



European Spatial Data Research

Annual Report 2024

EuroSDR Annual Report 2024

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 organises, 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 (2024)

Austria	Wolfgang Gold	Bundesamt für Eich- und Vermessungswesen
Belgium	Eric Bayers	Institut Géographique National Belgique
Croatia	Saša Cvitković	Državna Geodetska Uprava (DGU)
Cyprus	Andreas Hadjiraftis	Ministry of the Interior, Department of Land and Surveys
Denmark	Katarina Ritz	Styrelsen for Dataforsyning og Effektivisering
Estonia	Tambet Tiits	Maa-amet
Finland	Juha Hyypää	Maanmittauslaitos
France	Bénédicte Bucher	Institut National de l'Information Géographique et Forestière
Germany	Michael Hovenbitzer	Bundesamt für Kartographie und Geodäsie
Ireland	<i>To be confirmed</i>	Tailte Éireann
Norway	Jon Arne Trollvik	Statens Kartverket
Poland	Anna Bober	Główny Urząd Geodezji i Kartografii
Portugal	Mário Caetano	Direção Geral do Território
Romania	Iuliana Pârvu	Centrul National De Cartografie
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 Rijdsdijk	Kadaster, Data Governance Innovation & Projects
United Kingdom	<i>To be confirmed</i>	Ordnance Survey Great Britain

Our Associate Members and their Representatives (2024)

Digitaal Vlaanderen	Jo Van Valckenborgh
Esri/nFrames	Nick Land & Konrad Wenzel
Het Waterschapshuis	Jeroen Leusink
Hexagon	Simon Musaeus
ICGC	Julià Talaya
IGI	Philipp Grimm
RIEGL	Peter Rieger
Vexcel	Michael Gruber
1Spatial	Dan Warner

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Message from the President

Wolfgang Gold



Dear EuroSDR friends,

We can proudly look back on a typical EuroSDR-year – full of activities to bring EuroSDR further. We moved with our BoD-meeting compared to the year 2023 to the far south: to Zwolle in The Netherlands. But we found the way back to the north with our Copenhagen-meeting in Denmark. I personally love these regions, and the hosting teams did great work. The highlight, as so often, were the country days where one focus was how to deal with environment. Thank you for presenting your countries and giving insights into two traditional cities.

One of the main activities of EuroSDR is the EduServ course. The EduServ year 2024 started early in Leuven (Belgium) and was enabled by a motivated group of top-tutors in the first half of the year. Thunderous applause to all persons contributing to this story of success. The second object addressing young scientists was our PhD-award. We had an impressive presentation from the award-winner 2024 Kristina Wolf (University of Newcastle) at the Copenhagen meeting – congratulations to Kristina.

If 2023 was the year of changes, 2024 was the year of the first steps of EuroSDR-units. Our vice-president-team Jantien Stoter and Joep Crompvoets started the work with a review of the EuroSDR research plan and prepared the scientific sessions of the BoD-meetings very well. Eija Honkavaara and Ivar Oveland started took up the lead of their commissions which resulted in some interesting workshops. These workshops and all the others are the backbone of our scientific work. I am pleased that so many persons contributed to this, thanks to all of them.

And the EuroSDR-family has grown, with Romania becoming a member. A warm welcome to Juliana Parvu and Dragos Badea as delegates from Romania. And there were even more persons having their first meeting with EuroSDR. We have Jamal Jokar Arsanjani as new delegate from Denmark for academia. And also new prime delegates started with their duties or were nominated: Saša Cvitković from Croatia, Guillermo Castro Camba from Ireland, Mihaela Triglav Čekada from Slovenia and Antero Kukko from Finland. And then we have Jeroen Leusink who is not really new in BoD-meetings but has as 2nd delegate from The Netherlands a new status.

But every start into a function means that some persons have finished an intensive period of promoting EuroSDR. Please let's say thank you to

- Dalibor Radovan, prime delegate from Slovenia
- Juha Hyypä, prime delegate from Finland
- Paul Kane, prime delegate from Ireland

for their contributions to the success of EuroSDR !

And last but not at least a great thank you to all EuroSDR-delegates for their support to EuroSDR. Please let's continue this way of success next year.

Best regards

Wolfgang

Message from the Vice Presidents

Jantien Stoter and Joep Crompvoets



Dear EuroSDR friends,

2024 was an exciting and a productive year for the EuroSDR community as it was our first year that we were in charge as vice-presidents. The organization confirmed once again its leadership and presence in the geospatial sector organizing many scientific events and running multiple research activities for the benefit of the community. Our main task for this was to draft the **EuroSDR Rolling Research Plan** for the next 4 years. The content of the plan was intensively discussed during the two executive meetings (Leuven, Maynooth) and a breakout session of BoD 144 meeting in Zwolle. It is the intention to present the final version of the plan during BoD 145 in Tromsø, Norway.

Two BoD meetings took place, in Zwolle (The Netherlands) and Copenhagen (Denmark), with very interesting national days and reports of ongoing activities.

In terms of **organized and supported scientific events**, we can mention:

- Workshop Geodata discoverability, online, 16-17 January
- Webinar GEOE3, online, 18 January
- EuroSDR/EuroGeographics Workshop on Sustainable Business Models for NMCAs, Leuven, Belgium, 8-9 February
- Workshop on Historical and Time stamped data for SDGs, Zagreb, Croatia, 23 April
- EuroSDR/AGILE 2024 Workshop | Current trends of Volunteered Geographic Information in National Mapping and Cadastral Agencies, Glasgow, UK, 4 June
- EUREF/EuroSDR Workshop on How To Increase Use of Spatial Data & Sharing Data Across Borders - Relating to Reference Frames, Tromsø, Norway, 22 - 23 October
- Workshop on Artificial Intelligence in core business processes of NMCAs, Amsterdam, The Netherlands, 13 - 15 November
- Workshop on Recruitment and Capacity Development Challenges in the Geospatial Domain, Ljubljana, Slovenia 19 November

In terms of **projects and research activities**, delegates focused on various topics, such as: Point cloud datasets; Research needs of NMCAs in data acquisition; uncrewed aerial vehicles for NMCAs; spatial data (sharing) related to reference frames; GeoAI, 3D mapping at NMCAs; Linked data/Knowledge Graph; Open geodata; Volunteered Geographic Information; FELA – Framework for Effective Land Administration; Geo-ethics and Recruitment & Capacity development challenges. The two supported **PhD projects** (“Integration of multispectral LiDAR with imaging” and “Digital Twins”) are ongoing and their progress was reported during the two BoD-meetings

In terms of **publications**, the following Official Publications were published: 76. EuroSDR Knowledge Graph about Geodata Products in Europe and 77. Advancing FELA II. In addition, workshop reports on Sustainable Business Models for National Mapping and Cadastral Agencies, Data Ecosystems and Spatial Data Infrastructure - Facilitators for Data Value Creation, and Geodata Discoverability, were also published.

