EuroSDR

European Spatial Data Research

Annual Report 2022

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About EuroSDR

EuroSDR - formerly known as OEEPE - is a not-for-profit organisation linking National Mapping and Cadastral Agencies with Research Institutes and Universities in Europe for the purpose of applied research in spatial data provision, management and delivery. The result is a network of delegates, effectively and practically addressing Europe's spatial data research requirements. EuroSDR also organizes, in collaboration with related organisations, international workshops and courses which address key issues in a timely and focused manner.

Vision

EuroSDR is the recognised provider of research-based knowledge to a Europe where citizens can readily benefit from geographic information. Our mission is to develop and improve methods, systems and standards for the acquisition, processing, production, maintenance, management, visualization, and dissemination of geographic reference data in support of applications and service delivery.

Our Member States and their Prime Delegates (2022)

Austria	Wolfgang Gold	Bundesamt für Eich- und Vermessungswesen
Belgium	Eric Bayers	Institut Géographique National Belgique
Croatia	*To be confirmed*	Državna Geodetska Uprava (DGU)
Cyprus	Elia Elikkos	Ministry of the Interior, Department of Land and Surveys
Denmark	Jesper Weng Haar	Styrelsen for Dataforsyning og Effektivisering
Estonia	Tambet Tiits	Maa-amet
Finland	Juha Hyyppå	Maanmittauslaitos
France	Bénédicte Bucher	Institut National de l'Information Géographique et Forestière
Germany	Michael Hovenbitzer	Bundesamt für Kartographie und Geodäsie
Ireland	Paul Kane	Ordnance Survey Ireland
Norway	Jon Arne Trollvik	Statens Kartverket
Poland	Anna Bober	Główny Urząd Geodezji i Kartografii
Portugal	Mário Caetano	Direção Geral do Território
Slovenia	Dalibor Radovan	Geodetski Inštitut Slovenije
Spain	Julián D. Hernández	Instituto Geográfico Nacional
Sweden	Tobias Lindholm	Lantmäteriet
Switzerland	André Streilein	Bundesamt für Landestopographie
The Netherlands	Martijn Rijsdijk	Kadaster, Data Governance Innovation & Projects
United Kingdom	*To be confirmed*	Ordnance Survey Great Britain

Our Associate Members and their Representatives (2022)

Esri	Nick Land
Digitaal Vlaanderen	Jo Van Valckenborgh
Field Group	Leif Erik Blankenberg
Hexagon	Wolfgang Hesse
ICGC	Tais Arza
IGI	Philipp Grimm
RIEGL	Peter Rieger
Vexcel	Michael Gruber
1Spatial	Dan Warner

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Message from the President

Michael Hovenbitzer

Dear Colleagues and fellow Delegates,

A warm welcome to the EuroSDR 2022 annual report, to those of you that have been with us for years and to all new members of EuroSDR.

Most importantly, I would like to thank each and every one of you for your contributions to the work of EuroSDR throughout the year. A special thank you also goes out to the Secretariat, Publications Staff, and everyone who is working tirelessly to ensure that EuroSDR is running smoothly.

Plenty of projects on topics such as Digital Twins, Artificial Intelligence, New Lidar technology, Point Cloud Processing, SDI's, Linked Data, Historical Imagery, Remote Sensing and Photogrammetry shape the way we see things. The renewed focus on AI is more prevalent than ever, but climate concerns are still pressing topics that are not just being discussed in our field but also by the wider public. While building on the newest technology and combining areas of expertise, the goal is to develop several digital twins of our planet to help us make more informed and therefore better decisions – especially on a transnational or even global scale. I believe that EuroSDR can and should make an important contribution to this cause.

I would like to extend my gratitude to all members for their tireless efforts even under the current circumstances. Your work lies at the heart of this organisation and shapes it to be more impactful than ever before.

Over the last year, we have experienced several personnel changes. It is with great pleasure that we welcome the new board members. Furthermore, I would like to express my deepest thanks on behalf of EuroSDR for the commitment and contributions of those who recently retired.

I was very honoured to take up the role of president following the capable hands of Ireland's Paul Kane. Now it's time for me to say goodbye as president of EuroSDR and transfer the role to Wolfgang Gold from Austria. I wish him all the best and good luck with the honour and the challenge of taking over the next Presidency of EuroSDR.

Message from the Vice-President

Fabio Remondino

Dear EuroSDR friends,

2022 ascertained to be another successful and intense year for EuroSDR which confirmed its leaderships and presence in the geospatial sector through many events, research activities and cooperation with sister organisations.

The year was a productive and successful one, with two BoD meetings in presence (Dublin, Ireland and Naters, Switzerland) and many research activities and organized events. In terms of **organized and supported events** we can mention:

- Geoprocessing and Archiving of Historical Aerial Images
- Artificial Intelligence for NMCAs (in collaboration with EuroGeographics)
- Geodata discoverability (in collaboration with EuroGeographics)
- GeoData and Tools for Education and Research (in collaboration with AGILE)
- Data science for NMCAs
- Digital Twins
- Sustainable Open Data Business Models for NMCAs
- ISPRS and FIG congresses

In terms of **projects and research activities**, delegates focused primarily on the following topics:

- Linking data in Europe, Effective land administration (in collaboration with the UN Expert Group on Land Administration and Management)
- Distribution of historical and time stamped data from mapping agencies and other providers
- Digital Twins
- SP/GM LiDAR benchmarking
- 3D mapping from high-resolution satellite imagery.

In 2022 various interesting **projects** came to an end, including: the "*Benchmark - TIME - on historical aerial images"*, "*Benchmark - Hessigheim 3D - on semantic segmentation of high-resolution 3D point clouds and textured meshes*" and the "*Benchmark on RPAS geometric survey quality in the absence of ground information*". Papers and presentations related to these activities were given e.g., at the ISPRS Congress in Nice (June 2022).

In terms of **publications**, the survey report on "Sustainable Open Data Business Models for NMCAs" was released whereas the Special Issue "Upscaling AI Solutions for Large Scale Mapping Applications" on the MDPI International Journal of Geo-Information closed with 7 papers published.

On the educational side, the 20th edition of the **EduServ** course was offered and a dedicated celebration within the BoD meeting in Dublin was held. Two **PhD awards** were assigned (Lulin Zhang, Université Gustave Eiffel, Paris, France; Calimanut-Ionut Cira, Universidad Politécnica de Madrid, Spain). On the other hand, delegates agreed that EuroSDR should also support **PhD activities** and two topics were selected: Integration of multispectral LiDAR with imaging and Digital Twins.

We wish you all a very successful 2023 with many new research activities, events and educational courses under the EuroSDR umbrella!

Interesting examples of real life practices at NMCAs based on results of existing applied research

1. ALEGORIA: Multimodal Navigation Into The Geographic Iconographic Heritage

LASTIG, Univ. G. Eiffel, IGN ENSG, France (Valérie Gouet-Brunet and Nathalie Abadie)

The ALEGORIA project [10] aims at facilitating the promotion of iconographic institutional collections describing the French territory, from the interwar period up to nowadays. The collections are of variable sizes, between thousands and hundred thousand elements, which are oblique, vertical aerial or terrestrial photographs. Contrary to the well structured regular surveys in satellite imagery, the promotion of those collections remains confidential and scattered. They are generally spread among various institutions, heterogeneously documented and weakly georeferenced, while they represent a rich heritage, little known by the general public and exploited in a way forced by their main users (researchers, institutions and local authorities), on site at the library or via standard online digital libraries. In order to improve their structuring, we have studied the indexing of the collections by the harmonization of heterogeneous metadata (section 1) and by developing content-based indexes, both exploited in a web-based multimodal and large-scale search engine (section 2). To go deeper in the promotion of this heritage, we have proposed a second web-based platform, a visualization engine for their immersive restitution in their spatial context, allowing spatiotemporal navigation and interaction in the 3D environment (section 3). These two platforms can interact to improve the content geolocalization, for their better structuring and restitution in context. Finally, section 4 gives an insight into several use cases of the whole framework.

Collections. We managed more than 90,000 iconographic con- tents in ALEGORIA, coming from several institutions (French national archives, French mapping agency and Niépce Museum), which offer a bird's eye view of the French territory from the 20's to the 70's[1]. In the current demonstrator, a subset of 54,000 views (called DB-54k in the following) is indexed in the search engine; they share some common locations, 2/3 of them are associated with metadata and various levels of geolocation (no information up to a 6-DoF pose).

1. HARMONIZATION AND PUBLICATION OF FAIR METADATA

A part of the collections processed in the project are described by metadata. They provide structured information about the photographs that can be used for indexing, querying, and cross-referencing. As they are mostly derived from consolidated reference datasets, for each image, we generally have a title or keywords on its content or the place photographed, a date of shooting, a mention of the producer (the photographer, a company or an institution) and technical characteristics. However, this information is heterogeneous from one collection to another and is structured according to various models depending on the needs and practices of the institutions. Therefore, we needed to harmonized them to be fully exploitable in the multimodal search engine and more generally in the web of data community.

The Strategic Roadmap for Cultural Metadata and Web 3.0 Transition, developed in 2014 by the French Ministry of Culture, recommends publishing metadata according to the best practices of the Web of data[2]. These best practices are based on a graph data model (RDF for Resource Description Framework) and on the use of common and linked ontologies and thesauri to describe cultural objects, thus fostering the cross-referencing of metadata from different

[1] Links to the description and spatial distribution of the collections.

[2] This document, written in French, can be accessed here : https://www.culture.gouv.fr/

collections. In addition, the technical principles for publishing documents on the Web are extended to (meta)data: using URIs (for Unified Resource Identifier) to identify resources, using HTTP (for Hypertext Transfer Protocol) as a client-server communication protocol, and using content negotiation to provide a well-suited representation of the published resources. By following this recommendation, the project's (meta)data respects the FAIR data principles[3], a set of best practices to support discovery, access, interoperability, and reuse of digital data.

As there was no ontology designed to describe aerial photographs, the Records in Contexts (RiC-O) ontology[4], developed by a group of experts from the International Council on Archives (ICA), was chosen. This ontology was created to represent archival resources and their contextual entities consistent with the RDF model. RiC-O is thus particularly suitable for our project as the images and graphic documents selected are part of archival collections. It also has the advantage that it can be easily extended to describe the specific characteristics of a category of archival records, in our case aerial photographs and more generally geographical archival records[5].

All harmonized metadata (describing about 65,500 photographs on the whole collections available) are now published on the Web of data (see figure 1) and easily queryable, using the SPARQL end- point (SPARQL Protocol and RDF Query Language) located here: http://data.alegoria-project.fr/sparql. Examples of common queries and metadata dumps are also provided[6] to help new users discover this data set. In France, this is the first RiC-O-compliant RDF dataset of significant size that is published on the Web.

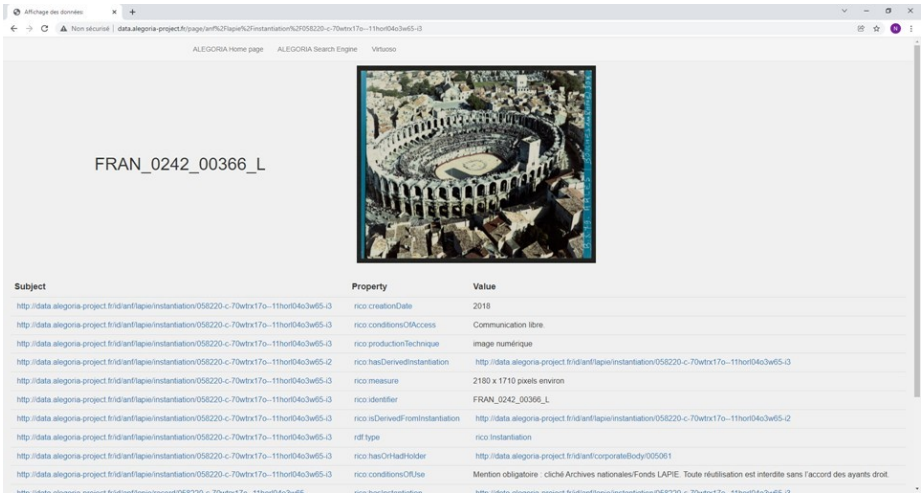

Figure 1 HTML version of the metadata of a photograph from the National Archives Lapie collection, accessed by dereferencing its URI: http://data.alegoria-project.fr/id/anf/lapie/instantiation/058220-c- 70wtrx17o--11horl04o3w65-i3. RDF-XML or RDF-Turtle versions are also available through content negotiation.

[3] https://www.go-fair.org/fair-principles/

[4] https://www.ica.org/standards/RiC/ontology. We used the version published in February 2021. RiC-O is the formal translation of the conceptual model RiC-CM: https://www.ica.org/sites/default/files/ric-cm-02_july2021_0.pdf

[5] RiC-O extension for geographical archival records can be found here: http://data.alegoria-project.fr/def/geotheque

[6] The metadata documentation is available there: https://www.alegoria-project.fr/sites/ default/files/22.01.07_MetadataAccessAndQuery.pdf

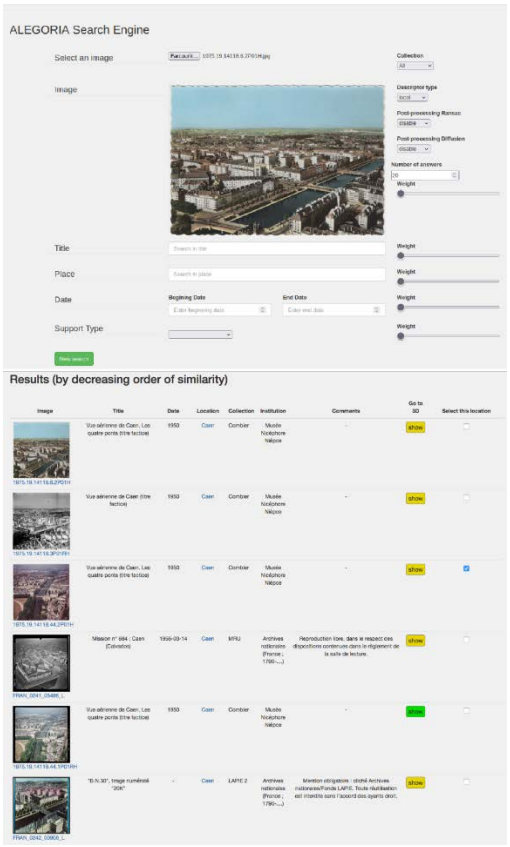

Figure 2: ALEGORIA search engine interface. The image on top was used as query by content, using local descriptors to search photographs of the same scene (Caen city). The ***k*** first results are presented with main metadata, by decreasing order of similarity; they show the same area (column "Location"), from different sources (columns "Collection" and "Institution"). Credits: Niepce Museum and French national archives.

2. MULTIMODAL SEARCH ENGINE

In order provide structure to the collections and to access them more easily, we have developed a web-based multimodal search engine, which indexes both the content of the images and the metadata associated when available. The photographs associated with metadata are indexed by the harmonized metadata presented in section 1. To deal with images without metadata and to propose complementary solution of structuring and access, we have also indexed all the collections in DB-54k automatically by content analysis. It was necessary to deal with image descriptors tuned to the contents considered : we have studied generalizable and robust deep descriptors for the problem of low-data, heterogeneous image retrieval, as well as post-processings to improve retrieval, such as geometric verification and query expansion. [6]

These different modalities are made available to query one or several collections together, by combining metadata and image con- tent search (through the query-by-example paradigm and various image descriptors). Fig. 2 shows the web client and an example of content-based retrieval. The search engine is client-server based, with a distributed server architecture that makes it scalable in terms of database size and descriptor complexity.

3. VISUALIZATION IN SPATIAL CONTEXT

One ambition of ALEGORIA was to show the user the visual content in its spatial environment. The proposed geovisualization platform is based on the open source web-based iTowns library [8] which leverages WebGL and OGC standards for accessing and visualizing 3D geospatial datasets. By accessing geographic web services, it renders the Earth with multimodal geospatial data into a common 3D reference model, anywhere where data is available, with a high precision, at large scale. New functionalities were developed within ALEGORIA, such as navigation through time [9], free viewpoint navigation and management of massive data; see Fig. 3 and article [2] for further details. When a photographic content is associated with a 6-DoF localization (*i.e.* a 3D position and 3D orientation) and internal camera parameters (focal length, optical center, distor- tion...), it can be displayed in the 3D scene, as illustrated in Fig. 3 (right image). In practice, such a precise geolocation in the metadata was missing in the historical contents of DB-54k, which lead to the development of a **semi-automatic geolocalization** functionality: from an initial position in the scene, we adopted the semi-automatic approach [7], where localization is performed with 2D-3D registration with at least 4 corresponding user clicks on the

overlaid image and the 3D model. In the demo, we exploit a textured terrain and a LoD1 3D model of buildings, provided by IGN on the whole French territory. When available, other models can be exploited, such as 3D point clouds (LiDAR, photogrammetry).[1]

The two web-based platforms presented above can be used separately on the same dataset, but more interestingly, they can communicate to be exploited jointly: they have the capability of communicating based on the different levels of image geolocation available, in order to give the possibility of improving the geolocation and structuring of the contents, or more simply to see the results of retrieval in their spatial environment. [5]

Figure 3 Visualization with 2 geolocation types: left, the view, associated with toponym "Chalendrey" converted in 2D geolocation, is displayed in the 3D scene by simple overlay, before semi-automatic geolocalization; right, the view (Nanterre) is 6-DoF localized and displayed in the camera pyramid model, around which the user can turn freely. Credits: Niepce Museum and IGN.

4. USE CASES

Currently, the two platforms are designed for professionals and non specialists. ALEGORIA's consortium gathers historians, sociologists, archivists and museum curators, who evaluated the proposed functionalities. The scenarios identified as most relevant were:

- Link by content similar images of the same location across collections, in order to improve metadata, or to share multi- source documentary information;
- Help in structuring a collection, for instance by retrieving duplicate or derived visual contents;
- Link similar images of the same location, across collections and times, in order to study the territory evolution. Similarly, show an old photograph in its present-day 3D spatial context;
- Navigate into the spatial environment and exploit other con- tents (photographs, vector features such as statistics).

