id 10.	Shape change, land cover change, intersections and geometry overlaps.
1	1	6	sd4	mg0 (trees in groups, woody vegetation)	polygon	mg0 = Table 5, DT id 6, sd4 do not overlay with Table 5, DT id 10, bl3.	Shape change, land cover change, intersections and geometry overlaps.
1	1	6	ms0	mg0 (trees in groups, woody vegetation)	polygon	mg0 = Table 5, DT id 6, ms0 do not overlay with Table 5, DT id 9 and do not overlay with Table 5, DT id 10, bl3 and do	Shape change, land cover change, intersections and geometry overlaps.

						not overlay with Table 5, DT id 1, bl3.	
1	1	6	mj0	mg0 (trees in groups, woody vegetation)	polygon	Direct replica.	Shape change.
1	1	11	1 2 3	mg0 (trees in groups, woody vegetation)	polygon	mg0 = Table 5, DT id 11, 1,2,3 do not overlay with Table 4, DT id 9 and do not overlay with Table 5, DT id 10 and do not overlay with Table 5, DT id 1 and do not overlay with Table 5, DT id 2, bl2 but within Table 5, DT id 2.	Shape change. Temporal coverage 2014-2016.
1	1	6	mj0	mg0 (trees in groups, woody vegetation)	polyline	Direct replica. Topologically correct.	No overlaps with DT id: 1 (Table 5).
1	1	8	nk1	nk1*****	point	Direct replica.	Foreseen as new LF type. Possible overlaps with DT id 1 (Table 5).

*-from Table 6.
**-from Table 7. Coded value az0 not found in study site.
***-from Table 5 . See Table 9 for descriptions of coded values.
****- to be defined in new CAP (LT legislation).
*****- Gkodas value officially not specified in the new LF specification yet.

Table 9. Description of features (ObjectCode) used for identification of potential LF. The full list of coded values provided in Annex I (in Lithuanian).

DT id *	ObjectCode	Description
6	hc31p	Buffered lines of 1-3 m wide streams, canals, drainage ditches.
6	hc32p	Buffered lines of 3-5 m wide streams, canals, drainage ditches
6	hc33p	Buffered lines of 6-12 m wide streams, canals, drainage ditches.
6	hd4	Ponds and other bodies of standing water (hydro technical structures) - the area of the artificial surface water body located on natural ground, the water reserves which are supplemented by surface water flows and which may be overgrown with aquatic vegetation (e.g. reeds).
6	sd15	Greenery, greenery of trees and shrub areas including non-forested greenery and greenery, newly planted forests and short rotation plantations, covering an area of at least 0.1 ha.
6	sd4	Non-utilized land areas comprising land unsuitable for agricultural use (unless they are built-up areas, areas overgrown with trees and shrubs, wetlands, damaged land, arable land or gardens, sand dunes), administrative boundary clearings in the forest, homesteads (except those where no rubble and visible hay or pasture meadows) and airport areas with undefined boundaries.
6	ms0	Forest areas comprising at least 0.1 ha of land overgrown with trees at least 20 years old, other forest vegetation, thinned or temporarily lost vegetation due to human activities and natural factors (forest cutting sites, burning sites, dead forest stands, forest squares). Forests also include land occupied by fire lines, nurseries, forest seed plantations, animal feed sites.
6	mj0	A strip of trees - is a strip of trees (not within the area of cities and towns) that are at least 100 m in length and in vicinity (along) of road, railway or canal and usually covers more than one row of trees.
11	1	Additional woody features.
11	2	Linear structures of trees, hedges, bushes and scrub.
11	3	Patchy structures of trees, hedges, bushes and scrub.
8	nk1	State natural heritage objects can be polygons or points and of different types: geological, geomorphological, hydrogeological, hydrographical, botanical and zoological. For identification of LF botanical State natural heritage objects can be used.

*-from Table 5.