On the educational side, the 22nd edition of the **EduServ** course was offered in Spring '24 focusing on four topics:

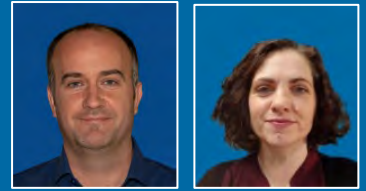
- Remote sensing and change detection with Sentinel time series data
- Sustainable Business Models for Open Geospatial Data
- From traditional to AI-based 3D scene capture and modelling
- Point cloud processing with laser scanning

The **PhD award** was assigned to Kristina Wolf (University Newcastle) with her thesis titled “Geospatial Data Infrastructure for multi-agency Incident Management”.

Finally, the vice-presidents (re)presented EuroSDR at the General Assembly of EuroGeographics (Seville, 18 March), General Assembly of PCC (Brugge, 19 June), and UN-GGIM Europe (19-20 June).

Report of the General Secretariat

Conor Cahalane and Neasa Hogan



This report reviews the annual Board of Delegates meetings that occurred in the framework of EuroSDR in 2024, the appointments of (new) delegates and Commission chairs, changes to members and delegates, the activities related to our partner associations, some operational changes and administrative updates.

Meetings

BoD 144 – Zwolle, The Netherlands

The 144th Board of Delegates meeting took place at the headquarters of Kadaster in Zwolle on 22-24 May in The Netherlands. The event was hosted by Kadaster, University of Twente and hetWaterschapshuis and 53 persons attended the meeting with a wonderful icebreaker and dinner at Bistro Pampus. The highlights of the events included the excellent National Day sessions with topics ranging from flood risk and housing, to repeat coastal laser scanning and keynotes on advances in LiDAR and Digital Twins. We were pleased to receive an update from the Secretary General of EuroGeographics on their latest initiatives and also our first EuroSDR-PhD update from Jack Metcalfe (UCL).

BoD 145 – Copenhagen, Denmark.

The 145th Board of Delegates meeting took place at Aalborg University in Copenhagen in Denmark. The event was hosted by the Danish Agency for Climate Data (KDS) and Aalborg University and 67 persons attended the meeting with a wonderful pizza icebreaker in the University. We enjoyed a picturesque 'night-lights' trip on the water taxi from near the University, a delicious sharing dinner at Bazaar Restaurant and a memorable walk around parts of Copenhagen central and the palace grounds that evening. Highlights from the National Day include many of the topics relating to updating elevation datums, mapping remote locations in Greenland and were followed in the EuroSDR sessions with keynotes on Education for Sustainable Development, and Copernicus activities of relevance for NMCAs. We were also delighted to receive a talk from the second EuroSDR-funded PhD, Narges Takhtkeshha on her work on multispectral LiDAR and a presentation from PhD award winner Dr Kristina Wolf.

Executive Management Team Meetings

In preparation for the two BoD meetings and directing the annual plan for EuroSDR, the Executive Management Team held two in-person planning sessions. The first one took place in Leuven (Belgium) 4 – 5 March 2024 in parallel with the EduSERV pre-course seminar where we meet the course presenters, the attendees and we were also joined by the EduServ scholarship recipients. The second EMT took place in Maynooth (Ireland) from 17 - 18 June 2024.

Appointments and Changes

Members

In 2024 we welcomed a new Member country at the BoD in Zwolle, with Romania joining the EuroSDR community. Iuliana Parvu (National Centre for Cartography) and Dragoş Badea (Technical University of Civil Engineering) were appointed as the Prime and Second Delegates and we enjoyed a presentation of the many interesting research topics that they are focussed on. hetWaterschapshuis resigned its Associate Member status in 2024, and instead Jeroen Leusink is now the 2nd delegate for the Netherlands.

Delegates

In 2024 the following appointments were approved:

We said goodbye to Juha Hyypä as Prime Delegate for Finland and Antero Kukko was appointed as his replacement (both from FGI/NLS). Paul Kane gave a (remote) farewell presentation at Zwolle and was replaced as Prime Delegate for Ireland by Guillermo Castro Camba (also Tailte Éireann). We welcomed Saša Cvitković (State Geodetic Administration) as Prime Delegate for Croatia and we said goodbye to Dalibor Radovan who was replaced by Mihaela Triglav Čekada (Geodetic Institute of Slovenia) as the Prime Delegate for Slovenia.

Ivar Oveland (Norwegian Mapping Authority) was appointed as the Chair of Commission 2, replacing Norbert Haala who stepped down as chair (after three terms in this role). Norbert will now represent Germany in his role as Academic delegate. We also made an invitation for any potential interested delegates to contact Martijn Risdijk as the potential Successor for Commission 3. André Streilen (Swisstopo) was appointed as the incoming President, and will take over in this role from Wolfgang Gold (BEV) after BoD 146 in May 2025.

Partnerships

EuroSDR continued collaborating with its key partner associations in 2024: including the Association of Geographic Information Laboratories for Europe (AGILE), EuroGeographics, International Society for Photogrammetry and Remote Sensing (ISPRS), International Cartographic Association, FIG, ISO TC/211 and UN-GGIM Europe. Joep Cromptvoets attended the EuroGeographics AGM in Summer 2024 as the outgoing EuroSDR Secretary General and Frédéric Cantat (Chair: Commission 4) co-hosted a workshop on VGI with AGILE in June 2024. Our President, Wolfgang Gold presented at the ICA congress *EuroCarto* in September 2024, and Joep and Frédéric co-organised a workshop on “Workshop on Sustainable Business Models for NMCAs” with EuroGeographics in February 2024. Together with Anka Liseć they also collaborated with UN GGIM on a EuroSDR publication entitled ‘Advancing FELA II’. Knut Jetlund was appointed at BoD 144 as the EuroSDR standards liaison with ISO/TC211 and Krzysztof Bakula received approval at BoD 145 that we re-activate the EuroCOW workshop on ‘calibration and orientation remote sensing’ in partnership with ISPRS.

Administrative and Logistics

Accounts

In 2024 Delegates also approved the first increase in membership fees since 2005, with an increase of 10% in the annual membership fee. This increase allows EuroSDR to continue to maintain the same high level of outputs (such as projects, workshops and EduSERV) while managing the costs of running the organisation and considering inflation over the past 20 years. The accounts and auditor reports for 2023 were also approved by the delegates at BoD 144, Zwolle.

Social Media and Engagement

We began to explore new social media options in 2024, including establishing a EuroSDR LinkedIn page – and this continues to attract new followers. Please feel free to use this and ‘tag’ EuroSDR related content and events to help us showcase and share the hard work of our delegates. The exploratory work for the new website also began in 2024, compiling list of the most useful parts of the current website.

Office of Publications

The secretariat continue to support the great work of Christine Ressler (BEV) in the OOP in 2024, and a number of changes were kicked-off on in 2024 that will help better disseminate EuroSDR outputs, including work on metadata of publications, and methods for indexing and cataloguing these publications such as DOI, eISSN and SCOPUS listings.

Logistics

Regarding the associated logistics, the secretariat was 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 in 2024.

Finally a thank you from us both in the Secretariat for the hard work of all the Commission chairs and delegates over the last 12 months, our first full-year in this role. Your timely responses to emails and on administrative matters makes our jobs much easier.

Conor and Neasa.

February 2025.