Some applications of these functionalities are obvious (study of the territory evolution, virtual and sustainable tourism, education, etc [3] Concrete use cases were implemented, such as the study by historians of the transformations of the Parisian metropolis in the 1950s, or a new use of photo-elicitation (*i.e.* photo as a medium for discourse during interview) in 3D context for visual sociology [2]

In the perspectives, we plan to study other descriptors to further improve image retrieval, especially in challenging conditions (aerial vs. ground-level, etc.) as well as improve the user experience between the two platforms for geolocalization.

ACKNOWLEDGMENTS

This work was supported by French ANR and DGA within ALE- GORIA (grants ANR-17-CE38-0014-01 and DGA-2017-60-0048).

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2. Austrian Geoportal Data.Bev.Gv.At Enables Use Of Bev Geospatial Data As Open Data

Wolfgang Gold, BEV

The geoportal data.bev.gv.at has been created by BEV to implement the legal framework of the Open Data Directive (Directive (EU) 2019/1024). One main idea of this geoportal is to enhance access to data by following the FAIR principles: data have to be findable, accessible, interoperable and reusable. The IT architecture follows a distributed cloud strategy for the provision of BEV´s geospatial data. A basic version of the open source product Geonetwork has been used to realize the geoportal. This enabled an easy tuning between the requirements of BEV and the open source community. One key functionality of this portal is the embedding of a DataCite connector for Digital Object Identifier (DOI) management to guarantee a clear, transparent and sustainable addressing and publication of datasets.

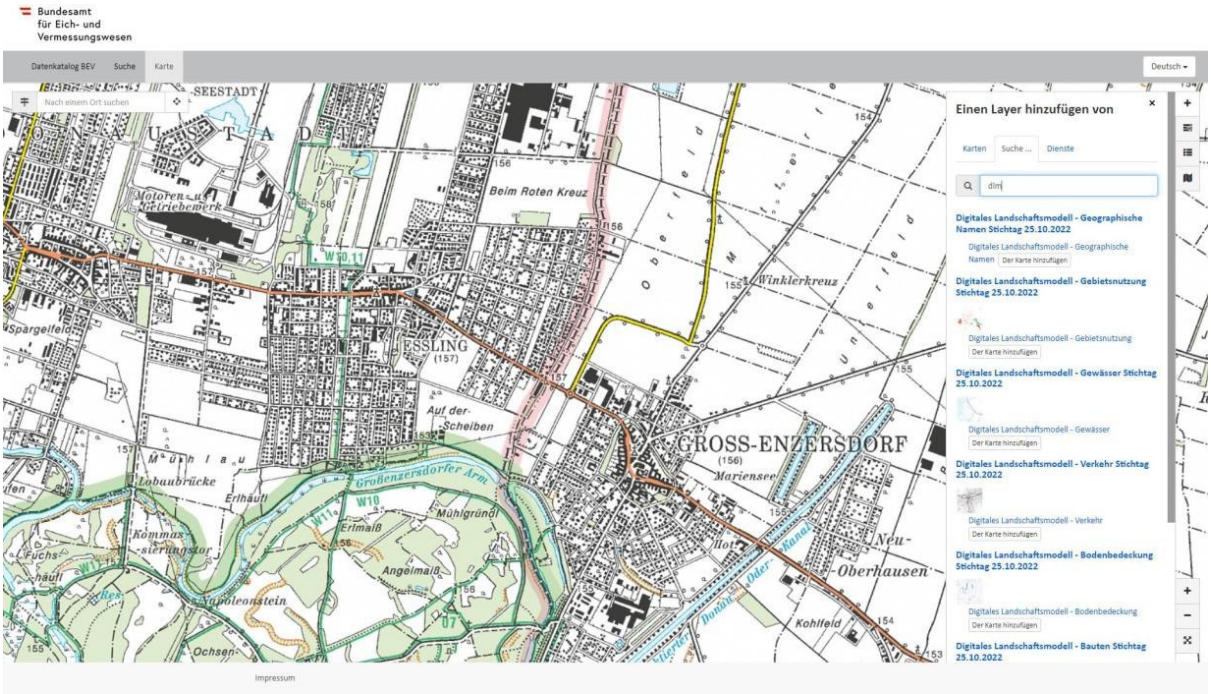


Figure 4 Geoportal data.bev.gv.at

Additionally, to the possibility of downloading geospatial data, BEV rolled out two information portals including Open API mapservices in 2022.

The first one is a classical service for maps: maps.bev.gv.at. It shows the full range of public Austrian maps. Content of this service are maps with scale 1:500.000, 1:250.000 and 1:50.000 in addition with an orthoimage mosaic based on digital aerial images with a groundsampling

distance of 20 cm. An embedded Digital Terrain Model allows to compute and visualize height profiles of digitized or imported tracks.

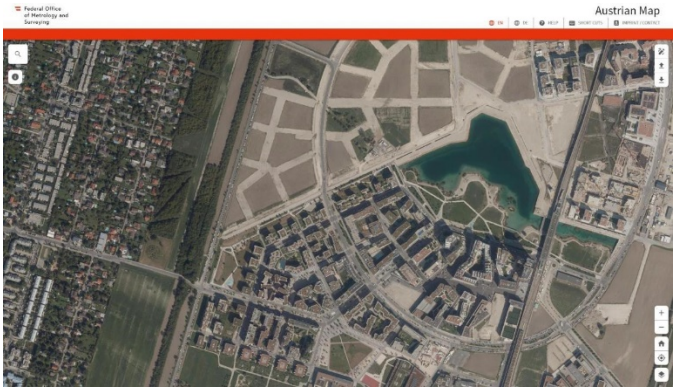


Figure 5 Map (orthoimage) of Seestadt – area of urban development in Vienna (maps.gv.at)

The second information portal and spatial data service – definitely one flagship service of BEV – is the cadastre service kataster.bev.gv.at. It provides graphical information concerning the parcels of the Austrian land registry on a daily basis. There are some different possibilities for presentation of these data. Besides a „pure“ cadastre view and a combined view cadastre + orthoimage, data can also be visualized in the look of a cadastre GIS layer.

Figure 6 example of a cadastre in GIS-layout (kataster.bev.gv.at)

Both information portals are extended with a powerful search service, realized as Open API json service, with help to find exactly the data you are interested in. It is possible to search for addresses, geographical names, towns, streets or simply coordinates in various coordinate systems.

We created this technical infrastructure to promote further use and processing of our spatial data at national as well as international level to generate high benefit for economy and society.

Please visit open BEV data:
Data.bev.gv.at
Maps.bev.gv.at
Kataster.bev.gv.at

3. New mass valuation methodology in Estonia

The first mass valuation project in 21 years, was automated and predominantly data-driven, determining the market value of the land (without buildings and forest) for each cadastral unit. It was done based on the data from different databases, onsite observations were not carried out. Crucial input into methodology and data quality, as well as the preliminary feedback from testing, came from professional real estate valuers and other experts from various fields.

To assess the value of the land, data from The Land Cadastre were combined with the data from other national registers. Sales data, in the form of actual real-estate transactions, were derived from the transactions database and combined with various spatial and non-spatial attribute data, to statistically analyse the relationship between the market price and the physical properties of cadastral units. As a result of this analysis, 5 different statistical models were created and then applied to predict the value of all cadastral units:

1. the building land valuation model
2. the building rights valuation model
3. the agricultural land valuation model
4. the forest land valuation model
5. the valuation model for land without an active market.

One of the methodical innovations was the inclusion of the nearest transaction. For example, the building land valuation model (used to valuate residential, commercial and industrial land, land for public buildings, mining industry land, and national defence land in larger cities) is a statistical model, which is based on transactions of undeveloped residential land. Model is used to calculate the base value for cadastral units, which is then adjusted with the effect of two factors: area and proximity to a water body. The base value itself is the estimated land plot square metre value for type of land which has an area of up to 1,000 square metres and which is located away from a body of water. Another part, that the base value consists of, is the effect of weighted average price of 10 nearest transactions. 10 nearest transactions are identified as geographical distance but also with the notion that these sales have to align with the location class. The weighted average price of 10 nearest sales explains the majority of market price variation and it is one of the main land value drivers.

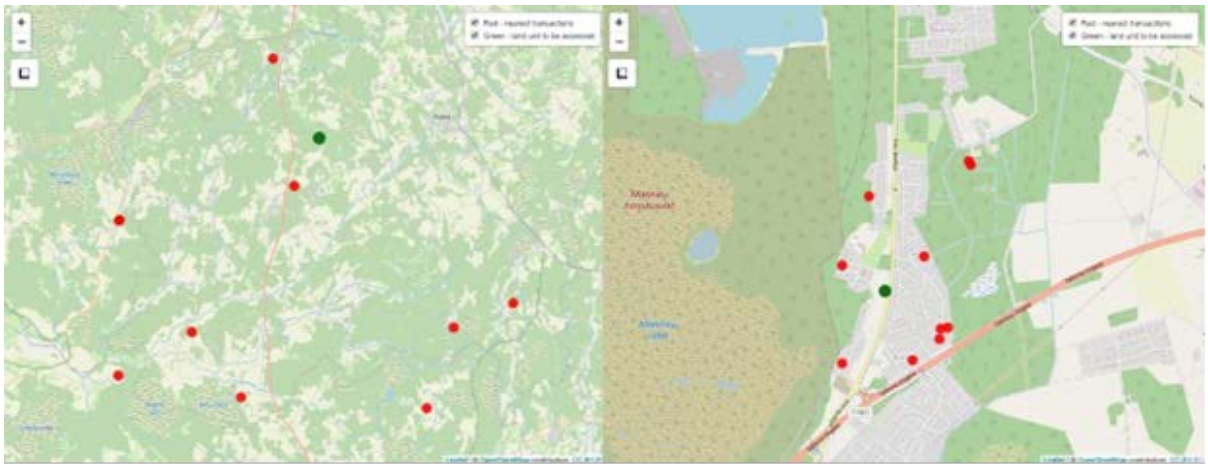


Figure 7 *Distance and dispersion of nearest transactions depends on how active real estate market in the area is.*

Another innovation was used in **the forest land valuation model**. The model is used for valuating the land registered in the land cadastre as forest land. The value of the forest land is found by multiplying the base value by the forest land quality factor. The base value of forest land is the average price of transactions with clear-cut forest land.

Two key aspects were indispensable for identifying whether the forest land was clear-cut:

1. satellite imagery in satellite data center ESTHub - the transactions were checked by comparing historical satellite photos and the dates of the transaction to ensure that the set of transactions used in the analysis would only consist of clear-cuts. Then normalized difference vegetation index (NDVI) was used to determine whether the cadastral unit was covered with dense vegetation.
2. Lidar data from yearly aero laser scanning – the forest land transactions were checked by analysing yearly canopy height values.

Figure 8 Lidar point cloud data for determining where dense vegetation is present and where not.

The valuation methodology is described in detail at Estonian Land Board **home page** and results can be seen here **https://minu.kataster.ee/**.

4. MODI – Automated transport on European roads

The Norwegian Mapping Authority
(Trond Storrønning -trond.storronning@kartverket.no)

Funded by the European Union

The Norwegian Mapping Authority (NMA) has participated in various research projects aiming to understand the needs and the mapping authority's role in the industry of intelligent transport systems. This industry presents extreme requirements towards detailed and dynamically updated maps, positioning technology and sensor fusion to assist an increasing level of automated transport and operations. The research topics have focused on innovative solutions for more dynamic collection and usage of point cloud data along the national roads and testing the performance, accuracy, and robustness of positioning under various conditions and by various technologies. NMA is now taking a big step forward as a research partner in the Horizon Europe funded project MODI, as one of 29 partners with ambitions to support a more automated European logistics sector. NMA is the only mapping agency participating in the project.

The logistics sector is likely to be the driver for the introduction of automated transport features on European roads. This is due to a shortage of heavy truck drivers in Europe and a high pressure to reduce costs in the sector. MODI is an innovation action funded by Horizon Europe, which aims to demonstrate automated driving features for the logistics sector. The project encompasses actors from five countries on the route from Rotterdam to Oslo and has a total budget of 28 million Euro. The project runs from October 2022 to March 2026.

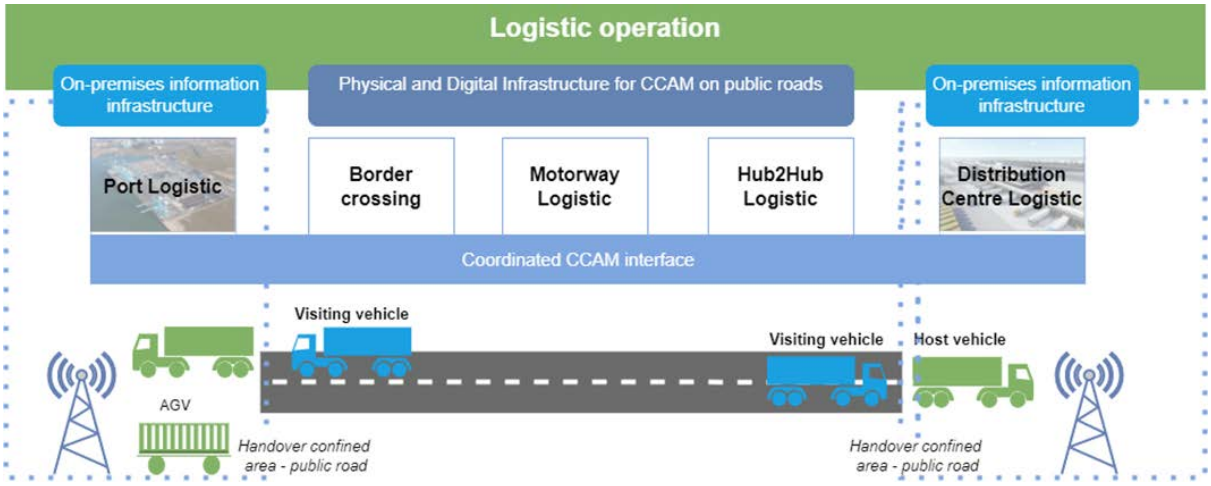


Figure 9 *The scope of the entire MODI project, from the port of Rotterdam to the port of Moss (Oslo)*

Figure 10 The Einride Pod, which will be used in the demonstration in the Norwegian Use Case

By participating in the MODI project, NMA will explore how publicly available map and positioning data will be a part of the future ecosystem of intelligent transport systems in Europe. The project includes five use cases, where one of them, “The Norwegian Use Case,” will include driving across the border crossing from Sweden to Norway at the Svinesund bridge. The border crossing requires the use a of a cross-border positioning service. It will also serve as an opportunity to explore how different reference systems can be handled in an environment with high accuracy demands. The demonstration will take place at the Svinesund bridge, but we aim to explore solutions that are applicable to all border crossings in Europe.

NMA has a strong collaboration with the Norwegian Public Roads Administration on road maps. MODI will strengthen our understanding of how our data is used by car manufacturers and commercial map providers when creating HD-maps.

MODI will contribute to standardisation of data for automated transport systems on roads. A lot of this data is geospatial data, and our primary mission in this work is to ensure that we build on already existing and open standards.

We foresee that dialogue with other mapping authorities in Europe will become relevant as the project progresses. Do not hesitate to contact us if you have any questions or input.

5. Poland's NMCA activity

Head Office of Geodesy and Cartography (GUGIK)

The Head Office of Geodesy and Cartography (GUGiK) pursue to continuously facilitate access to spatial data. In order to promote new solutions and increase knowledge among the public, in 2022, we organized and conducted numerous trainings. All this contributed to the development of Polish geodesy and cartography and the creation of innovative services that stimulate the development of the economy. The most important in 2022 were:

1. ASG-EUPOS SERVICES FREE OF CHARGE

Under the Act on improving the investment process of the Central Communication Port, effective October 2nd, 2022, fees for ASG-EUPOS system services (real-time services and post-processing services) usage were abolished.

Currently, the number of users who use the ASG-EUPOS system every day exceeds 3,000. After waiving the ASG-EUPO system services fees (October 2, 2022), the number of new registering users increased significantly and now the number of registered users exceeds 19,000. Moreover, that change, the leap increase in the number of users connecting at least once a day from about 2500-2600 to about 3000 has been noticed. In the following years, further increase in interest in ASG-EUPOS system services and the expansion of the group of users to industries that have not used satellite navigation so far should be expected.

The ASG-EUPOS system consists of approx. 150 ground stations evenly distributed throughout the country. 93 of them are owned by GUGiK, while the remaining ones belong to Polish universities or research centers and to foreign reference stations systems. The signals transmitted by the GNSS satellites are being continuously monitored, sent in real time (in 1 s intervals) to the computing centers located in Warsaw and Katowice, and there processed and then sent to the GNSS receivers operating in the field, belonging to end users.

The end users of the ASG-EUPOS system were initially the geodetic industry, because the receivers enabling the use of this type of services were expensive, while the greatest benefits in terms of time and effort could be obtained in this exact type of measurements. Over the years, GNSS positioning technology has expanded range of its recipients and entered new areas of the economy. Initially, the group of users from the construction and agricultural segments was dynamically increasing. Thanks to the use of construction projects in digital form, the technology of satellite measurements in these industries is used more and more often to control machines used in the road investments realizations (bulldozers, graders, pavers) and agricultural machines (tractors, combines) where subsequent field work is carried out based on a strictly planned routes of machines. Recent years have seen a dynamic development of commercial devices using the GNSS position, as well as a significant miniaturization of receivers and reduction of their costs. As an example, there are smartphones that have built-in miniature GNSS receivers that, using map applications, enable navigation in the field. Another group of users where a precisely defined position is crucial are professional unmanned vehicles (UAVs, drones). Equipped with appropriate sensors, they can develop precise 3D models of objects, make thermal maps or high-resolution photogrammetric documentation. Such applications require the determination of the precise position of the sensor, which is carried out by an on-board GNSS receiver using correction data from an ASG-EUPOS system or such. The innovative use of satellite measurements position determination takes place in various autonomous vehicles types. Equipped with inertial units with GNSS modules, can reach the indicated place without the operator's involvement. Despite an early stage of this type of work in Poland it is necessary to have the infrastructure for this kind of research in the form of a precise and reliable correction data available.