Currently, small-afforested areas and groups of trees can be recognised as landscape features (EFA objects) and integrated into LPIS EFA layer in case it is not included in the forest cadastre of the Republic of Lithuania. The same principle applies for ponds, it can be recognised as landscape features (EFA objects) and integrated into LPIS EFA layer in case it does not have concrete shorelines and not included in the cadastre of rivers, lakes and ponds of the Republic of Lithuania. The boundaries of small afforested areas and groups of trees are updated according to the objects falling into LPIS reference parcels layer (physical block – „bl3“) with an area of at least 0.1 ha, according to the visible tree coppice boundary of the data specified in Table 5, DT id 5. The tree coppice must overlap to form a solid array. The boundaries of ponds are updated according to objects (hd3 and hd4) in the LPIS reference parcels layer visible boundaries of the shoreline and (or) riparian vegetation within the data specified in Table 5, DT id 5. The ditches and inland water channels updated according data specified in Table 5, DT id 5.

Landscape features within EFA layer must be stable in time for at least three years.

Table 10. The list of new landscape features (LF) that foreseen in the new CAP (in the frame of national legislation). The coded values (Gkodas) of new LF officially not defined yet as well as the data sources from where LF can be taken. Potential LF coded values provided as is in original third party data specifications.

Geometry	New FL description	Potential data source for identification of LF
Polyline	Hedgehogs (boundary strips), field margins/edges	Data from large spatial scale topographic maps in or adjacent to agricultural areas.
	Shores of water bodies, ditches (including protection belts of surface water bodies)	Shores of water bodies: Feature class name: VAND_JUOST, coded value (Gkodas) - az30*
	Protective strips for trees and shrubs	Groups of trees and or shrubs: Feature class name: MISKO_AZ, coded value (Gkodas) az55*
Point	Individual trees or shrubs	Individual trees: Table 5, DT id 8, Gkodas nk1); Individual trees and or shrubs: Feature class name: ZELDINIAI, coded value (Gkodas) az37*
	Piles of stones, branches and stumps	Large spatial scale topographic maps in or adjacent to agricultural areas**
Point	Groups of trees and shrubs (including greenery of old homesteads)	Groups of trees and or shrubs: Feature class name: ZELDINIAI, coded value (Gkodas) az37*
	Areas in arable land that naturally soaked every year	Areas in arable land that naturally soaked every year: Feature class name: PIEV_GAN_P, coded value (Gkodas) az45*
	Ponds	Ponds: Table 5, DT id 7***

* - the spatial data (Feature classes: VAND_JUOST, ZELDINIAI, PIEV_GAN_P, MISKO_AZ) is available but not accessible through national SDI. Data is not updated since 2018. Data base specification shared in national SDI: https://www.geoportal.lt/download/Specifikacijos/SZNS_DR10LT_SPECIFIKACIJA.pdf
**- the data (accessible for authorised users only) that can be used for identification of LF. Table 20, #77, #81; KODAS: 2107, 2412, etc. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.103882/asr
***- the spatial data in Cadastre of river, lakes and ponds (Table 5, DT id 7) is available but not accessible through national SDI.

The foreseen duration of the commitments unchanged and defined as in previous period - 3 years. Longer commitments are needed because (i) there will be support for the establishment of new LF, and there should be a commitment to maintain LFs for a longer period of time, (ii) the aim is to maintain LFs for longer time, as plants and animals, especially wild pollinators need more time to enter and adapt into new habitats (iii) longer timeframe is needed to achieve a higher environmental impact, e.g. in the case of buffer strips, surface water is much more effectively protected from pollution when perennial, well-rooted plants grow in the area adjacent to surface water bodies.

The LF (Table 10) will be eligible for support i.e. direct payments will be available for ponds and woods or the catch crop can also be considered as a green cover. However, LF will not be eligible in case they are not on or adjacent to arable land and surrounded by areas of permanent grassland or permanent crop. Despite the fact that (i) it is legally envisaged not to identify LF that are not on or adjacent to arable land and (ii) in order to identify full potential of LF in this study all potential LF have been identified on (or adjacent to) all types of agricultural areas.