Report of Commission I – Data Acquisition

Eija Honkavaara

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.



Introduction

The year 2024 was my first full year as the commission chair. My primary objective was to identify challenges and key questions related to NMCA data collection. To support this objective, three questionnaires were conducted among the NMCAs. Another key focus was enhancing collaboration among NMCA experts involved in data acquisition, which led to the establishment of a Special Interest Group in Commission 1. The third major activity was the EuroSDR PhD “Multispectral Lidar and 3D imaging”. Further details are provided below.

EuroSDR questionnaires

Three questionnaires were conducted during the summer of 2024 among the EuroSDR members.

Questionnaire 1: Current state of point cloud datasets in Europe

Questionnaire 1 was prepared by Daan van der Heide (Rijkswaterstaat, TU Delft), Jantien Stoter (TU Delft), and Jeroen Leusink (het Waterschapshuis). Its objective was to assess the current state of point cloud datasets in Europe and explore the potential for national-level point cloud data integration. A total of 14 NMCAs responded to the questionnaire, and openly available information was also incorporated into the analysis. The results are still being analyzed.

Questionnaire 2: European NMCAs urban point cloud classification schemes based on airborne laser scanning

Report by Narges Takhtkeshha, EuroSDR Funded PhD student

The second questionnaire was prepared by the EuroSDR funded PhD student Narges Takhtkeshha. Its objective was to get an overview of the classification schemes used for the national LiDAR point cloud products in the NMCAs represented in EuroSDR and possible requests for extended classes.

By simultaneously capturing 3D spatial and spectral information, multispectral LiDAR (MSL) has enabled fine-grained and single data source 3D mapping (Takhtkeshha et al, 2024). To determine the classes for MSL-based 3D land cover classification in alignment with the European NMCAs schemes, a survey was conducted with the support of EuroSDR. The survey focused on urban point cloud classification schemes based on airborne laser scanning. A total of 16 responses were received from NMCAs across 14 European countries (Figure 1), and the results are detailed in Figure 2.

In total, 35 urban classes were identified. Of these, 15 are currently used in national point cloud classification schemes, including ground, water, building, wall, low vegetation, medium vegetation, high vegetation, bridge, high/low voltage cable, low/high noise, sports area, ship, snow, other, and jetty. Additionally, 16 classes are planned for future implementation, such as roof, chimney, facade, fence, car, truck, pole, tower, road, soil, rocky area, asphalt, road marking, cable, traffic sign, and solar panel. Lastly, four classes—container, windmills, hay bales, and window—were noted as "wish classes" that were not included in the original questionnaire options.

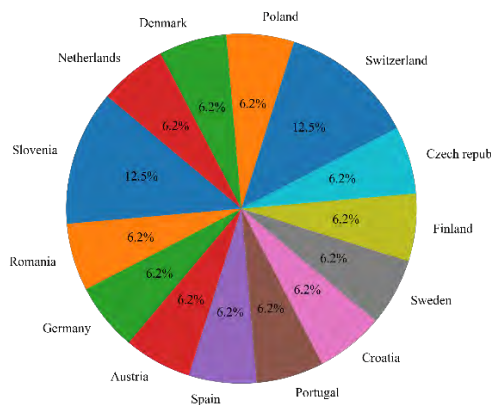


Figure 1. Contribution percentages of European NMCAs.

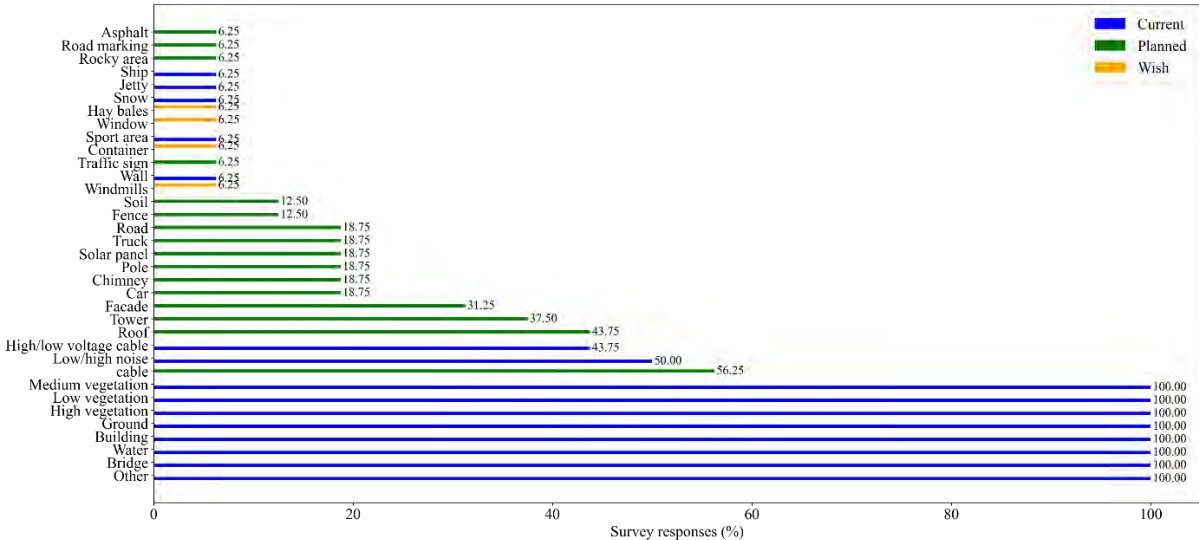


Figure 2. European NMCAs schemes based on airborne laser scanning.

Takhtkeshha, N., Mandlbürger, G., Remondino, F., & Hyyppä, J. (2024). Multispectral light detection and ranging technology and applications: A review. *Sensors*, 24(5), 1669. <https://doi.org/10.3390/s24051669> .

Questionnaire 3 "EuroSDR Questionnaire on Research Needs of NMAs in Data Acquisition"

This survey aimed to identify the key research and development (R&D) challenges related to data acquisition currently faced by NMCAs. The insights gathered will enable EuroSDR to better coordinate relevant activities, including research projects, workshops, and EduServ courses. The questionnaire covered six main themes: aerial imaging, aerial laser scanning, UAV-based data collection, terrestrial mobile mapping, satellite data acquisition, and hyperspectral imaging. For each theme area, six questions were designed. A total of 14 NMAs participated in the survey. The number of agencies identifying research needs in each category was as follows: aerial imaging (13), aerial laser scanning (11), UAVs (5), terrestrial mobile mapping (2), satellite data acquisition (6), and hyperspectral imaging (3).