ASG-EUPOS system development works have been carried out since the launch of the system. The main directions of the development of the system are to ensure the smoothness, availability and reliability of services and to follow the developing GNSS satellite systems. For the availability and security level of system services increacement in 2020-2022, the IT equipment in the Computing

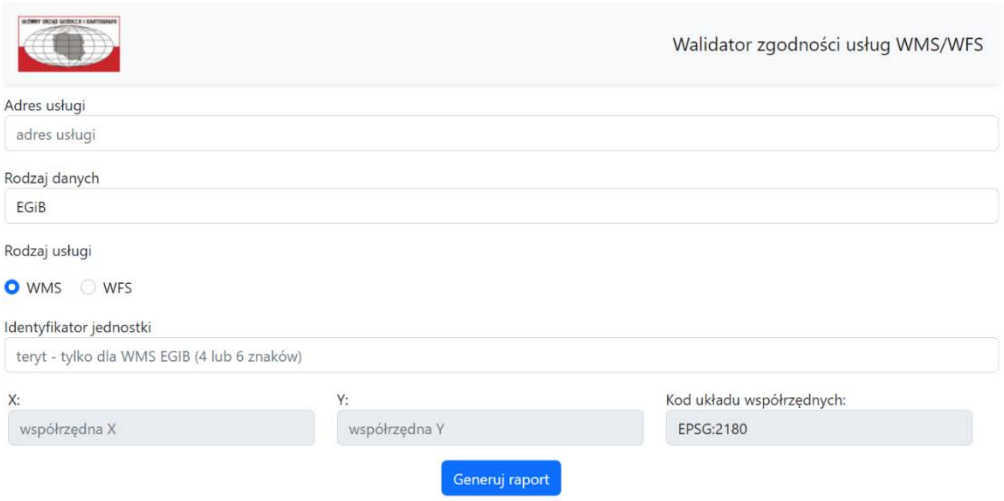
Centers in Warsaw and Katowice was modernized (new disk arrays, servers) and the software responsible for calculating the data provided as part of the services is updated on an ongoing basis. This year, further modernization works are to be held - edge network devices (router, switch) at the Computing Center in Katowice will be replaced.
From 2021, densifying the reference stations network work is underway and in total, by 2023, 15 new reference stations will be installed (or will be being installed) - including 4 stations installed in 2022, 11 for 2023. They were located in towns where the distance to the nearest reference stations was the greatest, and the problems with determining high-accuracy positions were reported.

2. VALIDATOR OF WMS/WFS SERVICES FOR CADASTRAL, TOPOGRAPHIC, UTILITIES AND GEODETIC CONTROL NETWORK

GUGiK published the first version of the compatibility validator for viewing (WMS) and downloading (WFS) land and building register (EGiB). The task of the validator is to check the compliance of services published by heads of counties with applicable law.
The validator works as:

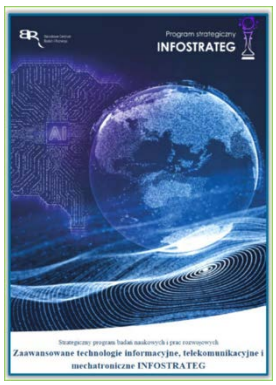
- an Internet application walidator.gugik.gov.pl/app;
- dedicated API (for advanced users): walidator.gugik.gov.pl/service

The validator was prepared only by GUGiK's employees.



3. AUTOMATIC DETECTION OF TOPOGRAPHIC OBJECTS

Proposal of a research topic submitted by GUGIK for the competition for INFOSTRATEG commissioned projects entitled "Automatic detection of topographic objects" was selected by the National Centre for Research and Development (NCBiR). The aim of the GUGiK project is to create tools based on artificial intelligence algorithms that enable the automatic detection of topographic objects using photogrammetric data. The implementation of this project will support the Topographic Objects Database (BDOT10k) update.

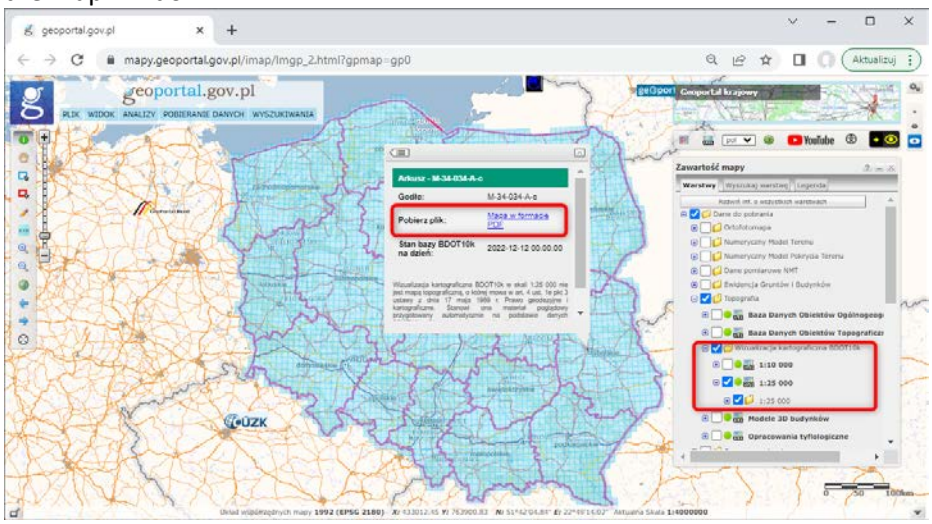


4. CARTOGRAPHIC VISUALIZATIONS OF THE TOPOGRAPHIC OBJECTS DATABASE

Pursuant to Art. 7a sec. 2. The General Surveyor of the Country and the Minister of National Defense cooperate in the implementation of tasks in the field of geodesy and cartography of importance to the country's defense, including the creation of standard cartographic studies. As part of this cooperation, and taking into account the geopolitical situation (state of war in Ukraine) and the military's need for topographic maps, in 2022 the Head Office of Geodesy and Cartography began, as part of its own work, the development of tools for the automatic production of standard cartographic studies in 1:10,000 and 1:25,000 scale. However, what needs to be realized, borne in mind and emphasized is the fact that the cartographic visualizations are a pilot project and at this stage are not a topographic maps (as defined in Art. 4 sec. 1e point 3 of the Act of May 17, 1989 Geodetic and cartographic law).

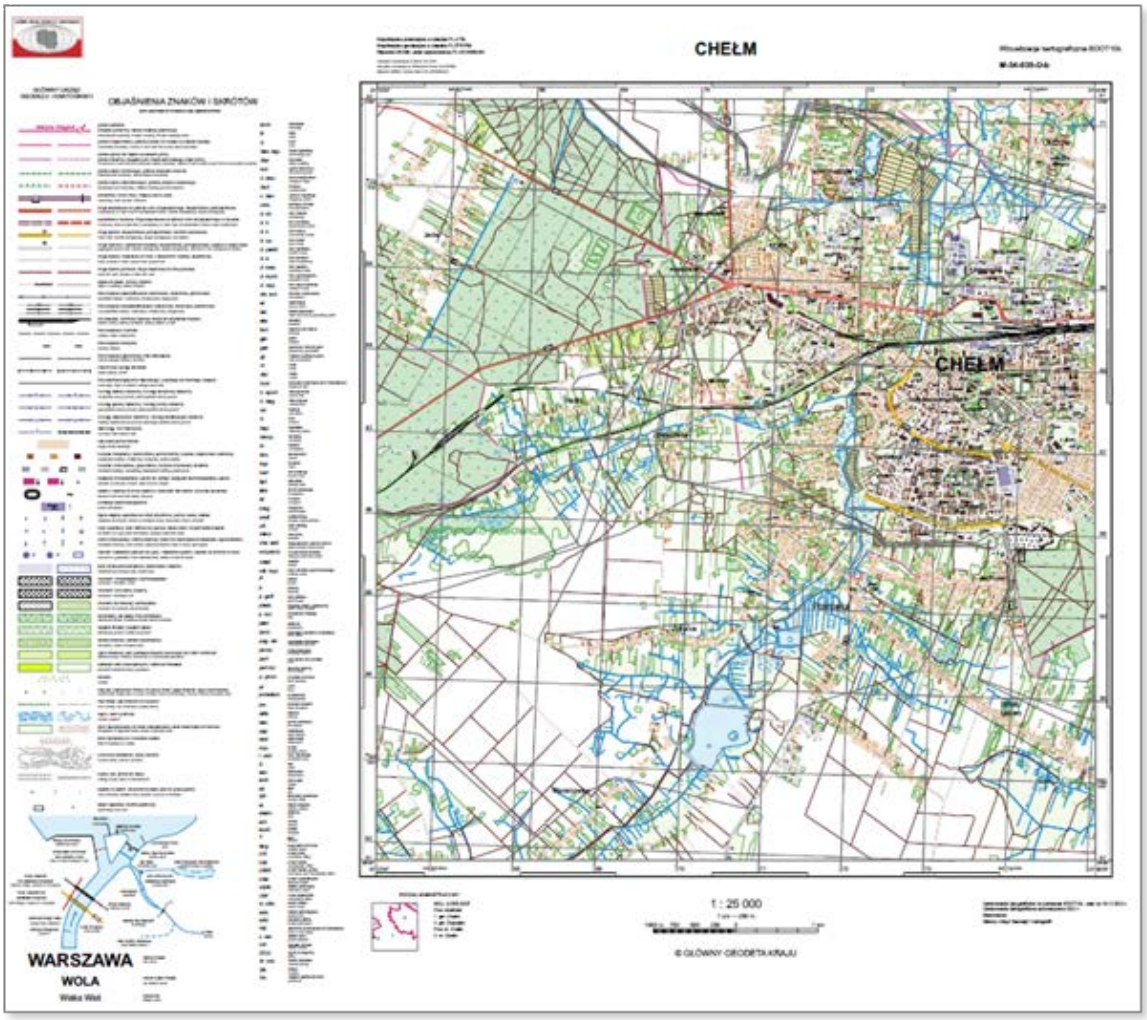
It should also be noticed that the actions taken in this regard were the office's response to the reported needs of users, in particular the Ministry of National Defence, who expect up-to-date maps that can be generated on an ongoing basis. One should also be aware, which is often emphasized by the Cartographic Offices (NMCA's), that automatic map generation is a necessity today and at the same time the "golden mean" between rational public funds' spending and manual map development.

The currently generated 1:10 000 and 1:25000 scale cartographic visualizations of the Topographic Objects Database can be downloaded directly from the www.geoportal.gov.pl website by selecting the "BDOT10k cartographic visualization" layer within the "Data to download" - "Topography" layer group. Download .pdf file option appears as a result of selecting the sheet and clicking on its area in the map window.



- **CARTOGRAPHIC VISUALIZATIONS OF THE TOPOGRAPHIC OBJECTS DATABASE IN 1:10000 SCALE**

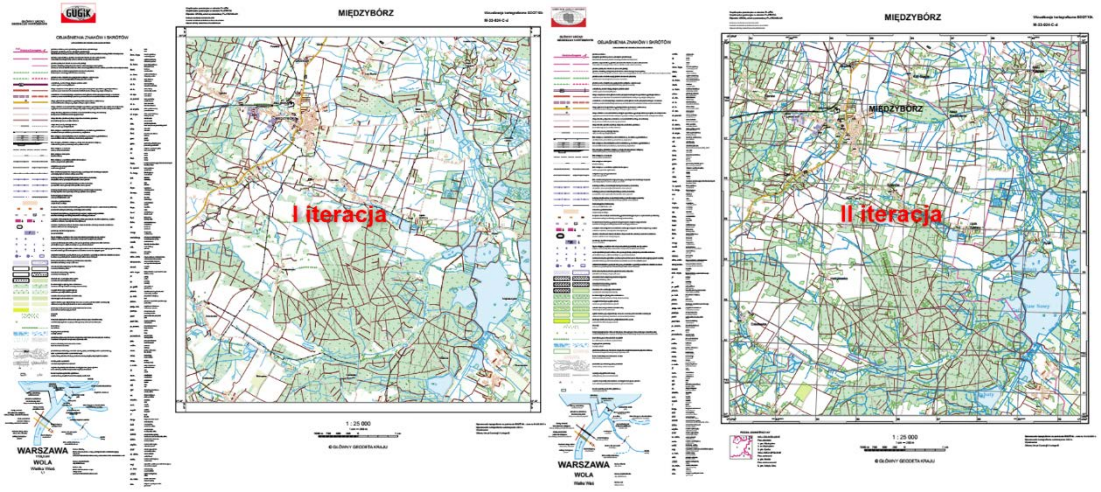
The methodology for developing cartographic visualizations of1:10,000 scale is shown on the picture below. Visualizations are generated automatically, using free QGIS software, with contour lines generated in FME software by Safe Software. To generate contours, 1-m DTM in the PL-EVRF2007-NH coordinate system is used, in the following step generalized to DMT with a 5 m grid interval. In this process, a dedicated plug-in for QGIS is also prepared allowing BDOT10k data loading with suitable symbolization or objects labeling settings. The process also uses sections of sheets defined for maps of 1:10,000 scale. There has also been created dedicated project in the QGIS software, where after loading data and indicating sheets, the automatic generation of visualizations of this scale. Thanks to carrying this task out as GUGIK's own work, no additional funds for this purpose is spent.



The intention of consistent actions taken by the Head Office of Geodesy and Cartography is developing tools enabling the creation of standard cartographic studies in 1:25000 scale that could be included into National Geodetic and Cartographic Resource. This approach will enable the delivery of up-to-date (correlated with the this of source data) and homogeneous topographic maps for the entire country, automation of the production process and significant costs' reduction.

In the currents version of the visualization, several corrections have been made both regarding:

1. legend and off-frame information (marginalia), such as: removing boundary mark, isobaths and its description, water depth description, slope indicator, strengthened scarp, corrections of names, signs, items' orders, numbering, display, colors and adding borders, signs, descriptions (UTM kilometer grid, minute line and 20 second dots, cartographic abbreviations, administrative division)
2. map content, such as: corrections, adding, improvement of generation processes of several items (roads numbers, lakes, rivers mountains names, parks descriptions, buildings moved away from road).



The next iteration intends to introduce further improvements. Contour lines, missing descriptions, roads and railways collision-free intersections, roundabouts are to be added. Short dual carriageway sections is to be removed and the placement of descriptions is going to be improved.

5. AUTOMATIC GENERALIZATION OF BDOT10K TO BDOO PROCESS

Works on creating an effective process generalizing the Topographic Objects Database (BDOT10k) to the General Geographic Objects Database (BDOO) have been ongoing since 2015 but last year achieved crucial point. While, the first version was semi-automatic (the BDOO database required manual editing after the generalization process), the current one is fully automatic.

From the beginning, the FME Desktop software by Safe Software was used and as the process developed, the Python – Arcpy library from ESRI was implemented, extending the range of tools available.

The subsequent versions of the processes kept providing improvements. The degree of nesting of processes in processes was reduced to two (the main - the controlling one and the others - the processes called by the controlling one). Great attention was paid to reduce the number of processes, simplify their construction and increase readability while maintaining good process construction practices. Some processes have been recreated. The number of PythonCaller transformers containing scripts written in Python has been kept to a minimum. Release of object cashing in FME Desktop allowed for the analysis of input and output data of each transformer without necessity of restarting the entire process.

All those efforts were dictated by the need of effective processes maintenance and ease of error removal that is complemented by the exceptional stability of the FME software (crucial in such complex processes).

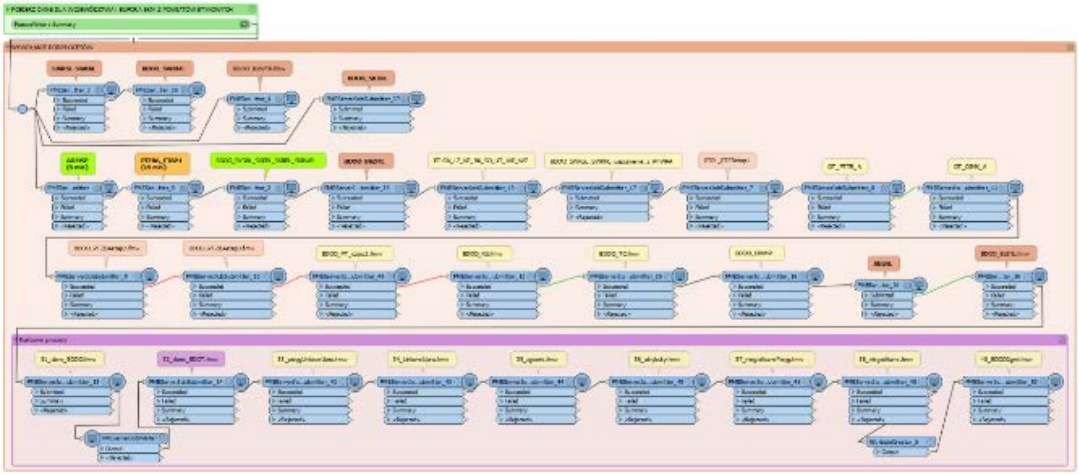
As a consequence of the work carried out, in 2021 the first fully automatic BDOT10k to BDOO generalization process was implemented in production.

This process is launched on the FME Server for one or more (up to 16) data sets - each covering the area of the voivodship. Automatic generalization for the whole country takes 3 days.

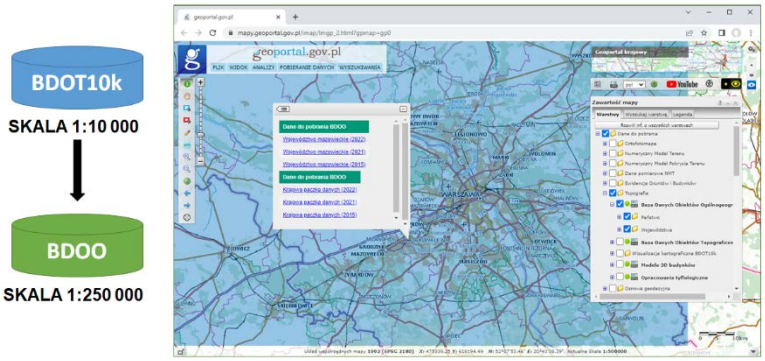
The main - controlling process consists of the following transformers:

- reading BDOT10k data (including the initial selection of objects) from the Oracle database and saving the results to .ffs files,
- starting the generalization processes for individual classes of objects,
- triggering the processes of preparing and saving the results in the .gml format.

The main process orders the execution of subprocesses on the FME Server (where the tasks are queued and executed in parallel using multiple engines).