The LF interactive identification exercise it is possible to anticipate, that in the case of direct mapping using aerial monitoring framework, it would be difficult to distinguish LF on permanent grassland and permanent crops. However, using third party data fusion and intersection algorithms and applying the rules for converting those intersections into LF would allow identifying LF not only on arable land but also on other types of agricultural areas.

Last but not least it is important to stress that large spatial scale data still not freely accessible and if accessible, might not be available (due to incomplete coverage) for all agricultural areas at national level.

Potential areas for landscape features

Functional landscape feature classes (as provided in the contract Table 1) provided in Table 6. Lithuanian landscape feature classes (Table 5, DT id: 1) provided in Table 7. Semantic mapping between third party data features and potential new LF feature (Table 5, DT id: 10) was performed and provided in Table 8. Comparison of the results has been performed, the discrepancies found, links and information gaps discussed in Table 8 (with data mapping example in Figure 4).

Currently the EFA layer of LPIS, if it includes stable LF as defined by the MS, is very detailed and accurate. However, by definition it is limited to arable land and features adjacent to it. LF on other types of agricultural area (permanent grassland, permanent crop, agroforestry) was also analysed during this study and included in the final dataset (Figure 5). The adjacency context of newly identified potential LF are not evaluated because it depends on the stakeholders decisions, however it can be spatially analysed using the database (Annex I) provided with this report.