Based on the responses, one of the frequently identified topics was concerns regarding the performance of novel airborne cameras, particularly the impact of the Bayer pattern on image quality. An emerging issue in the eastern areas of Europe is the challenge of GNSS positioning disruptions caused by intentional interference, which has serious impacts on data collection. Other priority topics included standardized data quality testing methods, AI-based processing techniques for the entire workflow, and the need to minimize both flight and processing times to enhance efficiency. A significant interest was placed on developing industry standards to support the acquisition and tendering of aerial imagery and LiDAR datasets. One proposed solution was a centralized website listing nationwide data acquisition projects along with links to tender documents. Additionally, research questions were raised regarding large-scale UAV surveys and the fusion of various data sources in the data analysis,

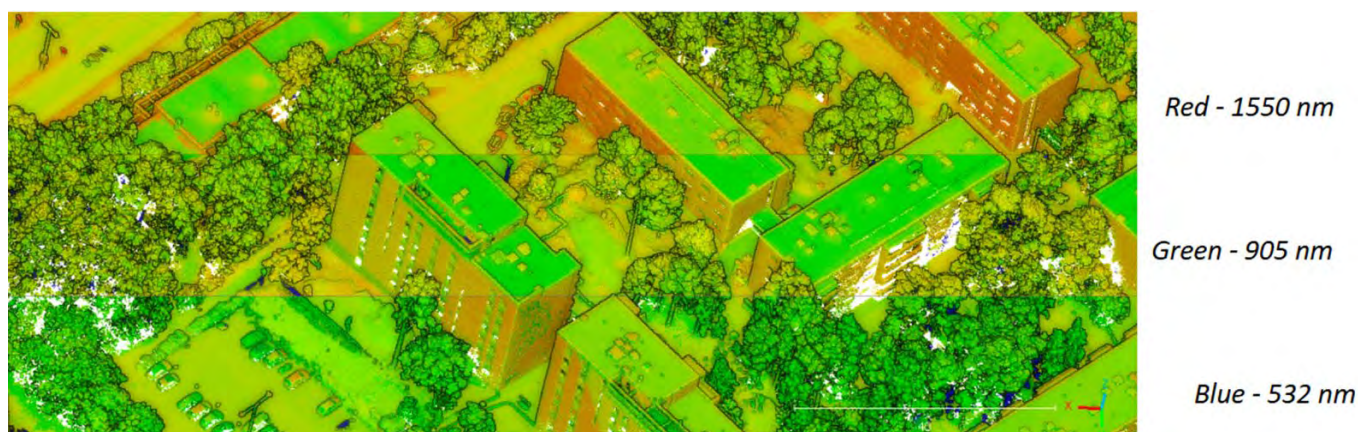
including airborne and satellite data. The Commission 1 research program is currently being developed based on these identified topics.

Special Interest Group in Data Acquisition

A Special Interest Group (COM1-SIG) in Data Acquisition was established to foster active participation from NMCAs in Commission 1's activities and improve information sharing and collaboration. The group's official kickoff has been planned as an in-person workshop in Amersfoort, NL, on January 29-30, 2025. Following the kickoff, the COM1-SIG will continue its work through regular virtual meetings focused on specific topics and will organize additional workshops to further engage participants. Additionally, the COM1-SIG will analyze the questionnaire results and may propose workshops, joint activities, and research projects to address shared challenges. The organizing team has been Jeroen Leusink, Jo Van Valckenborgh, and Eija Honkavaara.

PhD on "Multispectral lidar and 3D imaging"

As approved at the 140th BoD in Dublin in May 2022, EuroSDR is funding a PhD project entitled Multispectral LiDAR and 3D imaging. PhD candidate Narges Takhtkeshha from Iran officially started her studies in March 2023 with supervision from FBK Trento, TU Wien and the Finnish Geospatial Research Institute. The following is a summary report of the activities in the project prepared by Narges Takhtkeshha.



Introduction: Multispectral LiDAR (MSL) is a breakthrough in laser scanning technology that enriches 3D data by spectral information of different laser wavelengths. Unlike recently adopted data fusion approaches, MSL eliminates data fusion challenges and enables fine-grained 3D mapping across various applications, including ecology and forestry, land cover mapping, change detection, bathymetry, and archaeology. This PhD thesis investigates the potential of MSL data for national mapping and cadastral agencies (NMCAs). The impact of incorporating radiometric information has been examined through extensive ablation studies, evaluating the effects of using geometric data alone and integrating spectral information from a single channel, two channels, and beyond. So far, the advantages of MSL systems for forestry and urban mapping have been assessed. The results strongly indicate that MSL data holds significant potential for enhancing tree species classification, forest component segmentation, material detection, and detailed land cover mapping.

Datasets: To date, three airborne MSL systems have been examined: the Optech Titan (Teledyne Optech, Vaughan, ON, Canada—the first commercial MSL), HeliALS-TW (an in-house MSL system developed by the Finnish Geospatial Research Institute), and the VQ-1560i-DW (RIEGL). Among these, both Optech Titan and HeliALS-TW operate at three wavelengths (1550 nm, 1064 nm, and 532 nm for the Titan; 1550 nm, 905 nm, and 532 nm for the HeliALS-TW), whereas the VQ-1560i-DW functions at 532 nm and 1064 nm. Notably, HeliALS-TW delivers exceptionally high-resolution MSL data, with an average point density of 1,377.37 points/m². Optech Titan and HeliALS-TW cover Espoonlahti, Finland, while the VQ-1560i-DW covers Loosdorf-Melk-Hiesberg, Lower Austria.

Proposed Methodology

A) Forest management Multispectral lidar (MSL) forestry point clouds were generated by merging three spectral channels using the preMergeChannelsPointclouds module developed in OPALS software (TU Wien). Various deep learning and machine learning models, including PointNet++, DGCNN, EdgeCNN, MPNN, PointCNN, KPConv, OctFormer, and Random Forest, were employed for tree species classification. Among these, PointNet++ achieved the highest accuracy. The experiments demonstrate that MSL data has significant potential for improving tree species mapping. Additionally, the results highlight improvements even when utilizing radiometric information from a single wavelength.

Besides, to support precise and automated forest inventory, forest components—including ground, low vegetation, trunks, branches, foliage, and woody debris—were segmented using various semantic segmentation AI algorithms, such as Superpoint Transformer (SPT), Point Transformer V3 (PTv3), KPConv, KPConvX, and Random Forest. The results revealed the improvement of forest semantic segmentation using MSL data by 8.7% in mAcc and 5.18% in mIoU.

B) Land cover mapping To specify the urban classes of interest to NMCAs, a questionnaire was conducted with the support of EuroSDR delegates. In total, 35 urban classes were reported, of which 15 are currently implemented in national point cloud classification schemes, 16 are planned for future use, and four were noted as "wish classes" that were not originally included in the questionnaire options.

Additionally, training and evaluation data for AI-based classification were manually generated for the VQ-1560i-DW dataset. According to the case study, 20 urban classes were considered, 14 of which are based on the EuroSDR survey. The remaining classes were introduced to explore the potential of MSL data for material detection, including three roof materials, a distinction between paved and dirt roads, and a separate class for gravel surfaces. To eliminate the need for in situ reflectivity measurements—required for absolute radiometric calibration—Sentinel-2 data was used to obtain reference reflectivity values. Radiometric calibration was then performed using the RadioCal module in OPALS software. The KPConv deep learning model was employed for 3D point cloud classification.

Main Achievements: The following are the key achievements of this PhD thesis to date:

Publications:

Takhtkeshha, N., Remondino, F., Mandlbürger, G., Hyypä, J., Kukko, A. LiDAR forestry beyond geometry: forest semantic segmentation using multispectral LiDAR and 3D deep learning, in preparation.