The result data saved in the .gml format is then imported to the National Management System of the Topographic Objects Database (KSZBDOT), where undergoes several automatic controls before being loaded into the production warehouse. BDOO data is stored in the warehouse with the preservation of historical objects (objects are versioned). These data are then automatically transferred to a replica (from there are provided for other domain systems available at the Head Office of Geodesy and Cartography – as WMS, WMTS services of the www.geoportal.gov.pl).



Since the models and the data scope of both BDOT10k and BDOO has changed (as a result of the entry into force of the Regulation of the Minister of Development, Labor and Technology of July 27, 2021 on the topographic objects database and the general geographic objects database and standard cartographic studies), the processes of automatic generalization will need to be adapted.

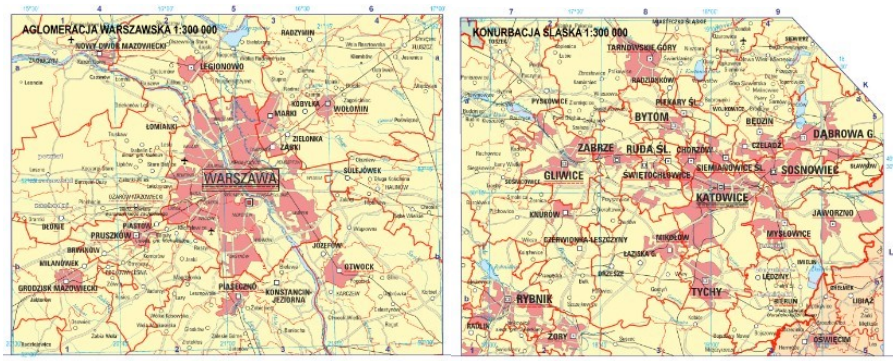
6. ADMINISTRATIVE MAP OF POLAND

With its own resources managed to prepare new version of the administrative map of Poland in 1:500 000 scale.

The previous edition of that map was published by GUGiK in 2011, in an analogue form (drop-down wall map on a roller), distributed in a set with a digital form on CD.

In vast majority the same editorial and technical assumptions and methods of graphic presentation were adopted. The changes mainly concern the nomenclature. The names of towns in minority languages were abandoned, leaving only official names. For fragments of neighboring countries on the map, the names of towns, rivers and lakes were given in the original languages (for Germany, Czech Republic, Slovakia, Lithuania) or in transliteration (for Russia - from Russian, for Belarus - from Belarusian, for Ukraine – from the Ukrainian language).

The National Geodetic Coordinate System PL-1992 was used - a flat rectangular coordinate system based on the Gauss-Krüger projection, with a cartographic grid of meridians and parallels drawn every 30'. As in the previous version of the map, for the areas of the Warsaw agglomeration and the Silesian conurbation, additional side maps were created in a larger scale (1:300 000), where the cartographic grid was condensed to 15'.



In general, the state as of January 1, 2022 was presented on the latest map.

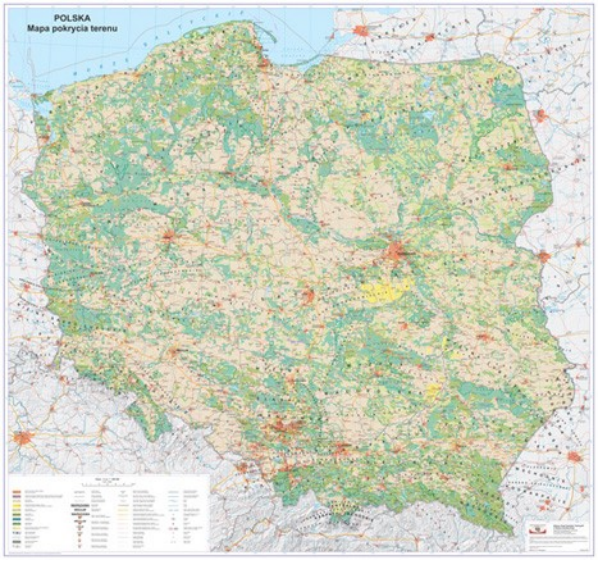
The main data sources are: National Register of Borders (PRG), National Register of Geographical Names (PRNG), the Topographic Objects Database (BDOT10k), the General Geographical Objects Database (BDOO), EuroGlobalMap, EuroRegionalMap , OpenStreetMap.
Due to the differences between the scale of study and the level of details of the source data, the selection and appropriate generalization criteria needed to be defined and applied.
Among water reservoirs, those with an area of more than 2 km^2 were presented, within flowing waters - main rivers and their tributaries and others of the length of more than 5 km. Cities and towns were also selected, based on their administrative function (the seat of the voivodship office, the voivodship assembly, the poviat office, the commune office), the number of inhabitants (division into groups:

- cities: over 1,000,000, from 500,000 to 1,000,000, from 250,000 to 500,000, from 100,000 to 250,000, from 50,000 to 100,000, from 25,000 to 50,000, from 10,000 to 25,000 inhabitants,
- towns and villages from 1,000 to 10,000 inhabitants,
- towns and communal villages with less than 1,000 inhabitants,
- other towns);

location (at road intersections, along longer communication routes), other advantages (major tourist destinations, health resorts, towns serving as border crossings or former border crossings). In addition, the built-up areas of cities with a population of over 25,000 have been presented in terms of area as surface 'blocks'.
The study was prepared in the QGIS software (with the support of FME Desktop by Safe Software and ArcGIS by ESRI) in raster format (as tiff and geotiff) in a size corresponding to a wall map with a map content window of 131 x 140 cm.
Since included in the geodetic and cartographic state resource (August 22, 2022) new administrative map of Poland is available on request, while its thumbnail for illustrative purposes is available on the website of the Head Office of Geodesy and Cartography.
From now on, an annual update of the map is planned.

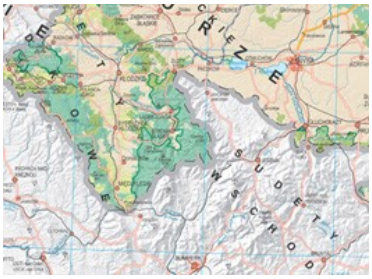
7. LAND COVER MAP OF POLAND

Another thematic study published by the Head Office of Geodesy and Cartography in 2022 was land cover map of Poland in 1:500 000 scale. It was created in a digital version by an external contractor company(KPGeo Sp. z o. o.) selected in a public tender.
As a spatial reference system, the PL-LCC flat rectangular coordinate system on the GRS80 reference ellipsoid (with the modification of the geodetic length parameter of the origin of the coordinate system from 100E at 190E) was used.



The thematic scope of the study includes the following layers:

- borders (states, provinces, territorial sea),
- main land cover categories related to the physical and biological use of the country's surface, i.e. anthropogenic lands, agricultural lands, forests, wetlands, etc.,
- hydrographic network,
- network of road and rail routes,
- nature protection (national and landscape parks),
- selected altitude points, passes, caves, rocks,
- settlement network with nomenclature,
- terrain relief based on a digital terrain model (shading method).



The content of the map has been enriched with the names of physical-geographical units (sub-provinces and macroregions levels) and the names of larger forest complexes. The main sources of data for the development of the land cover map were: National Register of Borders (PRG), the National Register of Geographical Names (PRNG), the Topographic Objects Database (BDOT10k), the General Geographical Objects Database(BDOO), the Official List of Polish Geographical Names of the World, General Directorate for National Roads and Motorways, Digital Terrain Model (NMT), EuroDEM, etc.
The project was prepared in ArcGis software of ESRI, in the shapefile format. Map is available in .pdf and .tiff (geotiff) format and since December 2022 provided on request (although under particular conditions may be obtained free of charge by entities pursuing, inter alia, educational purposes or performing public tasks).
For illustrative purposes only can also be downloaded as a thumbnail (reduced resolution file).

8. HIGH RESOLUTION PHOTOGRAMMETRIC DATA (MULTIANNUAL PLAN FOR SPTAIAL DATA ACQUISITION)

In accordance with the adopted spatial data acquisition plan, GUGIK acquires the high resolution photogrammetric data in 2 standards:

- high-resolution photogrammetric data for city areas,
- photogrammetric data for non-urban areas (STANDARD),

as pointed out in the table below:

	HIGHT RESOLUTION PHOTOGRAMMETRIC DATA – for city areas	**STANDARD PHOTOGRAMMETRIC DATA - for non-urban areas STANDARDOWE – dla obszarów pozamiejskich**	
	ALS + ORTO	**ALS**	**ORTO**
	2-year cycle	**5-year cycle**	**2-year cycle**
vertical aerial photos	0.05 m	-	0.25 m
classic orthophotomap	0.05 m	-	0.25 m
point cloud	12 p/m^2	4 p/m^2	-
DTM	1.0 m	1.0 m	5 m
DSM	0.5 m	1.0 m	-
OI	0.25 m	0.50 m	-

It's worth emphasizing that high-resolution photogrammetric data is being acquired with only one run, while photogrammetric data for non-urban areas (standard) are obtained in two separate ones as part of developing:

- an orthophotomap 0,25 m (ORTO),
- LIDAR 4 p/m2 elevation data (ALS).

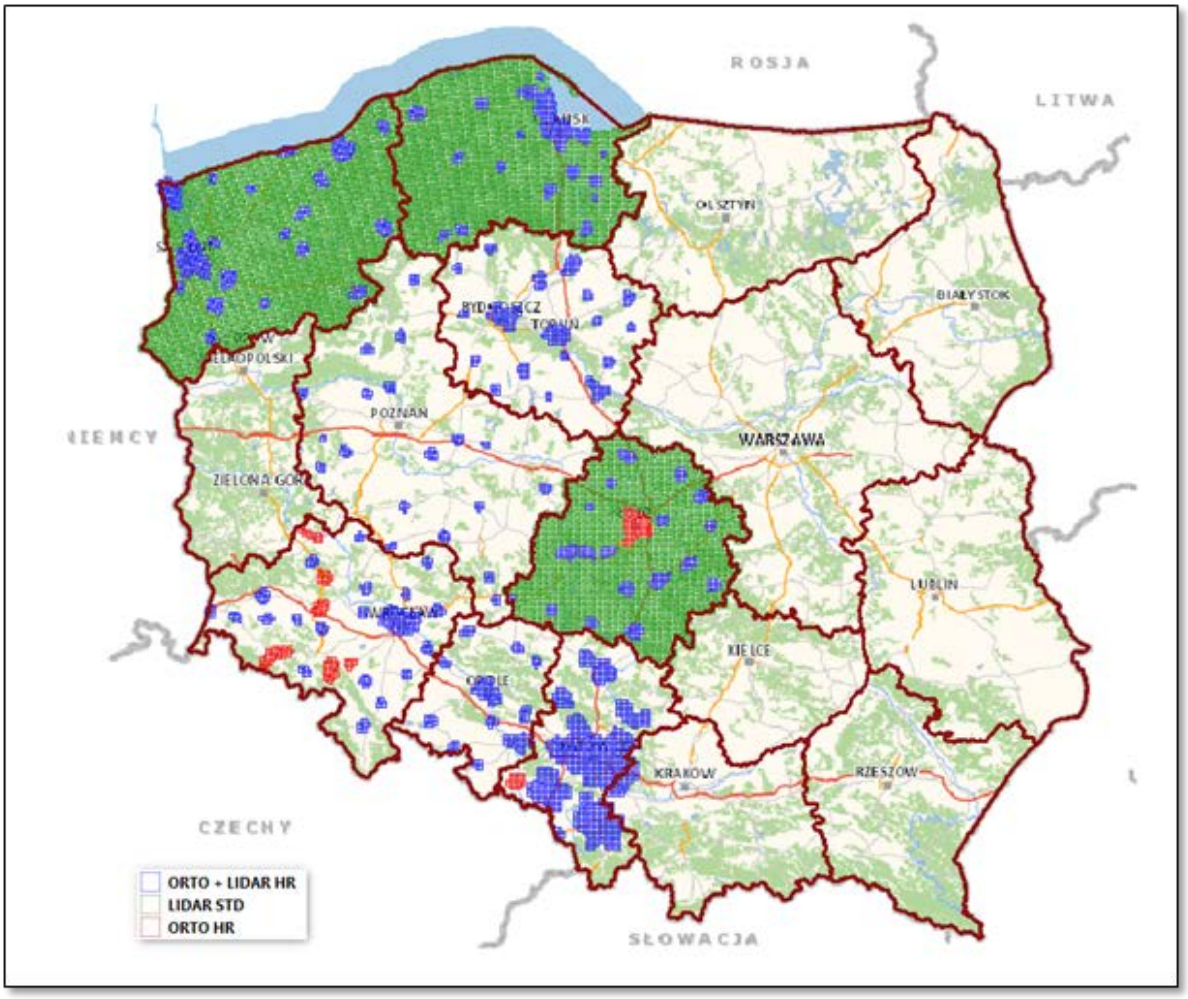
High-resolution data is obtained in a 2-year cycle, same standard orthophotomap (ORTO) data. But, since standard orthophotomap (ORTO) products also being developed for urban areas it makes the orthophotomap being obtained annually (in one year in the high-resolution standard, and the in other year as a standard one).

In 2022, the GGK commissioned the development of high-resolution photogrammetric data for the area of poviat towns in the western voivodships of Poland, i.e.:

- aerial photos with GSD = 0.5 m (approx. 18 472 km^2),
- an orthophotomap with a pixel size of 0.05 m (approx. 18 472 km^2),
- ALS point cloud with a density of 12 p/m^2 (14 570 km^2),
- digital terrain model with a grid interval of 1 m (approx. 18 472 km^2),
- digital surface model with a grid interval of 0.5 m (14 570 km^2),
- intensity images with a field pixel size of 0.25 m (14 570 km^2);
- and development of altitude data in airborne laser scanning technology for non-urban areas in the Zachodniopomorskie, Pomorskie and Łódzkie voivodships:
- ALS point cloud with a density of 4 p/m^2 (56 404 km^2),
- digital terrain model with a grid interval of 1 m (56 404 km^2),

- digital surface model with a grid interval of 1 m (56 404 km^2),
- intensity images with a field pixel size of 0.5 m (56 404 km^2).

The scope of completed works is presented in the illustration below:



All the data mentioned above are included in the National Geodetic and Cartographic Resource, although publishing these data in the services is still underway.

Worth mentioning here is that effective January 26th, 2023, a new photogrammetric regulation enters into force, not only simplifying and organizing the existing data formats provisions, also incorporates new photogrammetric data such as diagonal data and 3D mesh models into the resource.

GEODETIC INSTITUTE OF SLOVENIA

FERI Faculty of Electrical Engineering and Computer Science

6. Pilot project nationwide point cloud classification with AI ()
(IGN-Spain)

The Spanish National Geographic Institute (IGN) manages the project PNOA-LiDAR. The goal of the project is the acquisition of 3D data of Spain with airborne LiDAR. Two coverages of the whole country have been acquired until now (2009-2015, 2015-2021). During these years the importance of the data provided by the IGN have been proved, but the users have demanded more detailed and accurate classification of the points cloud acquired.

During 2022 the acquisition of the third coverage has started (2022-2025), during 2022 only a small area has been flown. The country will be acquired at 5 points/m2, being the challenge not only the density, but the surface. Spain has a surface of 505.000 km2, so in the period of 2023-2025 an average of 160.000 km2 per year will be acquired. Regarding the classification of the point cloud the goal is to increase the number of classes and the reliability (95%). For reaching this goal, Artificial Intelligence is being tested. Using AI we pretend to get more classes, more reliability and an improvement in processing time.

With this new methodology of AI classification, the software will learn how the LiDAR point cloud represents the elements in the territory (ground, buildings, vegetation…) so it will be able to label every point correctly, assigning them the right class. To achieve this, trainings areas are created. In these training areas each point is classified correctly (using manual classification when needed) getting a high accuracy. Using Deep Learning in these areas, the algorithm can learn how every class is shaped and then apply this knowledge in other areas. The validation of the classification is performed in other areas classified in the same way than the training areas (validation areas).

The process follows iterations (figure 1), in each iteration new training areas are added and the results are analysed with the validation areas. The process finalizes when the results get the accuracy established.

At this moment (January 2023) IGN is finalizing a pilot project for testing this methodology. For this project, an area acquired during the 2nd coverage at 5 points/m2 approximately is being used (19.345 km2). Some details:

- 55 training areas (14,61 km2, 0,075% of the project area) have been selected representing different kind of terrains such as urban, rural, mountains… (figure 2).
- 49 validation areas (166 km2) (figure 3).

Two set of parameters have been defined for analysing the results:

- Classification reliability: accuracy and f1-score for each class.
- Errors severity: % of critical points (distance >10m) and average distance per class.

The provisional results obtained are shown in figure 4. Analysing these results and considering the lessons learnt during the process, it is possible to reach these conclusions:

- Both training areas and validation areas must be classified with high accuracy and they must represent the complexity and variability of the area.
- Training areas need to cover at least a 0,20% of the project area. Validation areas at least 1%.
- The results of basic classes (ground, vegetation and buildings) are satisfactory, higher than 95%. For the other classes the accuracy is lower and heterogenous.
- High capacity of processing and storage needed (cloud computing).

The IGN is planning to follow the next steps:

- A real case project in a bigger area. At the same time it works like a second pilot project, it will be compared to “traditional” classification.
- Research in algorithm for advanced classes.
- Development of procedures for detecting automatically big isolated errors in the classification.

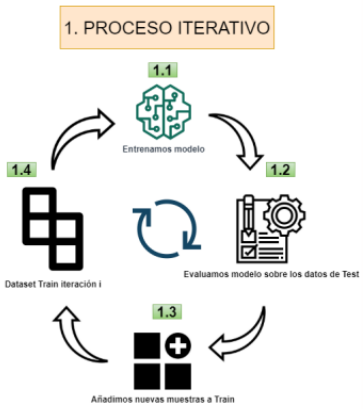


Figure 11 Iterative process for training models.