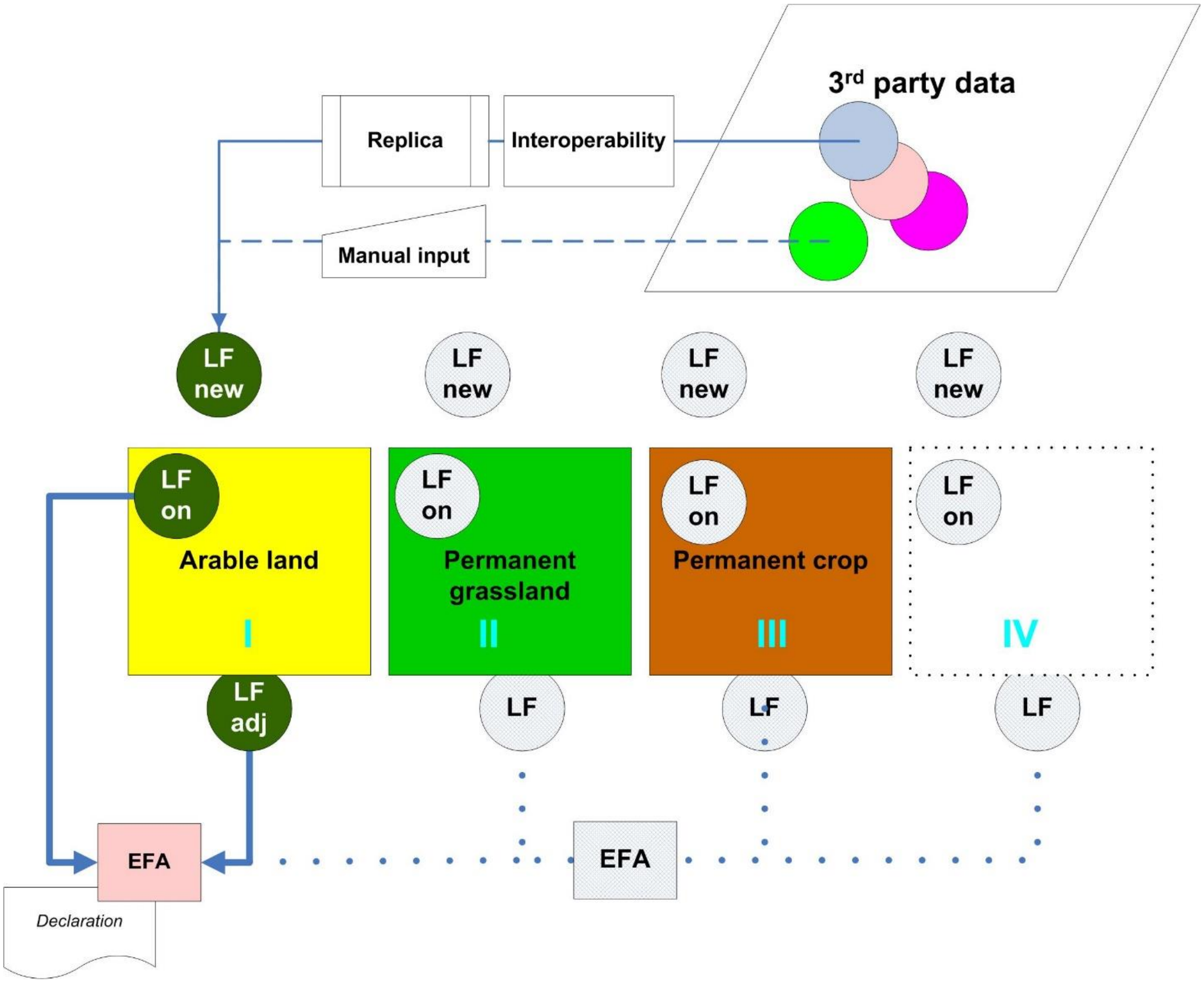

Figure 5. Conceptual LF mapping schema

Identification and characterisation of LF on all types of agricultural areas can be performed using the same data (3rd party) fusion approach. Third party data as auxiliary data also can be useful for validation of identified woody, wet, grassy and stony LF on all types of agricultural areas. However, identification of woody, wet and grassy features on permanent grassland and permanent crop areas can be a challenging exercise, because from domain point of view LF might be very homogenous to those that are already present on agricultural areas (permanent grassland and permanent crop). Also the national legislative framework for such exercise shall be approved before actual LF identification on or adjacent to all types of agricultural areas (which currently is not the case in the past and even new period).

Statistical analysis of results

Comparison of the “before/after” LF’s on the pilot site was performed. LF‘s area that was „before“ the digitization and existed in „old“ version of LPIS LF layer compared with newly digitized LF‘s area (the area of all existing LF‘s type (woody feature, ponds, ditches) are summed up). The increase in area is 33

%, so this LF's number is not in LPIS data (Table 5.DTid 1) on test site.

In order to benchmark the "matching/missing" LF's, the LF's from the different 3rd-party sources (Table 5.DTid 6 and Table 5.DTid 11) were selected and then checked with a spatial join if it had a match with the potential LF's (Table 5.DTid 10). The denominator is the number of digitized LFs compared to 3rd party features using spatial location (objects matching and missing digitized LFs).