Takhtkeshha, N., Remondino, F., Hyypä, J., Mandlbürger, G. Single data source and fine-grained 3D urban mapping- A deep learning-based multispectral LiDAR approach based on mapping agencies scheme, in preparation.

Takhtkeshha, N., Bayrak, O.C., Mandlbürger, G., Remondino, F., Kukko, A. and Hyypä, J., 2024. Automatic annotation of 3D multispectral LiDAR data for land cover classification. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, XLIII-B2-2024, IEEE International Geoscience and Remote Sensing Symposium, Athens, Greece.

Takhtkeshha, N., Mandlbürger, G., Remondino, F., Hyypä, J., 2024. Multispectral Light Detection and Ranging Technology and Applications: A Review. *Sensors* 2024, 24, 1669. <https://doi.org/10.3390/s24051669>.

Award:

First place in IEEE GRSS Geopitch 2024; innovating for a sustainable future with geoscience and remote sensing; presented idea: multispectral LiDAR processing to support precision forestry

Conclusions: By simultaneously collecting 3D spatial-spectral information, multispectral LiDAR technology has unlocked new possibilities for fine-grained 3D land cover mapping and precise forestry. Experimental results demonstrate that even the spectral values from conventional monochromatic LiDAR systems can bring advantages, encouraging the usage of laser radiometric information. This spectral advantage becomes particularly significant when differentiating objects with similar geometric characteristics (e.g., mapping tree species, identifying roofing materials, and monitoring asphalt and road conditions). Furthermore, the benefits of multispectral LiDAR become increasingly evident as the diversity of classified objects expands. Consequently, MSL data enhances the accuracy and automation of forest inventories and infrastructure monitoring using a single data source.

Future Plans: Based on the conducted literature review as well as the received suggestions from EuroSDR delegates, the future research directions are as follows:

- Exploring radiometric calibration methodologies and developing a system-agnostic solution for MSL data.
- Comparing various MSL systems, including Optech Titan, HeliALS, VQ-1560i-DW, and SAKURA5.
- Processing time-series MSL data (subject to data availability) and evaluating its advantages for change detection.
- Investigating potential applications of the newly acquired MSL dataset from Japan (SAKURA5, 532 nm, 1064 nm, 1550 nm).

Report of Commission II – Processing, Modelling & Integration

Ivar Oveland

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.



Revision of Commission 2

The appointment of a new Chairman and new Vice Presidents has prompted a revision of Commission 2's work description. At the 145th Board of Directors (BOD) meeting in Copenhagen, a breakout session was held to gather input from delegates on this subject. The outcome of these discussions has been reflected in the research plan for 2025.

Recent developments

Artificial Intelligence (AI) is increasingly becoming a key element across all commissions, and Commission 2 is no exception. AI is revolutionizing how information is extracted from various data sources, including imagery, point clouds, and radar, collected from diverse platforms such as satellites, aircraft, cars, and terrestrial systems.

AI methods, from the computer vision field, are rapidly advancing, and large language models has proofed as a valuable tool. Combining these two fields offers new opportunities for innovative approaches to geospatial data analysis.

A research topic which needs special attention in the further is how to utilize and take advantages of the additional information harvest from an AI based data extraction. Uncorrelated observations from multiple data sources gives the opportunity to estimate reliability in hence of accuracy and completeness. This, in turn, serves as the foundation for change detection and updating map objects including 3D models.

To update map objects and merge independent observations it is essential to ensure that all data are aligned within a reference frame that meets the required user accuracy demands. This alignment is particularly challenging when dealing with satellite imagery, as many products are delivered in a reference frame that is not supported by any transformation libraries. Similar challenges can arise if active choices are not made in relation to accurate reference frames. Typical examples are data formats such as Leaflet and hierarchical geospatial index systems like H3.

Workshops

JOINT EUREF AND EUROSDR WORKSHOP - How To Increase Use of Spatial Data & Sharing Data Across Borders - Relating to Reference Frames. «Georeferencing in the digital Era». 22 - 23 October 2024
The Fram Centre, Tromsø, Norway

The workshop has identified key problems relating to georeferencing geospatial observations and data. Important metadata regarding time and reference frame are often lost on the journey from the data collector via national database to the end user. This makes it very difficult for the end user and increases the risk of mistakes. The workshop concluded that the way forward is to collaborate on all levels, nationally, regionally and globally to find solutions. This must be a collaboration between data collectors, National mapping and Cadastre Agencies (NMCA), standardization organisation, software developers and end users.

The workshop was arranged in Tromsø, Norway 22-23 October 2024. In total 34 person from 10 different countries participated in the workshop. All in all, 14 different presentations divided into 4 different sessions where given:

- Background
- Today's situation
- Users' perspective
- solutions for the future.

All sessions included a breakout discussion. In the following a shot description of the presentations and results from the breakout sessions will follow. All findings are documented in a detailed report.

2 workshops for 2025 have been approved funding by the BOD meeting:

- 4th EuroSDR Workshop on Point Cloud Processing
- EuroSDR Workshop State-of-the-art 3D Mapping at national and regional mapping agencies

Report of Commission III – Information Usage and Visualisation

Martijn Rijdsdijk

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.



2024 was again a full year for the committee in terms of workshops, webinars, activities and projects. Below is an overview of everything that was held in chronological order:

Activities

Project Linking Data in Europe

The Linked Data project progressed. The plan this year was to concentrate on scientific and pre-standardisation matters related to how to propose a core knowledge graph structure. For example the knowledge graph could be used to register and manage users feedback related to the linked data products which is a nice success. Different use cases of a EuroSDR KG about geo digital assets in Europe are analysed and research, like the way of support the citation of products and of their different documentation by data experts; the support of publication of links between products by data experts and the publication and aggregation

Digital Twins paper, 3D GeoInfo; report May 2024

The digital twin paper is a result of the research of de digital businessmodel in NMCA's and the workshop Digital Twin and NMCA's (2022). It identifying several components like the exploit existing data, metadata and standards expertise. The development of multi-scale and temporal data expertise; and the development of new tools and approaches.

Workshops

[Workshop on Geodata Discoverability](#); co-organised with Eurogeographics KEN INSPIRE; 2nd edition after first successful edition in 2022; Paris, January 16th-17th;

In fact this was a co-organised with Eurogeographics KEN INSPIRE. There were 39 registered participants from 23 countries Data providers and portals developers. Some key trends/messages were presented like the importance of semantics (detailed, explicit, machine and human readable), products thinking and the cooperation of between metadata services and discovery portals.

[Workshop Geometadata and Usage](#), Amersfoort, Friday February 7th

The context is the EuroSDR/ Eurogeographics workshops on geodata discoverability, EuroSDR Linked (meta)data project in 2022. This was the follow up. The objective went on gaining and sharing insights on making the most of existing technologies to better engineer and use geo-metadata as well as engaging with academics working on that topic. During the programme there was focused on tools and platform dedicated to producing and using metadata.