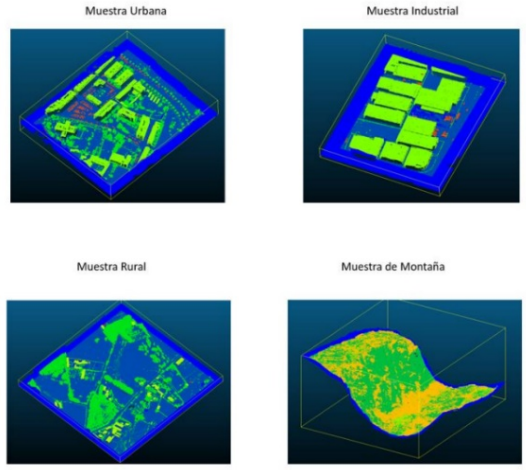


Figure 12 Example of training areas

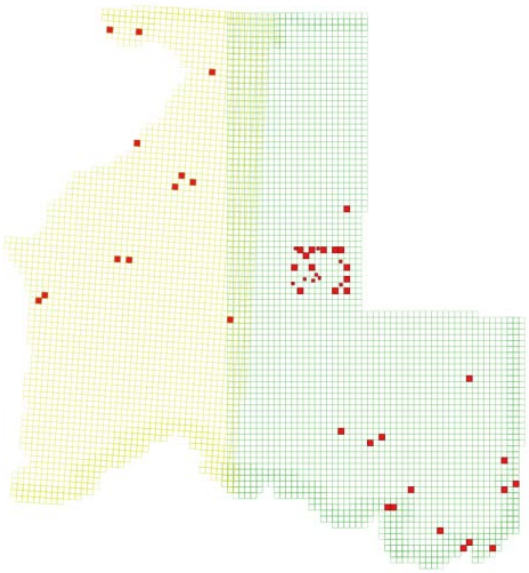


Figure 13 Test areas

	Evaluation	Metrics	
		Reliability	Severity
		f1 (%)	Distance (m.)
	Global	**95,3%**	**7,55**
Basic Classes	Class 2 - Ground	97,5%	0,98
	Class 4- Veg Medium/high	93,7%	1,48
	Class 6- Building	97,5%	10,96
Advanced classes	Class 3- Veg Low	43,5%	1,39
	Class 9- Utility pole	72,4%	58,05
	Class 10-Vehicles	86,1%	32,42
	Class 11-Power lines	94,7%	71,77
	Class 17-Bridges	83,0%	217,75

Figure 14 Results

7. Matching geometry of positionally improved cadastral data and detail municipality spatial plans

University of Ljubljana, Faculty of Civil and Geodetic Engineering,
The Chair of Geoinformation and Real Estate Cadastres (KGKN), Ljubljana, Slovenija
Author: doc. dr. Marjan Čeh

Research project V2-2156, financed by the Slovenian Research Agency and
the Surveying and Mapping Authority of the Republic of Slovenia (2021-2023);
Project title: Connectivity of spatial data of (other) official records with real estate cadastral data

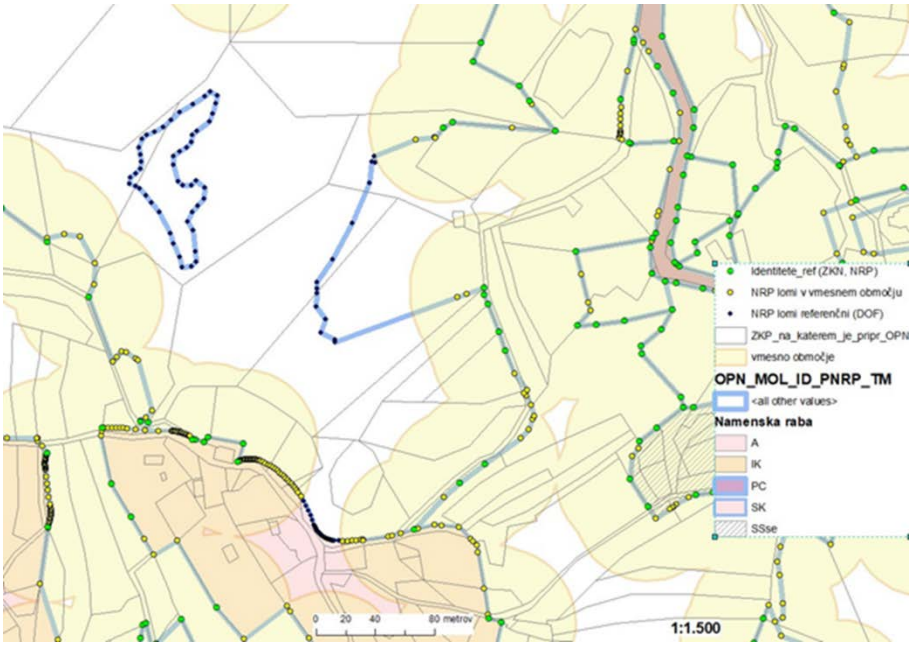
REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT
AND SPATIAL PLANNING
THE SURVEYING AND MAPPING AUTHORITY
OF THE REPUBLIC OF SLOVENIA

arrs
SLOVENIAN RESEARCH AGENCY

Keywords: integration, SDI, interoperability, LAS.

Slovenian SMA completed the locational improvement of the cadastre for the entire territory of Slovenia at the end of 2020. Within the framework of this project, the accuracy of the coordinates of land boundary coordinates was improved, and the integration of various cadastral data sources has to follow. In 2017 the EC introduced crucial European basic reference datasets (2017). Obligatory adoption of the cadastral data as the reference frame for local communities and cities was defined as the basis of land administration policies and authoritative geographic data management on multiple administrative levels. An effective spatial data integration technique is needed to produce updated accuracy information for the integrated data to facilitate the exchange of information between thematic layers.
The problem in the Slovenian context is the introduction of positional quality improvements (shift) in the reference layer (cadastre) due to the correction of systematic geometric errors with more accurate

field measurements and membrane proximity adjustment of the neighbourhood. Additionally, urban planning maps derived from an older, unimproved version of a basic reference data layer can cause interpretation ambiguities and decision uncertainty. Namely, users superimpose their thematic layer on top of the cadastral reference data and superimposition results in inconsistencies between the reference and other thematic layers.
The proposed solution is a semi-automated, iterative search of connective geometry – matching with adjustment and merging geometric information of other layers to the primary reference layer or vice versa. Updating superimposed layer geometry has to be carried out regularly due to updates in the reference data layer. We have developed a prototype of a technological solution to support decision-making on the eligibility of the positional coincidence of geometry of two test datasets (cadastral and municipal detail spatial planning geometry).



Green – discovered coincident points, Yellow - intermediate areas (do not coincide with the cadastre), Blue: drafted plan according to topography (do not coincide with the cadastre)

8. "Land use" of public building interiors

Geodetic Institute of Slovenia, Ljubljana, Slovenia

Development project financed by the Ministry of Justice
Project title: Real estate in use by the Ministry of Justice -
Upgrading the spatial information system and the real estate data records

Keywords: public buildings, interior, occupancy, management, detailed building data, 2D, 3D.

Ownership or management of real estate is associated with rights, obligations, and responsibilities. The Ministry of Justice of the Republic of Slovenia is the manager of spatially dispersed real estate used by judicial bodies (courts, prosecutors and state attorneys). The ministry is responsible for planning and coordinating the spatial needs of judicial bodies and managing investments for their needs.

In order to establish a comprehensive and high-quality collection of data on real estate under the management of the ministry, which would serve as the basis for building a complex management, analytical and decision-making system with integrated data sources, we approached the development of a solution. The task of editing and digitizing data consisted of tasks related to understanding and linking input data, which includes data from judicial bodies, real estate data, and other data for management purposes, such as data on cultural heritage and accessibility for the mobility impaired. Due to the graphical display of individual floors and related data, all buildings in which the ministry is at least a partial manager were included in the process of digitizing floor plans. The Slovenian Surveying and Mapping Authority also participated in the digitization of parts of the buildings.

The solution uses web technologies with (potential) use of data from various stakeholders in the public administration. The information solution has been updated based on the needs for different levels of data management and preparation of reports and statistics. With the use and increase of data and data connections, a need for changed/improved user experience has emerged.

In addition to implementing different levels of management, changes and improvements have been made in search and data entry in order to improve the user experience. Additionally, functionality for preparing automated reports written in document form, and a bulletin board displaying basic (statistical) data of the amounts managed in the system have been created. The update includes an expansion of graphical data viewing on the level of spaces.

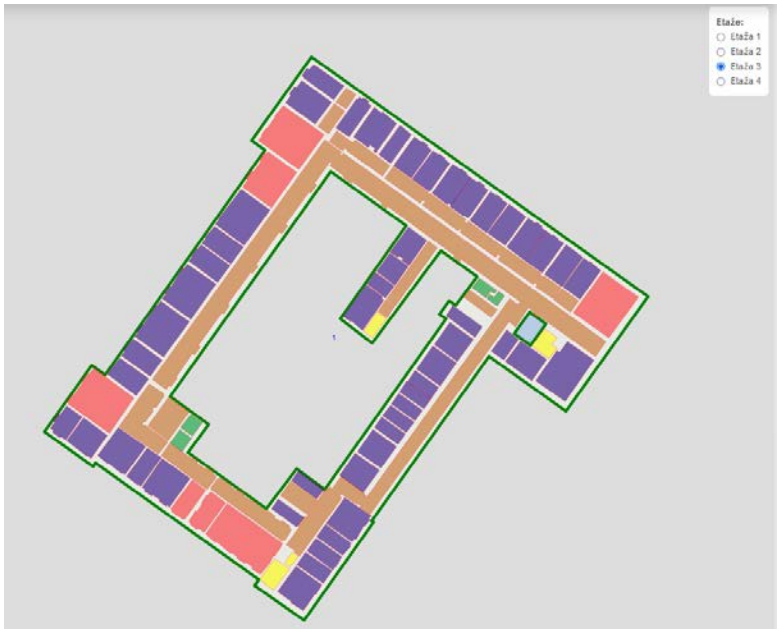


Figure 15 Digitization of building spaces, establishment of possibilities for connecting data such as occupancy

The SMA has, as part of the eSpace project, updated the real estate records and established a unified information solution that enables modern operation of the real estate system and represents a unified basic national spatial data infrastructure. In addition to the updated processes of registering and new information solutions of the cadastre, a renewed web portal Space - an information and service portal has also been launched. A large and demanding part of the task involved adapting the information solution to new data structures that were implemented as part of the update of the SMA's information solution. This also enabled the transfer and maintenance of cadastre data in the information solution.

9. Real estate 3D data and BIM

Geodetic Institute of Slovenia, Ljubljana, Slovenia
University of Ljubljana, Faculty of Civil and Geodetic Engineering, Ljubljana, Slovenia

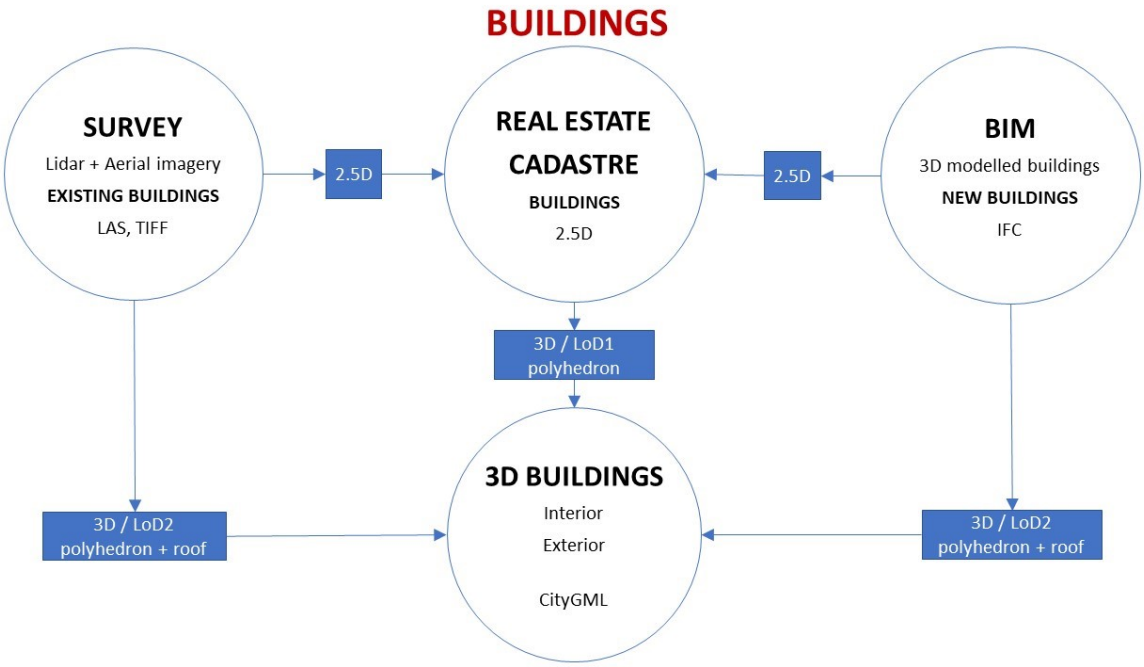
Research project V2-2155, financed by the Slovenian Research Agency and
the Surveying and Mapping Authority of the Republic of Slovenia (2021-2023)
Project title: GeoBIM and national geodetic data

Keywords: real estate, 2.5D data, 3D data, BIM, lidar, level of detail.

The new construction law in Slovenia prescribes the mandatory use of the BIM approach for the production of project documentation from 2025 onwards in the construction of buildings of public importance. This fact presents major challenges both when transferring construction data from BIM to update geodetic real estate data collections, as well as vice versa, when builders could use data from the geodetic profession for BIM. In both processes, it is necessary to carry out a series of substantive and technical data adjustments. In this regard, data on buildings and public infrastructure, which are already recorded for the entire country in 2.5D format, are currently the most suitable data from geodetic collections for connection to BIM, whereby the height of the building is an attribute.
At the same time, the Surveying and Mapping Authority of the Republic of Slovenia adopted a new law on the real estate cadastre, which enables the combined management of all real estate data in a single information system (plots, buildings, infrastructure, spatial units). A project of periodic aerial survey and scanning with lidar technology is also ongoing in parallel.

Due to all the mentioned innovations, the project of designing and testing the parallel setting of the real estate cadastre with 3D data is underway. This includes the possibility of generalizing BIM data for new buildings, automatic generation of 3D building data from aerial photographs and lidar point clouds, and automatic elevation of 2.5D building data into 3D (see figure). Different IFC and CityGML file formats were also tested, as well as the suitability of different levels of detail (LoD), which is also related to the subsequent connection of 3D building data with the new collection of floor plans. When converting data from BIM and when changing from 2.5D to 3D, topological problems, semantic differences and differences in geometric accuracy were recorded, which was especially evident when transforming data from public infrastructure, where re-survey of underground lines from the air is of course not possible.

The key goal of the project will be conceptual and technical guidelines for the transition of geodetic collections to 3D for the entire territory of the country.


BUILDINGS
SURVEY
Lidar + Aerial imagery
EXISTING BUILDINGS
LAS, TIFF
2.5D
REAL ESTATE
CADASTRE
BUILDINGS
2.5D
2.5D
BIM
3D modelled buildings
NEW BUILDINGS
IFC
3D / LoD1
polyhedron
3D / LoD2
polyhedron + roof
3D BUILDINGS
Interior
Exterior
CityGML
3D / LoD2
polyhedron + roof

Report by the Secretary-General

Joep Crompvoets

This report reviews the annual Board of Delegates meetings happening in the framework of EuroSDR in 2022, the appointments of (new) delegates, the activities related to our partner associations and some logistics.

Meetings

The 140th Board of Delegates meeting took place on 11 – 13 May 2022 at TU Dublin GrangeGorman and Morrison Hotel in Dublin (Ireland). The event was hosted by Ordnance Survey Ireland. 50 persons attended this meeting. The highlights of this meeting were: the keynote presentation 'Linked Data' by Erwin Folmer (Kadaster), the presentation about the TIME benchmark (Elisa Farella, FBKm Italy), and the special session on the 20th EduServ course program. As part of the social program, an interesting visit to the Guinness Storehouse in Dublin was organized followed by an excellent dinner in the building.

The 141th Board of Delegates meeting took place on 2 – 4 November 2022 at the World Nature Forum in Naters (Switzerland). The event was hosted by the Federal Office of Topography (Swisstopo) and Ecole Polytechnique Fédérale de Lausanne. 42 persons attended the meeting. The highlights of this meeting were the presentations of the two EuroSDR PhD Award winners, a keynote presentation on Single-Photon Lidar by Michael Hovenbitzer, the keynote presentation about EAASI by Marcos Martínez-Fernández, and the keynote presentation about JRC by Pietro Florio. During the meeting, Swisstopo and EPFL organized an exciting visit to the World Nature Forum and a wonderful dinner at restaurant Schlosskeller.

In preparation for these two Board of Delegates meetings, the Executive Management Team organized two meetings. The first one was online and took place 14-15 February 2022. The second one took place in Newcastle (UK) from 7 until 8 July 2022.

Delegates

In 2022, the following appointments were approved: Elikkos Elia as Prime Delegate of Cyprus, Aurélien Pleyer as Second Delegate of France, Norbert Haala as the Second Delegate of Germany representing Germany, Rui Reis as Second Delegate of Portugal, Marisa Silva as Third Delegate of Portugal, an Martijn Rijsdijk as Prime Delegate of The Netherlands.

RIEGL as well as IGI became associate member of EuroSDR. Peter Rieger represents RIEGL and Philipp Grimm represents IGI.

Norbert Haala was re-appointed for his third and last term as Chair of Commission 2 'Modelling, Integration and Processing.

Partnerships

EuroSDR continued collaborating with its key partner associations in 2022: Association of Geographic Information Laboratories for Europe (AGILE), EuroGeographics, FIG, ISO TC/211, International Society for Photogrammetry and Remote Sensing (ISPRS), and UN-GGIM Europe.

Some examples indicating our successful collaborations with our partner associations are the following:

- Attending the General Assembly in Sarajevo Bosnia and Herzegovina (15 – 17 May 2022).
- Organizing AGILE pre-conference workshop on GeoData and Tools for Education and Research (Vilnius, Lithuania, 14 June 2022)
- ISPRS/EuroSDR theme session at the ISPRS Congress in June 2022
- Attending the UN-GGIM meeting Europe in Brussels as an observer (20 – 21 June 2022).
- EuroSDR Session at FIG Conference (Commission VII) on Framework on Effective Land Administration (FELA)((Warsawm 11 – 15 September 2022)
- Relaunching the collaboration with ISO TC/211 by setting up a relevant web survey

Logistics

Regarding the associated logistics, the secretariat was among others strongly involved in preparing the meetings, processing the minutes, decisions and actions of each meeting, organising EuroSDR events (e.g. workshops, webinars, EduServ e-learning courses), editing publications and the annual report, financial accounting, auditing, updating the EuroSDR website, managing social media, etc.