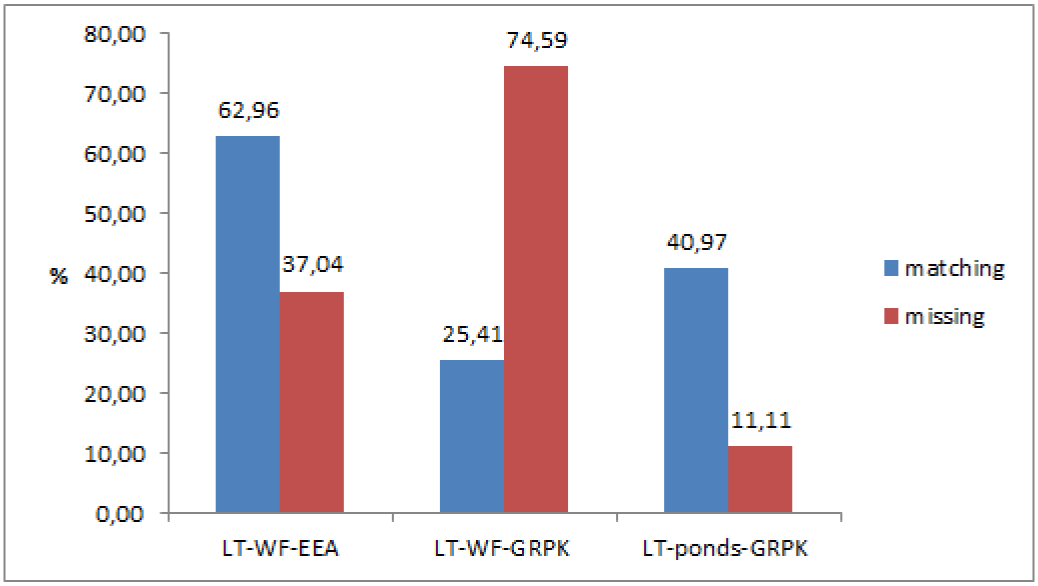

Figure 6. Comparison of the 3rd party datasets to the LFs digitised on the pilot site

Comparison results (Figure 6) show that EEA woody features (WF) match the digitised WF in ~63 % of cases while do not match in ~37 % of cases. However, GRPK WF show opposite, where only ~25 % of GRPK WF's and digitised WF's are matching, while ~75 % don't. EEA WF's represent WF's better than GRPK WF's because semantically EEA WF's definition fit the LPIS WF's definition better than GRPK WF's (by means of indicative location where potential WF might be identified).

Ponds (Figure 6) are more stable objects in time than WF's and, therefore only ~11 % are missing while ~41 % are matching. The mismatch might be related with different definition of ponds in different data specifications as well as different spatiotemporal issues.

Area monitoring system insights

Technically, full-fledged national SDI is available and working as data interoperability system already. National SDI contains constantly updated data that can be useful for spatiotemporal identification, characterisation and even enrichment of LF. The study results show that identification and characterisation of LF using national SDI interoperability and data fusion approach is realistic and implementable into area monitoring system within NPA. However, automating LF identification process require additional: (i) LF semantic mapping (ii) data specification mapping [5] (iii) data matching and (iv) data fusion algorithm development efforts. Developed algorithms can be shared and used by other users, especially in those cases when non-national (e.g. multi-national) data is used.

Conclusions

The aim of this study is to examine the suitability of existing spatial data in the context of IACS LF data interoperability. The study found that there are many large and small spatial scale data circulating in national SDI. However, all the data created according to different data specifications in most cases without pre-matching the semantic data relationships between the different specifications before data mapping is performed. Therefore, all source data created using different specifications and for different purposes and use cases.

Data interoperability that backed the large-scale data fusion (data mashup) may invoke data topology problems that are not present in the original databases. For example, the accuracy of data vectorization can result in heterogeneous LF boundaries (e.g., when spatial data from different data sources is intersected). In the case of small-scale data analyses, this issue is not a problem, but combining large scale data for identification of LF might become an increasingly common problem.

This study also found that only a small number of existing datasets can help to identify LF from existing data sources (that are available in national SDI) at the national level. For example, accurate large-scale topographic maps can help identify LFs. However, large-scale topographic maps are usually produced in urban areas, urban area agglomerations or at short distances from underground and/or air communications and/or power supply lines where agricultural activities are not that common. Examination of non-national spatial data sources has shown that they can be used to identify LFs, but due to compatibility problem between different specifications, this can only be done through interactive case-by-case scenarios.

The study results show that data conversion might invoke the loss of original data quality. Data interoperability backed data (SDI) fusion for identification and enrichment of LF is possible, but through interactive mapping processes only. Extra quality visual inspection and 4-eye control is necessary.