[Workshop on historical and time stamped data for SDGs](#), physical venue, Zagreb, Croatia, April 23-24;

This workshop gave a brief overview of EuroSDR activities on historical and time stamped data. Historical and time stamped data for SDGs: requirement analysis from the UN-GGIM: Europe WG on core data. Lot of presentations and discussions with a very several programme. The participants strongly supported the organization of future workshops related to the topic of historical and time-referenced spatial data and expressed the need to continue the activities. It remains an open question when it would be optimal

to organize the next workshop on this topic, whether to do it in a year or two. Considering the available resources, it would be optimal to coordinate and implement activities in cooperation with other organizations such as Eurogeographics and UN-GGIM.

[Workshop Using AI in the core processes of Kadaster](#), Amsterdam NL, November 13-15;

The context of this workshop was that AI, Deep and Machine Learning is not only experimental anymore. After lots of use cases more focus for applications in core processes eg. deed registration, quality validation of aerial images, mapping, surveying (like predictions capacity, work eg.); lots of NMCA's (in coop with universities) already experimenting and working on it. So more sharing knowledge will support innovations and development at this point definitely. During the workshop common core processes are presented; also discuss what should be the most effective AI-elements which could be effective and why. The workshop was quite successful; several ideas for a follow-up workshop were formulated (See ideas and projects for 2025).

Ideas and projects for 2025:

- Workshop on Geodata Discoverability, on-line, January 16th 2024, 13:30 to January 17th 2024, 12h30; Co-organised with Eurogeographics KEN INSPIRE; 2nd edition after first successful edition in 2022;
- Workshop on the development of (GEO) chatbots; as all participating NMCAs expect to be developing these tools in the next 3 to 4 years. By cooperating on the development of these tools together, existing knowledge and expertise can be better put in place to the benefit of all.
- Workshop on the development and implementation of AI governance; will be beneficial to all NMCAs. A proper AI governance structure still needs to take shape and it is a common challenge.
- Workshop about the importance of data quality. Many NMCAs struggle to enhance and ensure their data quality, especially in relation to the development of their AI-models aiming to extract or detect certain features.

During next months these workshops will be further worked out to a potential proposal.

Report of Commission IV – Business Models and Operation

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

[Workshop Report on Data Ecosystems and Spatial Data Infrastructure \(SDI\)](#), facilitators for data value creation
A workshop on Data Ecosystem and Spatial Data Infrastructure (SDI), facilitators for data value creation stood on December 12th and 13th 2023 in Copenhagen (Denmark), hosted by Danish Agency for Climate Data Supply (KDS, ex. SDFI). This operation was reported in EuroSDR Annual Report 2023¹. The Official Workshop Report reporting the findings was published on EuroSDR website in 2024² on October 1st. The publication took time because we have some internal discussion (authors vs contributors). A new EuroSDR principle was settled on this occasion: "Agreed that policy from now will be that for any EuroSDR workshop, one named EuroSDR member must be agreed prior as an author if they are collaborating/contributing."

Workshop on Sustainable Business Models for NMCAs

Context

National Mapping and Cadastral Agencies (NMCAs) have an important role, providing geospatial data that are the backbone of social, economic and environmental services of the countries and territories they serve. All geospatial agencies are facing increasing challenges: limited resources, financial constraints, rapid technological advancements and legislative/national obligations, and competition from challengers from alternative providers of tools and services.

EuroSDR and EuroGeographics invited NMCAs, researchers and policy makers to present, discuss and share their experiences during a workshop on 8th and 9th February 2024. The aim was to provide an inventory of which Business Models NMCAs have implemented, are implementing or will plan to implement to adapt themselves to complete their assignments. This workshop was hosted by KU Leuven and was a follow-up of a Commission 4 project (see EuroSDR Annual Report 2022³).

Presentations and publication

Twenty renowned experts from EuroGeographics and EuroSDR attended the workshop in Leuven. They presented and discussed their case studies, issues and challenges. The agenda and all the presentations displayed during the workshop are available on EuroSDR website⁴ as well as the Official Workshop Report⁵.

¹ <https://www.eurosd.net/publications/annual-report-2023>

² <http://www.eurosd.net/publications/workshop-report-data-ecosystems-and-spatial-data-infrastructure-facilitators-data-value>

³ <http://www.eurosd.net/publications/annual-report-2022>

⁴ <https://www.eurosd.net/workshops/workshop-sustainable-business-models-nmcas>

⁵ <https://www.eurosd.net/publications/workshop-report-sustainable-business-models-national-mapping-and-cadastral-agencies>



Workshop Sustainable Business Models for NMCAs' attendees (February 8th 2024)

Main takeaways

"HVD regulations is finally more challenging than expected 2 years ago" and "I have learned that the Open Data directive HVD implement act is not so simple than the European Commission said. There is a real big shift between all NMCAs willing to share their data but they all need money to do so. It definitely has a cost!" are the two most quoted participants' takeaways.

On the positive side, many observations were shared, among them:

- INSPIRE Directive was a good leverage in many cases.
- The Business Models issue is fostering digital transformation and allowing to be more efficient.
- Good practices and issues sharing are very valuable (collective intelligence).

All participants agreed on the very crucial period that comes and on the necessity to take another look at the situation in two years (early 2026) with a repetition of the workshop.

EduSERV 2024 course on Sustainable Business Models for Open Geospatial Data

The EduSERV 2024 course on Sustainable Business Models for Open Geospatial Data (back-to-back session after the EduSERV 2023 course) was given in the context that in the European Open data directive geospatial and earth observation data are labelled as High Value. As National Mapping and Cadastre Agencies (NMCAs) in Europe are key providers of these types of data and as there is no such thing as a free lunch, NMCAs are enforced to provide geospatial for free but at a cost for themselves. The objective of the course (pre-course given on March 4th 2024, and e-learning session from April 8th to 19th 2024) was to identify and analyse relevant business models that provide open data in a sustainable way. It was the intention that course participants build a sustainable open (geospatial/Earth Observation) data business model for their organisation or an imaginary one. The instructors were Joep Crompvoets, KU Leuven, Public Governance Institute (Belgium) and Frédéric Cantat, IGN France. 10 participants were registered (3 from NMCAs and 7 from Academia) and 5 got certifications.

Volunteered Geographical Information (VGI) Project

Context

As reported in the EuroSDR Annual Report 2023, a small team was formed at the beginning of 2023 to set-up an EuroSDR project about Volunteered Geographical Information (VGI), as follow-up of previous actions, aiming to assess the current trends of VGI in NMCAs practices, to see how the field has advanced in this time, fourteen years after the first action led by EuroSDR on VGI. The two main operations led were a survey and a workshop.

Survey

The survey was web based, available online between 30th October and 14th December 2023 and was conceived to obtain information organised in three sections: (1) information about the organisation, (2) its involvement in VGI projects and (3) future trends and engagements.

Among 25 respondents completed the survey, 23 are from NMCAs (100% of EuroSDR members) and 2 from Academia field.

Vision of the future of VGI: the majority of respondents believes that VGI will bring a real shift in “collecting role of data”. The Top 1 Key success factor is the organisation’s culture (“showing the added value to stakeholders to collaborate in up-dating data, open collaboration attitude with other government levels and data producers.”; “Manage to get VGI as an integral part the organisation’s culture”).