Moreover, the first concrete actions took place to shift the EuroSDR Secretariat back to Ireland. From Fall 2023, Conor Cahalane will serve as the new Secretary-General of EuroSDR. This also means that the secretariat will move to Maynooth University.

On behalf of the current secretariat, I would like to express that we really look forward to continue cooperating with our members and associate members, Commission Chairs, President, Vice-President, representatives of our partner associations and those that are simply interested in the activities of EuroSDR in the (near) future.

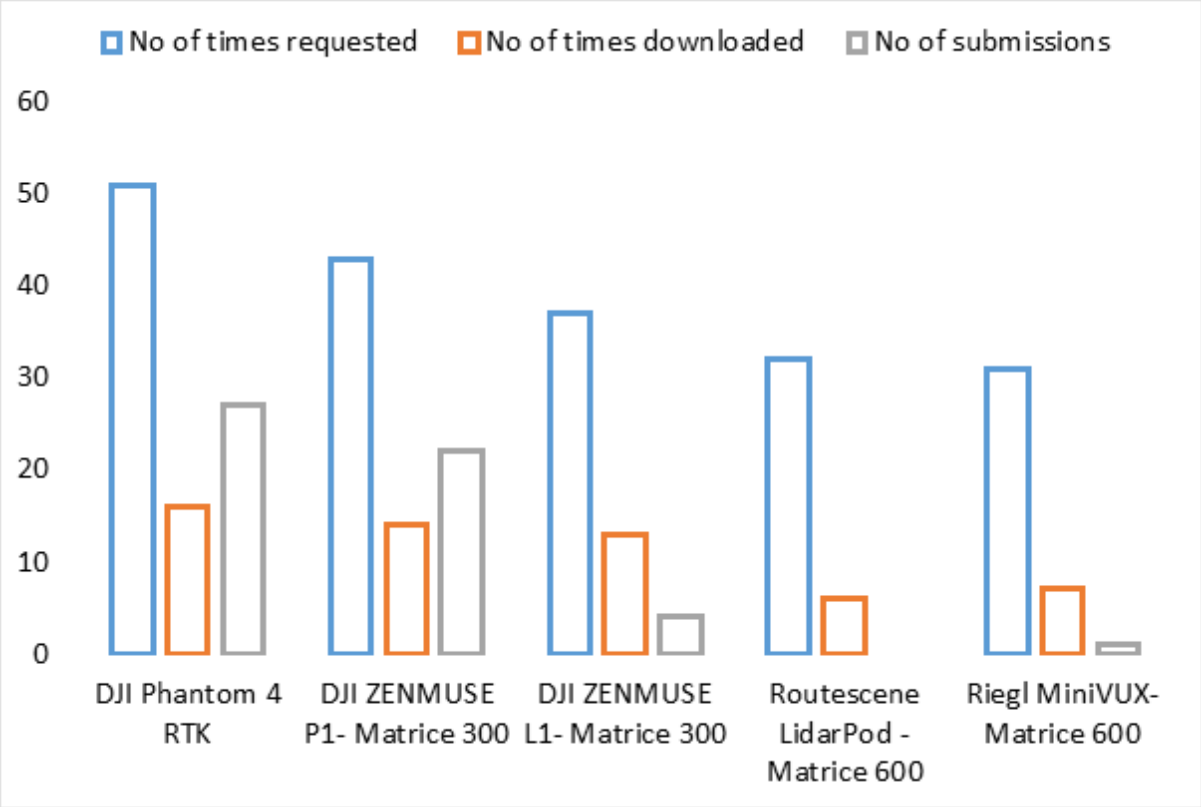
Commission I: Data Acquisition

Jon Mills

The mission of Commission 1 is to investigate, test and validate platforms, sensors, algorithms and human sources to acquire geospatial data, with emphasis on precision, accuracy, reliability and standardisation of primary data acquisition procedures.

RPAS benchmark

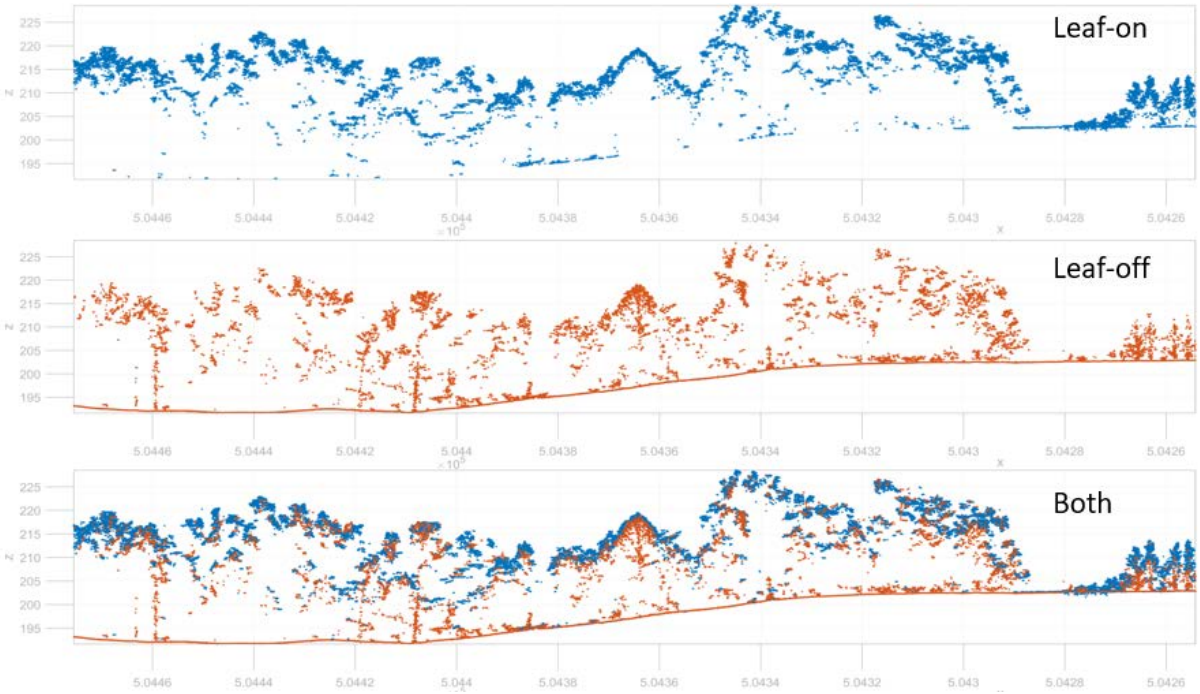
Commencing in mid-2021, the Commission 1 remotely piloted aircraft systems (RPAS) benchmark aims to independently evaluate the true geometric quality of real-world survey data generated from numerous RPAS mounted sensors (both lidar and photogrammetry). The benchmark focuses primarily on the geometric quality of data generated in the absence of ground control and local GNSS base station information. Early stage benchmark tasks were reported in the 2021 EuroSDR Annual Report. In 2022, participants submitted independently generated results to three separate phases, commencing with Phase 1 data (no ground control or local base station) and concluding with Phase 3 (full ground control and local base station). Despite a significant number of requests, submission numbers were somewhat disappointing (see figure below), though meaningful results were still obtained. Results from all three phases were reported at the EuroSDR BoD held in Switzerland in Fall 2022. Further details on the EuroSDR RPAS Benchmark can be found at the website https://geospatialncl.github.io/eurosdr-rpas-benchmark/.



Participant data for EuroSDR RPAS benchmark: 54 different submissions were received from seven independent participants (representing six countries) across all phases and datasets.

Single Photon and Geiger-Mode lidar

The EuroSDR lidar benchmark project originally aimed to collect different datasets over a test site in Innsbruck, Austria, in order to perform detailed investigations and analyses. Unfortunately the lack of any European-based sensors and the COVID-19 pandemic meant the project did not proceed as planned throughout 2020 and 2021 and data acquisition over Innsbruck ultimately proved impossible. However, following the establishment of a new link with VeriDaaS (Geiger-Mode lidar) and a Hexagon Single Photon lidar sensor active in Germany as part of their national digital twin project, further analysis has proven possible. Gottfried Mandlburger presented results of analysis for both Geiger-Mode (USA) and Single Photon (Hamburg, Germany) Lidar sensors to the BoD meetings held in both Dublin and Switzerland (see example figure, below). It remains an ambition of Commission 1 to proceed with further analysis and reporting of these exciting technologies wherever feasible.



Example of leaf-on versus leaf-off for Geiger-Mode lidar in Purdue, USA. Analysis and image courtesy, Gottfried Mandlburger, 2022; original Geiger-Mode Lidar data courtesy of VeriDaaS.

Satellite-borne high resolution stereo imagery

At the Dublin BoD in May 2022, a new joint Commission 1-2 benchmark was approved to investigate the use and potential for satellite stereo imagery. This is a joint activity to explore how high-resolution satellite imagery could benefit or support NMCA mapping needs and operations, with a focus on geometric processing for DSM / ortho generation and feature extraction. Work is ongoing.

EuroSDR participation in 2020/21/22 ISPRS Congress

With the ISPRS Congress in Nice, France, finally able to proceed in-person in 2022, EuroSDR ran a successful Theme Session on National Mapping on 9th June 2022. David Henderson of Ordnance Survey gave an invited paper, entitled "Mapping change in a fast changing world", to one of the best attended sessions held at the Congress, and the EuroSDR Time and RPAS benchmarks were also presented in amongst other papers. Papers from the Congress are published as ISPRS Archives and Annals via the ISPRS website at https://www.isprs.org/publications/Default.aspx. The next ISPRS Congress will be held in Toronto, Canada, from 4 - 11 July 2026.

Well attended EuroSDR Theme Session on national mapping at the ISPRS Congress, 9 June 2022.

EuroSDR Executive Management Team Meeting

Commission 1 hosted a EuroSDR Executive Management Team (EMT) meeting in North East England from 6th to 8th July 2023. The meeting was held at Slaley Hall, on the outskirts of Newcastle upon Tyne, UK. In amongst planning for the Swiss Board of Delegates Meeting, the EMT found a little time to undertake some large scale surveying and visit the Hadrian's Wall World Heritage Site (see figures below).

The EuroSDR Executive Management Team visit the Terris Novalis sculpture (l) and Sycamore Gap, Hadrian's Wall (r), the latter made famous by Kevin Costner and Morgan Freeman in the 1991 Hollywood blockbuster, Robin Hood: Prince of Thieves.

Centre for Doctoral Training (CDT) in Geospatial Systems

The Engineering and Physical Sciences Research Council (EPSRC) Centre for Doctoral Training (CDT) in Geospatial Systems aims to graduate 50 PhD students by 2028. The final cohort of 10+ students will commence their studies in September 2023. The Centre has the support of EuroSDR and a number of its members, including Ordnance Survey, Finnish Geospatial Research Institute, and IGN France. Continual opportunities exist for NMCA collaboration, including student placements, with further details available via the new CDT website at https://geospatialcdt.ac.uk/.

Geospatial Systems CDT students discuss their research with industry at the centre's annual Innovation Festival, held at Meadow Lane, home to the world's oldest professional football club, Notts County FC, 16-17 May, 2022.

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Commission II: Modelling, Integration and Processing

Norbert Haala

The mission of Commission 2 is to investigate, demonstrate and evaluate the generation, processing, structuring, integration and maintenance of spatial information. The focus is on algorithms, including machine learning, Cloud-computing and upscaling.

Recent research initiatives and developments

Methods of Artificial Intelligence (AI), especially including Machine Learning and Deep Learning are becoming a game changer for data modelling, integration and processing within the work of National Mapping and Cadastral Agencies (NMAs). This growing importance motivated EuroSDR to compile a special issue on *Upscaling AI Solutions for Large Scale Mapping Applications*. This issue was supported by the guest editors Fabio Remondino, Joep Crompvoets and Norbert Haala and published within the ISPRS International Journal of Geo-Information. Further information and selected papers can be found at https://www.mdpi.com/journal/ijgi/special_issues/AI_solutions

While airborne and spaceborne imagery is a standard data source for automated geographic object extraction during mapping, 3D point clouds either from airborne LiDAR and/or Multi-View-Stereo-Image-Matching are becoming more and more important. Since this is also true for NMA applications, special emphasis within Commission 2 is put on knowledge transfer and research for applications in the context of 3D point cloud processing.

EduSERV Course on 3D Point Cloud Classification for Mapping Purposes

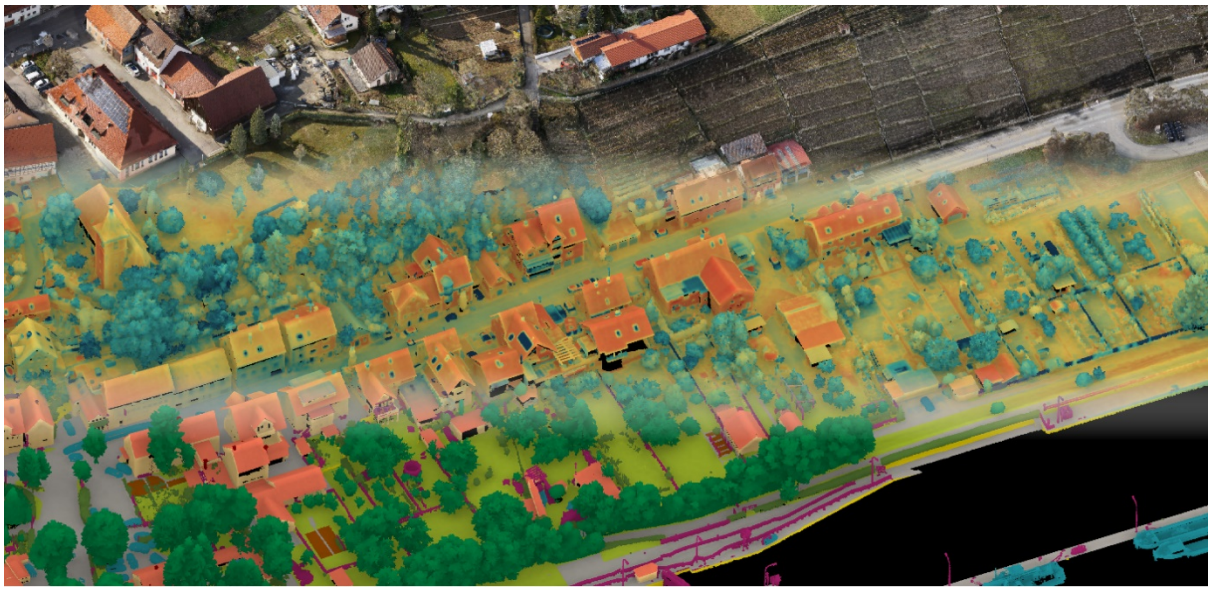
As an example, the interest of the EuroSDR community in semantic segmentation of 3D point clouds triggered the implementation of an EduSERV Course on 3D Point Cloud Classification for Mapping Purposes. The course co-organized by Commission 2, took place from May 23 to June 3, 2022. It presented the latest developments and solutions for 3D point cloud classification, with particular emphasis on mapping needs. Overall 53 participants mainly from academia and NMAs enrolled for the course. Starting from traditional yet functional Machine Learning solutions, the course focussed on more recent Deep Learning methods. In order to provide the participants with a comprehensive and complete overview, from the classification of 2.5D DSM to the semantic segmentation of 3D aerial point clouds The course coupled theoretical aspects and practical work. Tutors were Eleonora Grilli and Fabio Remondino from the 3D Optical Metrology unit of the Fondazione Bruno Kessler and Michael Kölle and Norbert Haala from the Institute for Photogrammetry at the University of Stuttgart. The course was organized as a mix of offline and live lectures and labs, where especially the practical work examples to be solved during the labs, which were run on Google Collab was very much appreciated by the participants. These labs covered topics like Image segmentation and feature computation of 2.5D data, semantic segmentation of 2.5D DSM data with Random Forests, Random forests for 3D point cloud classification as well as image classification with Deep Learning. The course will be repeated from April 17 - April 28 in 2023. The number of 37 registrations reached also for this second round demonstrates the great interest of the EuroSDR community on that topic.

3rd International Workshop on Point Cloud Processing

In view of the growing impact of Deep Learning and Machine Learning approaches on future solutions of NMAs tasks, we furthermore organized the 3rd International Workshop on Point Cloud Processing on January 26. - 27. 2023. As it can be seen in the program at https://pcp2023.ifp.uni-stuttgart.de/ the 1.5 day seminar co-organized by EuroSDR and the Institute for Photogrammetry, University of Stuttgart covered 24 presentations in 5 sessions. The more than 110 participants from 21 nationalities

very much enjoyed the presentations as well as being able to meet and discuss in person in post COVID times again. The sessions covered topics like hardware developments and demands from National Mapping Agencies, visualization and representation of 3D point clouds, state-of-the-art in semantic segmentation, generation of training data, multi-modal processing of LiDAR data and imagery, and information extraction from 3D point clouds. Slides of the event which was co-sponsored by EuroSDR, nFrames and Hexagon had been made available for the participants at https://ifpwww.ifp.uni-stuttgart.de/pcp2023!.

During the workshop, the good mix of participants from academia, industry and NMAs within the audience triggered very interesting discussions, which clearly showed the great benefit of mutual information and potential collaborations between the respective NMAs in the context of automatic data interpretation. These first steps will for sure be continued by Commission 2 in the year 2023.



Commission III: Information Usage and Visualization


Martijn Rijsdijk & Bénédicte Bucher

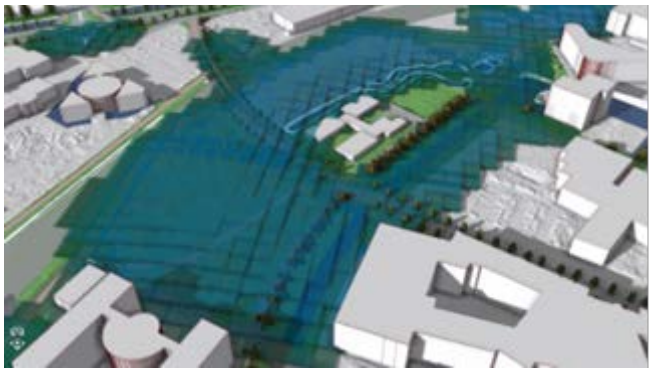
The mission of Commission 3 is to explore, demonstrate and contribute to further increase the usage, access, distribution and visualisation of authorised geospatial data as well as to investigate better service mechanisms for the dissemination of geodata from database to end-users.