The usability of existing datasets that can be potentially suitable for inventory and quantification of LF has been analysed within the context of interoperability. In particular (i) data compatibility and semantics, (ii) spatial representation and (iii) encoding have been analysed in order to provide the input for IACS-INSPIRE Data Sharing Guideline (TG) and documentation of TG according the rules of INSPIRE [4].

After investigating datasets available in Lithuanian SDI[2], it was concluded that data are not consistent/harmonised in the country. Majority of datasets managed by different bodies independently and this is the core reason why thematic gaps might occur. Data update is subject on resource availability and updated not-periodically. Therefore, usability of these data for identification of LF must be performed with extra attention to third party feature specifications. It is manual process and currently is more burden than efficient long-term solution. In order to achieve full potential of third party data it is important to perform thematic harmonisation of data specifications. Harmonisation of data specifications and update of third party data cannot be achieved without tight collaboration between the different data providers. Harmonization of data specifications would be a long-term solution and would allow full automation of LF identification processes.

Acknowledgements

The technical report was prepared using data accessible through national SDI custodian SE GIS-Centras (data providers: SE AIRBC, National Land Service, Environmental protection agency, State service of protected territories, Lithuanian State Forest Service), European Environmental Agency and National Paying Agency of Lithuania.

[2] The online webmap services are accesible through the INSPIRE network services, operated by national SDI http://www.geoportal.lt

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Annex I. Database specification

IACSINSPIRE.gdb database specification provided in the tables below. In the tables below documented only those feature classes and attributes that are relevant for this study. Other feature classes and attributes might be not documented but present in the database for traceability reasons.

1. List of deliverables

Following deliverables[3] produced during this study (Figure A1):

- ESRI file geodatabase IACSINSPIRELT.gdb (Annex I);
- ESRI project file IACSINSPIRELT.mxd;