EuroSDR survey’s results – types of communities engaged by NMCAs (slide extracted from EuroSDR / AGILE 2024 Conference Workshop)

Workshop Current trends on Volunteered Geographic Information use in NMCAs practices.

Eleven years on from the first AGILE workshop in Leuven (2013) on VGI from the NMCA perspective, Year 2024 was an opportune time to assess where we are now and what has been achieved in the domain of crowdsourcing and VGI. EuroSDR and AGILE invited NMCAs and researchers to present, discuss and share their experiences during a new dedicated workshop on 4th June 2024 in Glasgow (United-Kingdom) during the AGILE 2024 Conference: *Current trends on Volunteered Geographic Information use in NMCAs practices.*

The results of the survey ran a semester served as insight for reflections. Renowned experts or practitioners from NMCAs (Denmark, Finland, France and United-Kingdom gave presentations) and AGILE community shared the lessons learned and good practices, presented current flagship projects or initiatives in this area and discussed in order to bring into focus the current research exploring VGI methods, technologies, and crowdsourcing communities. The agenda and all the presentations displayed during the workshop are available on EuroSDR website⁶. The Official EuroSDR Workshop Report, Including the survey results, will be published in the beginning of 2024.

⁶ <http://www.eurosdrr.net/workshops/eurosdrragile-2024-workshop-current-trends-volunteered-geographic-information-national>



Experiences with VGI from NMCAs (K.Ritz, Denmark, J.Oksanen, Finland, A.Crépin, France and J.Morley, United-Kingdom) during AGILE Conference 2024's workshop

Main takeaways

NMCAs' speakers reported very insightful feedbacks with VGI, with projects seeming to scale-up to a national level for a long-term period (see Panoramax and GeoFA initiatives in France and Denmark for instance).

VGI for NMCAs seems more mature (even if EuroSDR still put it on the technology trigger phase on its 2023 Geospatial Hype Cycle). That's why there is a clear potential for further researches (well targeted) and for a future standalone workshop (S1 2026) which could address the key topic *"Do NMCAs see VGI and Crowdsourcing as part of their future strategies and plans?"*

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

Context

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 a survey in Spring 2022 on the 3 first pathways (Governance, Policy and Legal, Financial - see EuroSDR Official Publication n°74⁷ and figure below). The second one was to lead a survey on the three following ones during spring 2024 (Data, Innovation and Standards).

⁷ <http://www.eurocdr.net/publications/official-publication-no-74-2023>



Nine Pathways of the Framework for Effective Land Administration

Survey Results - UN-GGIM FELA Pathways on Data, Innovation and Standards

32 organisations from 22 European countries participated to the survey (questionnaire during Spring 2024). The key facts are:

- 85% of organisations manage parcel data
- 78% continuously monitor data security
- 45% of innovations are driven by government requests

For UN-GGIM FELA Pathway: Data, "Parcels" is the most prominent theme at 85%, with high percentage themes like "Buildings" and "Addresses" also being essential. In contrast, lower-percentage themes, such as "Land Use" at different levels at 21% are less commonly managed. The "Others" category (24%) includes niche data such as cable and pipelines etc. Most organisations manage data security internally (49%), while 33% use centralised, country-level control. A small number outsource security fully (3%) or partially (9%).

For UN-GGIM FELA Pathway: Innovation, sources of Innovation Process are Government Requests (45%), Innovation Board (36%) and Citizen Requests (30%). The participating organisations saw many opportunities for innovations, particularly in the domain of data acquisition and data collection processes and in the domains related to interoperability, but fewer opportunities are associated with data dissemination and security.

For UN-GGIM FELA Pathway: Standards, answers suggest that ongoing global efforts to enhance data and technology standards are critical for efficient land administration and management. And that there is room for some organisation to improve their coordination practiced to enhance overall standardisation processes in their specific country.

All the results and findings of the survey can be found in EuroSDR Official Publication n°77 Advancing FELA II⁸.

Next steps: survey on the three last pathways and a workshop in June 2025

A survey on the three last UN-GGIM FELA Pathways (Partnerships, Education, Advocacy and awareness) will be run in the beginning of 2025. A workshop on the whole Framework for Effective Land Administration is scheduled on June 16th and 17th 2025 in Paris, hosted by IGN France.

⁸ <http://www.eurosdrr.net/publications/eurosdrr-official-publication-no-77-advancing-fela-ii-2024>

Inventory of main open datasets from EuroSDR's members

Decided during the EuroSDR Board of Delegates meeting in Tallinn (BOD142), an inventory of main open datasets from EuroSDR's member was carried out from September to December 2023. As a first step, the inventory of them was done with the common filter of 'high value datasets' (HVDs) according to the Commission implementing regulation (EU) 2023/138 *laying down a list of specific high-value datasets and the arrangements for their publication and re-use*.

A form was sent to delegates and finally 15 answers (2 more answers received early 2024) were submitted. During the report of activities in Zwolle (BOD144), it was decided to wait for the "very full" entry in force of the EU regulation (Entry in force on June 9th 2024 but, if asked by State Members possible extension of the deadline up to February 2025). This report of activities in Zwolle led to fruitful exchanges with EuroGeographics (EG) during the summer. EG has conducted during the first semester an audit of its members HVD datasets, under its programme of activity for the European Environment Agency (EEA). The work led on behalf of EuroSDR was shared with EG (for cross-checking) and in return the information (spreadsheets from each EG member) was shared in November with EuroSDR Executive Team members.

Geo-ethics project

Initially planned during Year 2024 (see [EuroSDR Annual Report 2023](#)), and due to lack of availability of people committed in it, the project has been postponed and rescheduled in 2025, with a survey during first semester and a workshop during second semester (date and place to be decided).

Report of Commission V – Knowledge Transfer

Anka Lisec

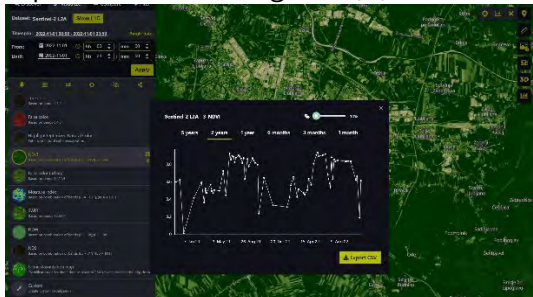
The mission of Commission 5 is to provide educational services to support the transfer of knowledge from EuroSDR research projects to national mapping and cadastral agencies (NMCAs), academia and industry. The Commission also focuses on fulfilling specific NMCAs' demands for knowledge update, collection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



Overview of activities 2024

The main educational tasks were related to the organisation of online courses. Under the umbrella of EduServ (Educational Service) activities, EuroSDR annually offers four two-week e-learning courses in the domains of geoinformation (GI) and geospatial technologies. The educational services have been designed for knowledge transfer from the research to the production domain. Related to educational and knowledge-transfer activities of EuroSDR, the synergy of Commission 5 activities with other EuroSDR 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 as well as to other training and knowledge-transfer activities.