2022 was a full year for the committee in terms of workshops, webinars, activities and projects. Below is an overview of everything that is organised in chronological order:

Workshop Digital Twins and NMCA's, (January/ May),

The concept of a Digital Twin (DT) originates from industry and manufacturing. In the geospatial domain, the concept has been gaining significant momentum since it was introduced in 2012. Despite the frequent use of the term, there is not a common definition in use and, consequently, the term is used in different ways: as a digital replica of an asset in a BIM context, as a 3D city or landscape model, as a digital representation of the physical environment including its dynamic processes, as geospatial information infrastructure, etc.

Even though a single definition of a DT in the geospatial domain is lacking, there is consensus that it should be based on 3D city models, containing objects with geometric and semantic information; it should contain real-time sensor data; and, it should integrate a variety of analyses and simulations to be able to make the best design, planning and intervention decisions. The aim of the workshop was 1) to share experiences and exchange ideas and plans among NMCAs and 2) to share information about existing national Digital Twin programmes.



Of course, there were some conclusions:

1. There is no common definition for DT and NMCA's,
2. There is a different approach in relation to DT and their experiments, use cases and co-operations;
3. Digital Twin thinking; is more an approach or concept, it's not a product, 3D only or concrete or physical thing (like a database);
4. NMCA's have a national focus, from all presentations it was clear they have a certain importance to play a role in DT's.

At May 25th there was a follow up workshop; in fact it was a redo of the digital presentation about the outcomes of the EuroSDR questionnaire on the status of DTs in Europe.

Workshop Discoverability of Geodata, [April];

Data discoverability has been identified as an important stake both by the Spatial data Infrastructure community and by the Web of data community. This was the objective of this workshop. The outcomes were:

1. As more and more data are produced and published online in our societies, this stake is only growing;
2. Sharing practical experiences, findings and roadmaps related to the discoverability and accessibility of data with a geographical characteristic, in particular but not limited to data covered by the INSPIRE directive.

A report of the workshop was made and published on the EuroSDR website. Some thought and plans being made about organising a next workshop targeting developers upcoming.

Workshop Datascience and NMCA's, [June];

This was the first workshop ever about the relation between National Mapping and Cadastral Agencies (NMCAs) and datascience ever. Goals of the workshop are to share knowledge about how it has been organised in Europe, different show- and use cases of different NMCA's, different countries, different stories and problems and finding overlaps and differences between all organisations. General conclusion of this successful workshop were datascience; in the context of NMCA's very diverse and wide spread used; different appearances depending on core business and national topics; wide improvement of the original classical core processes in NMCA's thanks to AI; new insights appear combining different datasets manual and automatically; lots of challenges are appearing around quality of data and meta-data/semantics and its authority.

Workshop AI and NMCA's (EuroGeographics), [October];

In January 2021 a first workshop in cooperation with EuroGeographics was organised. This workshop had a general conclusion about National Mapping and Cadastral Agencies (NMCAs) see Artificial Intelligence (AI) as an opportunity not a threat. In this follow up new objectives workshop were developed: to employ AI as a catalyst to becoming the innovative geospatial organisations of the future. Next to that; NMCAs need to anticipate, understand and meet their users' future needs; proactively moving forward with new ideas and services while retaining users' trust even if the data or services are produced using AI. So in this session different speakers of universities, institutes and NMCA's using AI did show their showcases within the context of NMCAs. This was bringing together presentations and discussions and was all about research trends and experiences.

Workshop Geoprocessing and Archiving historical aerial images, December;
Input by Fabio.**Workshops in process**

Two workshop/webinars are in preparation for 2023. First, a follow up of the 2020 Workshop which deals with the use of Sentinel satellites in relation to the Copernicus programme. The objectives are showing the actual developments in relation to Sentinel satellites from Copernicus and ESA. Additionally, knowledge and experience from different national Collaborative Ground Segments (CGS) will be presented. Also, it is important to raise awareness of the possibilities and motivate ideas to make use of earth observation data making sure the scaling up phase in the programme is embedded. This edition will get more focus at uses cases like water management.

The other workshop deals with Managing and distribution of Orthophotos. In fact, the Norwegian Mapping Authority (Kartverket) is looking for a new Orthophoto maintenance system. Today they store around 300 Terabyte of Orthophotos covering Norway in different versions. The main goals for them is to have safe storage of all orthophotos produced in public sector, an effective and easily run maintenance system, offer good services (WMS, WMTS) and download services to our partners. And of course a good portal for viewing (www.norgeibilder.no). The last 7 years they have been running our maintenance and services based on commercial software. However, Kartverket is essentially satisfied with the present technical solution, but realise that the cost for running such a system is expensive and the cost are increasing. Both caused by expensive licenses, but also storage and I/O. Different NMCA's wonder if they have other experiences with similar systems. What kind of system are others running today? Plans for the future? Have they been looking into open-source platforms? Are they running the system internal in your organization? Cost per terabyte? Objectives are to get these questions been answered in a workshop.

Projects of Commission 3
Project Linking Data in Europe

This project deals about combining data across different domains. First about the heavy engineering workload (coping with silos and heterogenities), second for the needed time for creating the real value out of dat. The project has the intention to avoid designing 27 times the same solution Transposition and scaling up is hindered by silos and by little self-learnability of schemas. Further is focussed on specific themes: buildings, as they are useful to integrate data for smart and sustainable cities application. Objectives of the project are 1)Assess methods to publish data and links; 2)At the level of metadata and at the level of data 3)Across governmental data and Wikidata, and OSM 4)Develop consistent methodologies across different countries. At this moment the project is on schedule. In May 2023 a mid-term workshop will be organised combined with a physical venue mid-term report and dissemination. In Fall 2024 the Final report and dissemination will be expected.

Project historical aerial images

This is a research activity in collaboration with several NMCAs and Universities. The aims are

1. to exploit the potential of archival aerial images;
2. to Investigate open issues in various photogrammetric steps.

This project could be seen as a follow-up of the EuroSDR workshop on «Geoprocessing and Archiving of Historical Aerial Images», which was hold in Paris, May 2019.

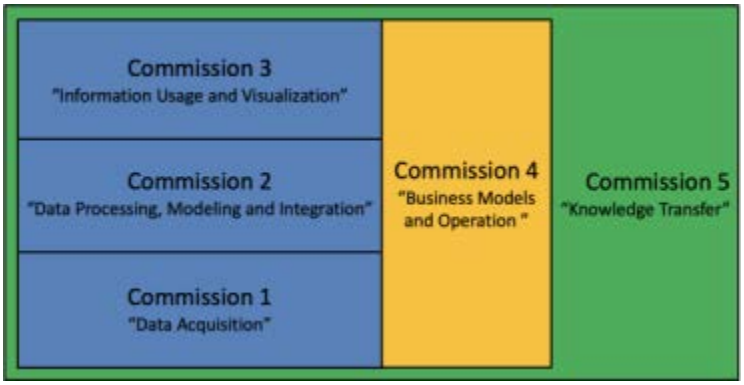
Activities around this project started in spring 2021 and were finalized in early 2022. A collection of (ca 700) aerial images from 1940 till 2000 + metadata + GT was collected and analysed. Results, data and a general overview of the project could be found on: https://time.fbk.eu/

Commission IV: Business Models and Operation

Joep Crompvoets & Frédéric Cantat

The mission of Commission 4 is to contribute to the development and implementation of business models describing the rationale of how mapping and cadastral agencies can create, deliver and capture value, in economic, legal, social, governance, cultural, sustainable or other contexts.

The role of Commission 4 within EuroSDR commissions works is transverse, as is Commission 5:



Sustainable Open Data Business Models for National Mapping and Cadastral Agencies (NMCAs) : survey and workshop

Switching to an open data policy may pose a challenge to the business model of National Mapping and Cadastral Agencies (NMCAs), especially if they are required to generate revenues to cover a substantial part of their operating costs. EuroSDR and TU Delft led in 2017 a research on this topic : *Adapting National Mapping & Cadastral Agencies business models to open data supply: the survey results* by F.M. Welle Donker, J. Crompvoets and B. van Loenen (EuroSDR's Official publication n° 67 – 2017).

In 2019, an important milestone was the publication of the Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information. This directive provides (article 14) that publications and re-use of specific high-value datasets such as geospatial or earth observation and environment (annex 1) shall be free of charge from mid-2023 onward.

Therefore, EuroSDR decided to lead a follow-up, as a repetition of the 2017's action, in association this time with EuroGeographics. This follow-up had two parts once again: a survey and a workshop.

The survey work was reported in EuroSDR Annual Report 2021. The Official Survey Report was written and published on EuroSDR website in November 2022.

The topic of the workshop was to bring together the NMCAs, researchers and policy makers to present, discuss and share their experiences of open data. The workshop gathered up to 80 participants (during the first day. 50 participants on the second day). The slides are available on the EuroGeographic workshop website.

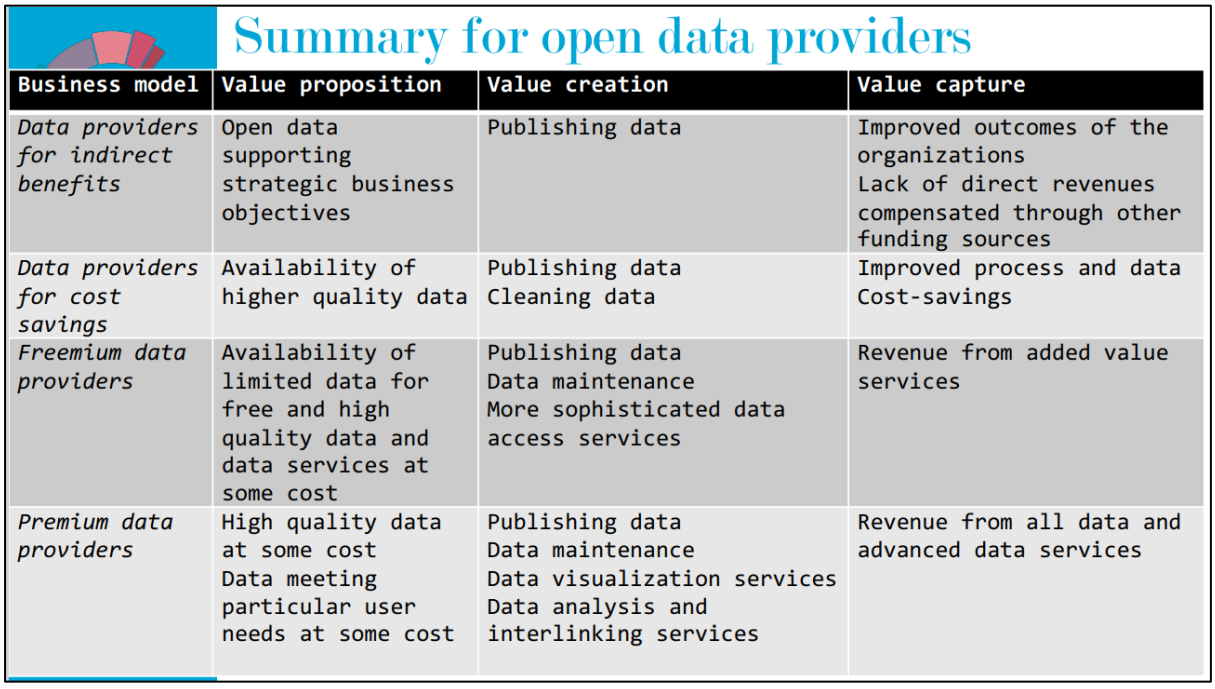
The workshop started with a presentation of the results of the survey from EuroSDR chair of commission 4.

His presentation was followed by a presentation from European Commission (DG for Communications Networks, Content and Technology – DG CONNECT). Jiri Pilar gave an overview of European Union's Strategy for Data and zoomed in Open Data policy in 2022 more specifically.

Bastiaan van Loenen, from Delft University of Technology, presented The "Towards sustainable Open Data ECOsystem (ODECO)" initiative, a 4-year Horizon 2020 Marie Skłodowska-Curie Innovative Training Network for a new generation of creative and innovative early-stage open data researchers, able to face current and future challenges, in the establishment of sustainable open data ecosystems supporting the EU ambitions to become a worldwide leading information economy.

Clément Gaudin testified on how IGN France twisted its business and funding model with the changeover of Open Data while Peter Knudsen focused on the impact of the organisation of the Danish Agency for Data Supply and Infrastructure SDFE).

Frederika Welle Donker, from Delft University of Technology, provided an introduction to business model theory and an overview of business models for open data organizations and for open data platforms as an ecosystem.



Summary for open data providers

Business model	Value proposition	Value creation	Value capture
Data providers for indirect benefits	Open data supporting strategic business objectives	Publishing data	Improved outcomes of the organizations Lack of direct revenues compensated through other funding sources
Data providers for cost savings	Availability of higher quality data	Publishing data Cleaning data	Improved process and data Cost-savings
Freemium data providers	Availability of limited data for free and high quality data and data services at some cost	Publishing data Data maintenance More sophisticated data access services	Revenue from added value services
Premium data providers	High quality data at some cost Data meeting particular user needs at some cost	Publishing data Data maintenance Data visualization services Data analysis and interlinking services	Revenue from all data and advanced data services

Figure© Delle Wonder: Potential value propositions for open data providers

Caterina Santoro, from KU Leuven, assessed in her presentation the implementation of open data initiatives in local contexts (Italian municipalities) through the attainment of transparency goals, and improved the understanding of the open data phenomenon in the context of Italian local administration.

Amalia Velasco shared the pioneer experience of Spanish Cadastre (started in 2003) in its facilitation of access and re-use of its data for free for both commercial and non-commercial purposes and how this long term Open data strategy has enhanced the role of the cadastre as fundamental tool for territorial polices and socio-economic development in Spain.

Hugh Mangan presented a story of a work in progress, about how OSI (Ordnance Survey Ireland) is transitioning its funding model to more fully support Open Data, and shared a look to what OSI expects to do into the future and what it has learnt from other Open Data leaders in Ireland.

Clare Hadley outlined the objectives behind making data 'open', how the United Kingdom has responded and shared Ordnance Survey's journey in providing open data products and services (by addressing the challenges of getting clarity in government objectives, achieving sustainable funding, getting user input, building an eco-system, and tackling legal and regulatory hurdles).

Anna Bober from Head Office of Geodesy and Cartography (Poland NMCA) explained how the opening of authoritative spatial data is a great help in fastening implementation of the investment projects, improving activities and developing new initiatives in Poland.

Dick Eertink shared the ten years journey of Kadaster (The Netherlands) on the path of Open Data and gave answers to the following questions: what were expectations and concerns, and to what extent did these become true? What was the impact of open data on the existing business model? And what are current challenges in the provision of open data?

Figure: word cloud "origin country of the workshop attendees"

Monitoring the regulation work of the European Commission on its Open Data policy

As announced by Jiri Pilar on the 2nd February 2022 during his presentation at the EuroSDR/EuroGeographics sustainable Open Data Business Models for NMCAs workshop, Year 2022 was very active for EU regulations on Open Data, specifically about the implementing regulation act laying down a list of specific high-value datasets. EuroSDR members were kept up-to-date as discussions or publications progressed:

- when EC published and opened for feedback the draft act about availability of public high-value datasets according the European "Open Data" directive (May/June 2022).
- with the communication of an overview of NMCAs' feedbacks to the EC consultation
- when the EC adopted on 21st December 2022 the final text of the implementing regulation act laying down a list of specific high-value datasets

Commission Implementing Regulation (EU) 2023/138 of 21 December 2022 laying down a list of specific high-value datasets and the arrangements for their publication and re-use was finally

published in the Official Journal of the European Union. It will entry in force on 9 February 2023 and shall be binding in its entirety and directly applicable in all Member States from 9 June 2024. Where making high-value datasets available free of charge by public sector bodies that are required to generate revenue to cover a substantial part of their costs relating to the performance of their public tasks would lead to a substantial impact on the budget of the bodies involved, Member States may exempt those bodies from the requirement to make those high-value datasets available free of charge for a period of no more than two years.

Project 'Advancing the UN-GGIM FELA – Framework for Effective Land Administration'

An important and significant milestone for land administration globally arrived when the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM) welcomed and adopted the Framework for Effective Land Administration (FELA) at its 10th session in 2020.

EuroSDR, with the support of EuroGeographics and the UN Expert Group on Land Administration and Management (EG-LAM), initiates a project to raise awareness of the merits and benefits of effective land administration and share knowledge and experience leveraging the FELA as the overarching policy guidance. In addition, the project seeks to support FELA, as a 'living document', cognizant of the changing and evolving societal, economic, environmental, political, and technological landscapes and national circumstances.

The first step of this project was to run an on-line survey in Spring 2022. Partially inspired by the FIG Cadastre 2014 work from the mid-1990s and subsequent Cadastral Template surveys, the applied online survey approach aimed to gain an overview of the different stages of awareness and uptake of FELA by the members of EuroSDR and/or UN-GGIM Europe. To this end, the FELA framework was transformed into a series of questions addressing a selection of FELA strategic pathways (see figure below). Due to time and resource constraints, not all pathways could be explored (Governance, Institutions and Accountability – Legal and Policy – Financial). In total 21 countries participated: Austria, Belgium, Bosnia & Herzegovina, Bulgaria, Cyprus, Czech Republic, Denmark, England and Wales, Estonia, Finland, Germany, Italy, Latvia, Luxembourg, Netherlands, Portugal, Scotland, Slovenia, Spain and Sweden, Switzerland.

Main take-aways of this first step of the project are:

- from the participation and interest that this initiative has generated, the FELA can be seen as an opportunity for partnerships and regional cooperation.
- the study confirms that there is no one size fits all approach in the land administration domain.

The survey report has been done at the end of 2022 and will be published on the EuroSDR website as an official publication in the first quarter of 2023.