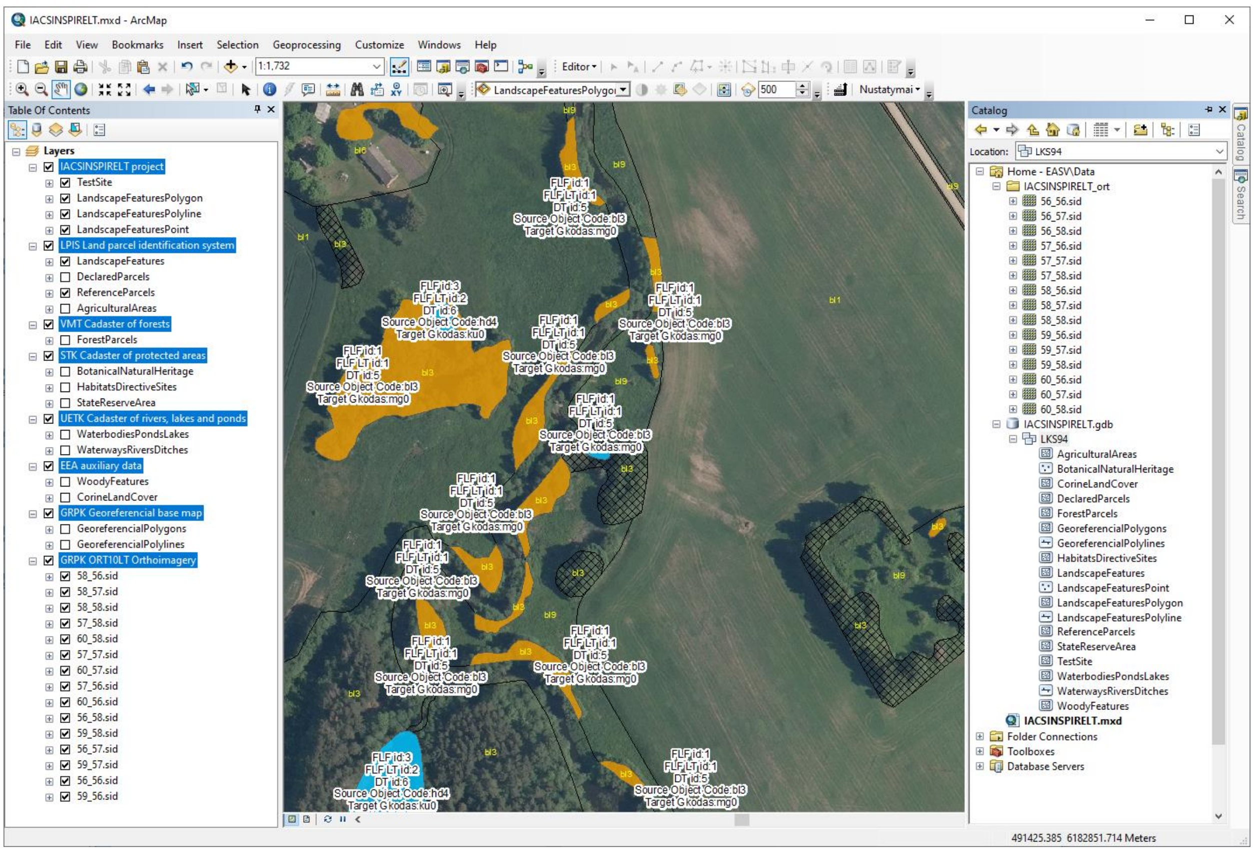

Figure A1. ESRI inc. ArcMap project (table of contents), file geodatabase and orthophoto imagery.

[3] The data used in this study are archived and provided in separate *.zip file. This report and derivative data (except data that belong to 3rd parties) shall be treated as data prepared under Creative Commons Atribution Licence (CC BY). The CC BY permits unrestricted use, distribution, and reproduction of the material in any medium, even commercially, provided that this report is properly cited. Rules for sharing 3rd party data that are described by the providers of the data are not included in this report.

2. Project deliverables, Table 5, DT id 10:

Table A1. Feature class (Polygon): TestSite

Attribute name	Field type	Length	Values	Description
id	Long	n/a	OID	Unique identifier of the test site.
areaHa	Double	n/a	Area	Area of the test site in hectares.

Table A2. Feature classes (Polygon, Point, Polyline): LandscapeFeaturesPolygon, LandscapeFeaturesPoint, LandscapeFeaturesPolyline (new).

Attribute name	Field type	Length	Values	Description
id	long	n/a	OID	Unique identifier of the LF
FLF_id	Short	n/a	Id	Values provided in Table 5, FLF_id field.
FLF_LT_id	Short	n/a	Id	Values provided in Table 6, FLF_LT_id field.
DT_id	Short	n/a	Id	Values provided in Table 4, FLF_LT_id field.
ObjectCode	String	50	Coded values	Feature (Gkodas, Ids, Coded values etc.) values derived from different data specifications of different data sources (Table 4, DT_id 6-9, 11).
Gkodas	String	6	Coded values	Values provided in Table 6, Gkodas field.
notes	String	254	Text	Mapping interpretation notes.

3. IACS data, Table 5 DT id 1-4:

Table A3. Feature class (Polygon): LandscapeFeatures (present)

Attribute name	Field type	Length	Values	Description
BLOKAS_ID	String	11	UID	Unique identifier of the block where LF is located as described in data specification https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx
GKODAS	String	12	Coded values	Coded values as described in data specification: https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx

Table A4. Feature class (Polygon): DeclaredParcels

Attribute name	Field type	Length	Values	Description
DKL_ID	String	254	UID	Unique identification of declaration.
KZS_NR	String	254	Id	Unique identifier of the block where declared parcel is located as described in data specification https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx

Table A5. Feature class (Polygon): ReferenceParcels

Attribute name	Field type	Length	Values	Description
NUMERIS	String	20	UID	Unique identifier of the physical block as described in data specification https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx
GKODAS	String	100	Coded values	Coded values as described in data specification: https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx