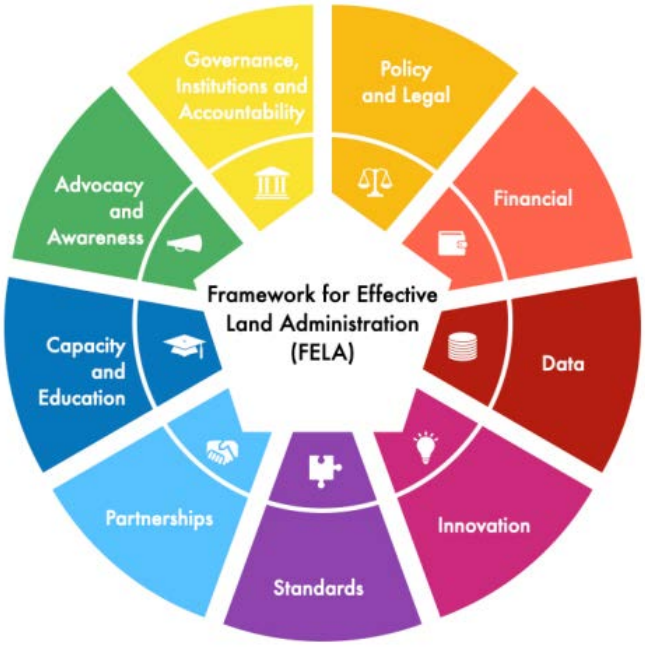


Figure: Nine Pathways of the Framework for Effective Land Administration

A joint EuroSDR/FIG session was held at FIG Congress (12 September 2022) 'Framework for Effective Land Administration – NMCA Good Practices and Further Developments'. It had been chaired by Anka Lisec (chair of EuroSDR commission 5).

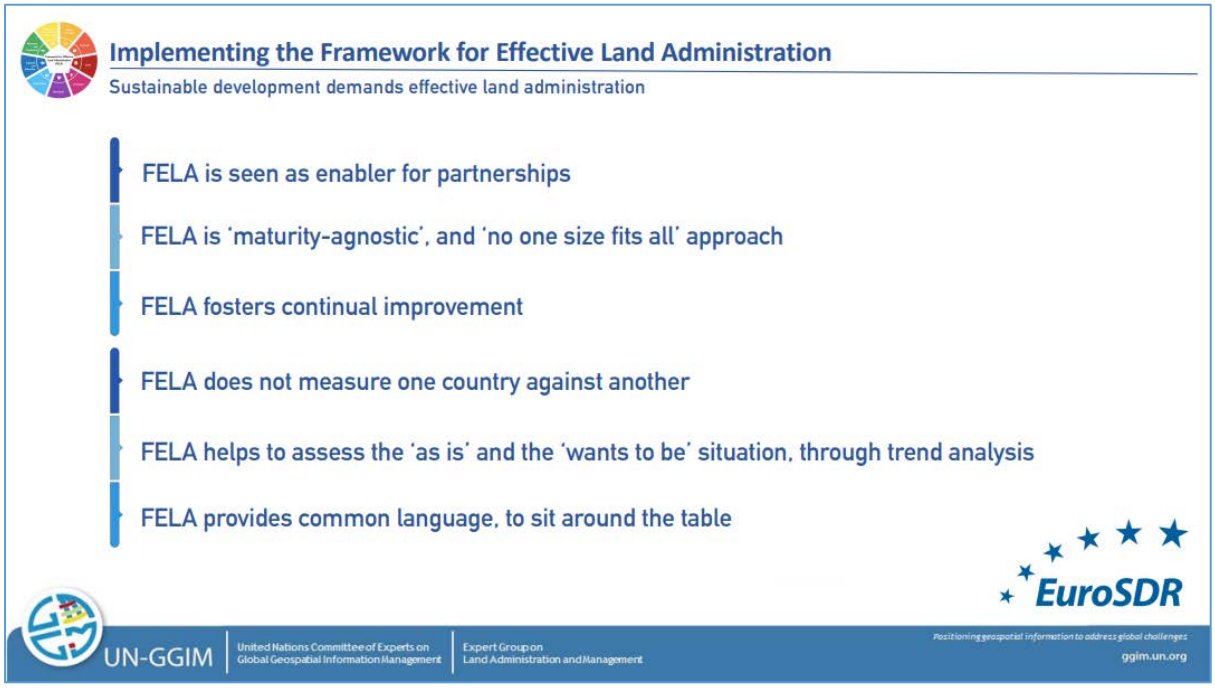


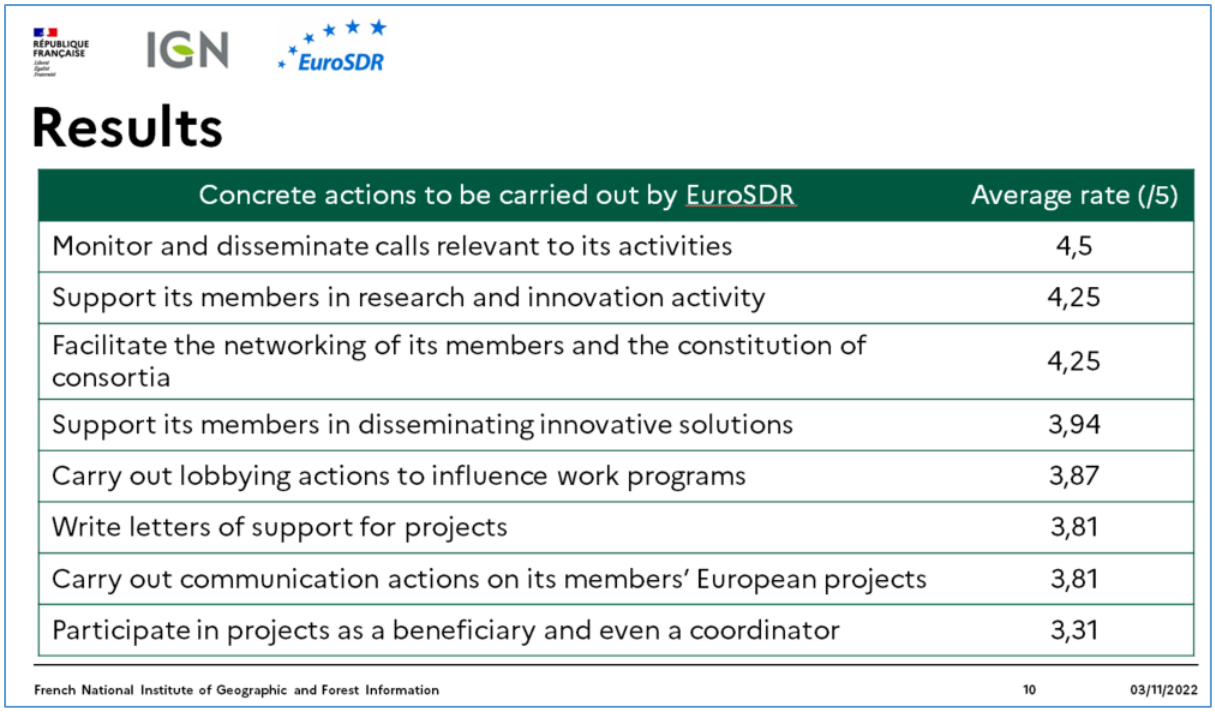
Figure: slide presented by Ana-Maria Unger during EuroSDR/FIG session at 2022 FIG Congress

During 2023, the follow-up project's works will be focus on the other six pathways for European countries only. And a workshop should be scheduled to share all the survey results and to have panel sessions to share good practices.

European Union funding action

An on-line survey was run in 2022 to collect and identify the needs of EuroSDR members towards EU funding and to add value to EuroSDR membership regarding EU funding. It gathered 18 participations (representing 16 countries). The detailed results of the survey were presented during EuroSDR Board of Delegates 141 in Naters (Switzerland) on November 2022. The three most popular concrete actions which could be carried out by EuroSDR are: 1. Monitoring and disseminating calls relevant to its activities; 2. Supporting its members in research and innovation activity; 3. Facilitating the networking of its members and the constitution of consortia.

A workshop will be organized in the beginning of 2023. Among the expected outcomes, there are, a list of identified needs and opportunities, a first set of propositions (incl. actions plan) and a workshop report.



Results

Concrete actions to be carried out by EuroSDR	Average rate (/5)
Monitor and disseminate calls relevant to its activities	4,5
Support its members in research and innovation activity	4,25
Facilitate the networking of its members and the constitution of consortia	4,25
Support its members in disseminating innovative solutions	3,94
Carry out lobbying actions to influence work programs	3,87
Write letters of support for projects	3,81
Carry out communication actions on its members' European projects	3,81
Participate in projects as a beneficiary and even a coordinator	3,31

Figure: *slide presented by Flora Errecart during EuroSDR BOD 141*

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Commission V: Knowledge Transfer

Markéta Potůčková & Anka Lisec

The mission of Commission 5 is to provide educational services to support the transfer of knowledge from EuroSDR research projects to national mapping and cadastral agencies (NMCAs), academia and industry. The Commission also focuses on fulfilling specific NMCAs' demands for knowledge update, collection and dissemination methodologies, developed tools and other research outcomes in the form of EuroSDR's official publications and via EuroSDR's homepage.

Overview activities 2022

Although the Covid-19 crisis still had some impact on the Commission 5 activities, many results were made. We are glad that the 20th series of EduSERV online courses were successfully completed. The participants' feedback on EduSERV20, which was shared with us through the online questionnaire, was very positive. Within the questionnaire, the participants also proposed topics that would be interesting for future EduSERV courses – these ideas were discussed during the Executive Management Team meeting in Newcastle (July 2023) and the Board of Delegate meeting in Brig (November 2023). The topics that were highlighted in this context were in particular (i) machine learning and deep learning in relation to satellite remote sensing and photogrammetry, including UAS photogrammetry; (ii) AI for change detection for topographic mapping; (iii) 3D (semi)automatic city and landscape modelling using various data sources, e.g. oblique aerial imageries, laser scanning point clouds, BIM (GeoBIM); (vi) RPAS and georeferencing; (v) mobile mapping; (vi) open data business model, data quality; (vii) ground penetrating radar for mapping of utility infrastructure, etc. Here, the synergy of Commission 5 activities with other commissions has to be emphasised: the EuroSDR projects and workshops organised within the Commissions 1-4 have already significantly contributed to the content of the EduSERV courses, which has been proven as a good approach to the planning of EduSERV courses.

In 2022, Commission 5 was actively involved in the follow-up activities concerning the topic "Geodata and Tools for Education and Research". Furthermore, in collaboration with Commission 4, we have been involved in the UN FELA initiative dedicated to effective land management and the role of NSMA. For both initiatives, short reports have been prepared.

EduServ20

In 2022, EuroSDR Commission 5 for Knowledge Transfer continued to organise the EuroSDR Educational Service (EduServ) – a series of e-learning courses that reflect new trends in geospatial information science related to the needs of research, development and practice within NMCAs and industry. The 20th series of EduServ e-learning courses opened on February 14-15, 2022, with the EduServ pre-course seminar, which was organised as an online version due to the pandemic situation in Europe. The online pre-course seminar was attended by 64 participants, including teachers and guests. The EduServ20 offered four e-learning courses from March to June 2022 on the following topics:

- **Recent LiDAR technologies** (February 28 – March 11, 2022)
  Tutor: Gottfried Mandlburger (TU Vienna)
  The course tackled the recent progress in Airborne Laser Scanning (ALS), the state-of-the technique for 3D mapping of topography and shallow water bathymetry, including the following topics: (i) point density and spatial resolution; (ii) full waveform analysis with state-

of-the-art FWF processing techniques; (iii) multispectral laser scanning; (iv) hybrid sensors; (v) single Photon LiDAR; (vi) topo-bathymetric LiDAR for high-resolution mapping of the littoral area; (viii) UAV-LiDAR with new close-range airborne applications due to the integration of lightweight LiDAR sensors on Unmanned Aerial Vehicles.

- **Working with Volunteered and Crowdsourced Geographic Information** (March 28 – April 8, 2022)

  Tutors: Peter Mooney (Maynooth University) and Levente Juhász (Florida International University)

  Volunteered Geographic Information (VGI) and Crowdsourced Geographic Information (CGI) have transformed from being considered 'disruptive' and poor quality to well-known mainstream data sources used widely in industry, research, and other applications. The goal of the course was to introduce participants to VGI and CGI, the state-of-the-art research in these areas, methods for obtaining and processing VGI/CGI data (API sources, processing GeoJSON, etc.), and advanced topics such as assessment of the quality of the data.

- **GeoBIM and 3D City modelling** (May 2 – 12, 2022)

  Tutors: Francesca Noardo (Open Geospatial Consortium Europe), Ken Arroyo Ohori (Delft University of Technology)

  The topic is wide, complex and technically demanding. The course was dedicated to the basic knowledge of GeoBIM integration based on the needs of use cases and showed two examples of conversions procedures that supported those who use cases. After introducing the basics of 3D city models and Building Information Models, students learnt a method to compare two datasets (a 3D city model and a BIM) in order to analyse their integration possibilities and define the actions necessary to get to an integrated dataset, useful for a use case.

- **3D point cloud classification for mapping purposes** (May 23 – June 3, 2022)

  Tutors: Michael Koelle, Norbert Haala (University of Stuttgart), Eleonora Grilli, Fabio Remondino (Fondazione Bruno Kessler)

  The course was dedicated to the latest developments and solutions for 3D point cloud classification, with particular emphasis on mapping needs, activities and purposes. Starting from functional Machine Learning solutions, the course focused on more recent Deep Learning methods. Theoretical aspects and practical work were coupled in order to provide a comprehensive and complete overview of the topic, from the classification of 2.5D DSM to 3D aerial point clouds.

A total of 69 participants attended the e-learning courses. The following table gives an overview of the number of participants who attended each course and the number of participants who successfully completed the courses and received certificates from EuroSDR.

Course title	**Number of**	
	active participants	**issued certificates**
Recent LiDAR Technologies	42	28
Working with VGI and Crowdsourced Geographic Information	11	4
Integration of 3D City Models and BIM: GeoBIM	25	8
3D Point Cloud Classification for Mapping Purposes	52	34

EuroSDR PhD award

To enhance collaboration between European academia and NMCAs, as well as to engage young scientists in its research endeavours, EuroSDR introduced in 2016 an annual competition for the best PhD thesis in the fields related to geoinformation science. Ain June 2022, the call for applications for the 2022 EuroSDR PhD Award was announced.

We received 11 applications from candidates holding PhDs from universities in Italy, France, Germany, Poland, Russia, Spain, The Netherlands, United Kingdom. The evaluation committee (Joep Crompvoets, Julián Delgado Hernández, Anka Lisec, Markéta Potůčkova, Fabio Remondino) reviewed the applications, and two winners were announced in September 2022:

- **Lulin Zhang,** PhD: Feature matching for multi-epoch historical aerial images, Université Gustave Eiffel, Paris, France
- **Calimanut-Ionut Cira**, PhD: Contribution to Object Extraction in Cartography: A Novel Deep Learning-Based Solution to Recognise, Segment and Post-Process the Road Transport Network as a Continuous Geospatial Element in High-Resolution Aerial Orthoimagery, Universidad Politécnica de Madrid, Spain

The winners gave a presentation on the key findings of their research during the online 141st Board of Delegates meeting in November 2022. More information is available at: http://www.eurosdr.net/news/eurosdr-award-winners-2022

Workshop on NMCA Data and Tools for Education and Research

In collaboration with EuroSDR Commissions 4, we continued activities related to the survey from 2020 on "Data and tools for research and education". A thematic workshop was organised dedicated to this topic within the AGILE conference on June 14, 2022. Over 50 participants joined this hybrid workshop, where tha participants discussed (i) how to improve the visibility of all existing approaches, tools, good practices, reusable resources, and (ii) how to prepare the user scenarios which would benefit from a European approach and distinguish what already exist to support them. The summary of the presentations and discussion will be published in the EuroSDR report "Geodata and tools for education and research Workshop report", prepared by Bénédicte Bucher, Frédéric Cantat , Joep Crompvoets, Anka Lisec, Markéta Potůčková, Conor Cahalane , Evelyn Uuemaa and Mathieu Chartier.

Figure: Section of the Swiss open data portal dedicated to Schools

Workshops

- Digital Twins for National Mapping and Cadastral Agencies and other governmental organisations (21 – 28 January 2022) – Virtual
- Sustainable Open Data Business Models for NMCAs (2 – 3 February 2022) – Virtual
- Joint EuroSDR & EuroGeographics Workshop on Geodata Discoverability (28 April 2022) – Virtual
- Follow-up workshop Digital Twins (25 May 2022) – Virtual
- Datascience for NMCAS (2 – 3 June 2022) – Virtual
- XXIV ISPRS Congress 2022 (6 – 11 June 2022) – Nice, France
- EuroSDR theme session at ISPRS Congress 2022 (9 June 2022) – Nice, France
- AGILE pre-conference workshop | GeoData and Tools for Education and Research (14 June 2022) Vilnius, Lithuania (hybrid)
- FIG Congress 2022 (11 – 15 September 2022) – Warsaw, Poland
- Artificial Intelligence for NMCAs (27 – 28 October 2022) – Leuven, Belgium
- Geoprocessing and Archiving of Historial Aerial Images (5 – 6 December 2022) Rome, Italy

Publications

WR	Bucher B., Cantat F., Crompvoets J., Lisec A., Potůčková M., Cahalane C., Uuemaa E., Chartier M.: Geodata and Tools for Education and Research, 2022, 14 pages
WR	Bucher B., Grudzień M., Delattre N., Escriu Paradell J., Folmer E., Garrone A., Kügeler A., Lopez Á., Parsons E., Perego A., Pilar J., Reini J., Reuter H.I., Saligoe-Simmel J., Schneider M., Ticheler J.,: Geodata Discoverability, 2022, 35 pages
74	Unger E-M., Bennett R., Crompvoets J., Lisec A., Cantat F.,: EuroSDR Advancing FELA – The Framework for Effective Land Administration, 2022, pages 21
SR	Cantat F., Crompvoets, J., Agius C., Baker A.,: Sustainable Open Data Business Models for NMCAs, 2022, 22 pages

All publications can be downloaded on the EuroSDR website.

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