Table A6. Feature class (Polygon): AgriculturalAreas

Attribute name	Field type	Length	Values	Description
NUMERIS	String	11	UID	Unique identifier of the physical block where agricultural area is located, as described in data specification https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx
GKODAS	String	6	Coded values	Coded values of agricultural areas as described in data specification: https://zum.lrv.lt/uploads/zum/documents/files/3D472aprasas607.docx

4. 3rd party data, Table 5, DT id 5-9,11:

Table A7. Feature class (Polygon): ForestParcels (Auxiliary)

Attribute name	Field type	Length	Values	Description
skl_geo	String	255	UID	Unique identifier of the forest parcel, as described in forest cadastre data specification https://e-seimas.lrs.lt/rs/legalact/TAD/TAIS.236889/format/ISO_PDF/

Table A8. Feature class (Polygon): BotanicalNaturalHeritage

Attribute name	Field type	Length	Values	Description
ID	String	12	UID	Unique identifier of the object as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf
PAVADINIMAS	String	200	Text	Name of the object in Lithuanian.
GKODAS	String	6	Coded values	Coded values as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf

Table A9. Feature class (Polygon): HabitatsDirectiveSites (Auxiliary)

Attribute name	Field type	Length	Values	Description
ID	String	12	OID	Unique identifier of the object as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf
GKODAS	String	6	Coded values	Coded values as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf

Table A10. Feature class (Polygon): StateReserveArea (Auxiliary)

Attribute name	Field type	Length	Values	Description
ID	String	12	OID	Unique identifier of the object as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf
GKODAS	String	6	Coded values	Coded values as described in data specification https://www.geoportal.lt/download/Specifikacijos/STK_geoobjektu_specifikacija_3.2.pdf

Table A11. Feature class (Polygon, Polyline): WaterbodiesPondsLakes, WaterwaysRiversDitches

Attribute name	Field type	Length	Values	Description
Code	Long	n/a	Id	Unique internal identifier of the object. Depersonalised because of access rights.

Table A12. Feature class (Polygon): WoodyFeatures

Attribute name	Field type	Length	Values	Description
code	String	1	Coded value	Coded values based identifier of the object as described in data specification https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features/small-woody-features-2015?tab=metadata
class_name	String	80	Text	Class names as described in data specification https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features/small-woody-features-2015?tab=metadata

Table A13. Feature class (Polygon): CorineLandCover (Auxiliary)

Attribute name	Field type	Length	Values	Description
Code_18	String	3	Coded value (3^{rd} level)	Coded values based identifier of the object as described in data specification https://land.copernicus.eu/pan-european/corine-land-cover/clc2018?tab=metadata

Table A14. Feature class (Polygon): GeoreferencialPolygons

Attribute name	Field type	Length	Values	Description
TOP_ID	GUID	36	GUID	Unique global identifier of the feature.
Gkodas	String	12	Coded values	Coded values as described in data specification https://www.e-tar.lt/portal/lt/legalAct/f9f40a00ec6d11e78a1adea6fe72f3c5

Table A15. Feature class (Polyline): GeoreferencialPolylines

Attribute name	Field type	Length	Values	Description
TOP_ID	GUID	36	GUID	Unique global identifier of the feature.
Gkodas	String	12	Coded values	Coded values as described in data specification https://www.e-tar.lt/portal/lt/legalAct/f9f40a00ec6d11e78a1adea6fe72f3c5

Table A16. Raster dataset: Orthoimagery xx_xx.sid (15 images) within IACSINSPIRELT_ort directory.

Attribute	Values
Data type	File System Raster
Columns and rows	25,000, 25,000
Number of bands	5
Cell size (X, Y) metres	0.2, 0.2
Format	MrSID
Source type	Generic
Pixel type	Unsigned integer
Pixel depth in bits	8
Compression	Wavelet (MG4)
Size on disk in MB	119
Uncompressed size in GB	2.91

End of report.