In 2024, the EduServ courses addressed the current challenges and technological advances in (i) Sentinel data analytics for change detection, (ii) sustainable business models for open geospatial data, (iii) AI-based 3D scene capture and modelling, and (iv) laser scanning point cloud processing.



The EduServ22 courses also addressed Sentinel data processing (left) and open data (right) (Sources: Oštir et al., 2024; Crompvoets et al., 2024)

In 2024, Commission 5 was further actively involved in follow-up activities concerning the topic of geospatial data and tools for education and research. In addition, due to the detected lack of human capacities in the geospatial domain, Commission 5 organised a workshop on how to motivate young people to become interested in the geospatial information profession.

EduServ advisory board – new members

The EduServ Advisory Board was established at the 123rd EuroSDR BoD meeting (October 2013). The main objective has been to specify the EduServ concept and content and to guarantee a high level of offered educational services, which include:

- Design of EduServ structure, organisation and their update based on own observations and feedback from participants, tutors and hosts of seminars,
- Suggestions of course topics interesting for NMCA, academia and the GI industry,
- Approval of course topics and content, scholarships
- Promotion of EduServ (contributing to conference papers),
- Collaboration with other organisations (ISPRS, EARSeL) in educational activities.

During BOD 144 (May 2024), the new members of the EduServ advisory board were confirmed as follows: Conor Cahalane (Maynooth University, Ireland), Joep Crompvoets (KU Leuven, Belgium), Anka Lisec (University of Ljubljana, Slovenia), Ivar Maalen-Johansen Norwegian University of Life Sciences, Norway), Audrey Martin (TU Dublin, Ireland), Marketa Potůčková (Charles University, Czech Republic), Jantien Stoter (TU Delft, The Netherlands.)

In 2024, EuroSDR Commission 5 for Knowledge Transfer organised traditional 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 22nd EduServ began with a pre-course seminar hosted by KU Leuven, Public Governance Institute, Leuven, Belgium, from March 4-5, 2024. The four two-week e-learning courses were scheduled from March to June 2024 on the following topics:

- **Remote Sensing and Change Detection with Sentinel Time Series Data** (March 11–22, 2024)

Tutors: Krištof Oštir, Bujar Fetaj, Matej Račič (University of Ljubljana, Slovenia)

Copernicus, the European Union's earth observation programme, is served by a set of dedicated satellites and contributing missions. Since the launch of Sentinel-1A in 2014, the European Union has set in motion a process to place a constellation of almost 20 more satellites in orbit before 2030. The course covered several aspects of processing dense time series data provided by the Sentinel satellites. The focus was on high-resolution radar (Sentinel-1) and optical (Sentinel-2) data, where data access services were also presented - both via classic download via Copernicus Open Access Hub and via Sentinel Hub. The basic processing was done with the open-source programme SNAP and the individual Sentinel Toolboxes. Particular attention was given to time series provision using Jupyter Notebooks and the Sentinel Hub Statistical API with the cases of simple machine learning classification.

- **Sustainable Business Models for Open Geospatial Data** (April 8–19, 2024)

Tutors: Joep Crompvoets (KU Leuven, Belgium), Frédéric Cantat (Institut National de l'Information Géographique et Forestière, IGN, France)

In the EU Open Data directive, geospatial and earth observation data are labelled as High Value. As National Mapping and Cadastre Agencies (NMCAs) in Europe are key providers of these types of data and as there is no such thing as a free lunch, NMCAs are enforced to provide geospatial for free but at a cost for themselves. The course on sustainable business models for open geospatial data was designed to identify and analyse relevant business models that provide open (geospatial) data in a sustainable way. The course participants built a sustainable open (geospatial/earth observation) data business model for their organisation or an imaginary one.

- **From traditional to AI-based 3D scene capture and modelling** (May 6–17, 2024)

Tutors: Michael Weinmann (Delft University of Technology, The Netherlands), Dennis Haitz and Martin Weinmann (Karlsruhe Institute of Technology, Germany)

Deep Learning has led to significant breakthroughs in various fields. The advent of implicit, neural-network-based scene representations marks a significant leap in photogrammetric computer vision and novel view synthesis, as well as respective applications in robotics, urban mapping, autonomous navigation, virtual and augmented reality, etc. Employing neural networks to encode high-resolution scene information was demonstrated to capture precise 3D models while additionally being more compact than scene representations in terms of point clouds or voxel block models. Through a blend of theoretical insights, visual illustrations and practical exercises, this course included core concepts, implementation strategies, and advanced applications of traditional and neural-network-based 3D scene capture and visualisation, as well as strengths, innovation potential and limitations of current approaches.

- **Point cloud processing with laser scanning** (June 3–14, 2024)

Tutors: Juha Hyyppä, Joseph Taher, Matti Lehtomäki (Finnish Geospatial Research Institute, Finland)

The development of point cloud generation optoelectronics has been fast during the last three decades. The first Airborne Laser Scanners (ALS) were built in the early 1990s by Optech Teledyne and Swedish and German militaries, followed by various Mobile Laser Scanners (MLS) in the early 2000s. Autonomous cars today use similar mobile lidar technology for autonomous perception. Previously, Google Tango and, today, iPad Pro include a laser scanner allowing crowdsourced applications. Today, there are also hand-held, backpack and drone systems, including lidars. Terrestrial laser scanning has become a standard tool

for providing 3D data of the surrounding environment in non-built and built environments. This course was dedicated to the challenges of how such point clouds could be processed into informatics. Introduction was given to laser scanning physics and general point cloud processing techniques, and then more focus was given to AI, namely machine-learning and deep-learning approaches in point cloud processing.

A total of 47 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
Remote sensing and change detection with Sentinel time series data	16	9
Sustainable Business Models for Open Geospatial Data	10	5
From traditional to AI-based 3D scene capture and modelling	26	18
Point cloud processing with laser scanning	32	16



The EduServ precourse seminar took place at KU Leuven from March 4-5, 2024.

Aiming to improve the EuroSDR education service, the EduServ participants were asked for their opinion on the EduServ courses they participated. The feedback was very positive. Within the questionnaire, the participants also proposed topics that would be interesting for future EduServ courses – these ideas were presented during the Board of Delegate meeting in November 2024.

EduServ23 announcement

Based on the information gathered by EuroSDR commission chairs, EuroSDR delegates and EduServ participants, the new EduServ courses for 2024 were proposed and announced:

- **From traditional to AI-based 3D scene capture and modelling** (March 17–28, 2025)
Tutors: Michael Weinmann (Delft University of Technology, The Netherlands), Dennis Hartz and Martin Weinmann (Karlsruhe Institute of Technology, Germany)
- **Point cloud processing with laser scanning** (April 7–18, 2025)
Tutors: Juha Hyypä, Joseph Taher, Matti Lehtomäki (Finnish Geospatial Research Institute, Finland)
- **Machine Learning for Earth Observation** (May 5–16, 2025)
Tutors: Hao Cheng, John Ray (JR) Bergado, Claudio Persello (University of Twente, Faculty of Geo-Information Science and Earth Observation – ITC, The Netherlands)
- **Spatial Data Quality** (June 2–13, 2025)
Tutors: Joep Crompvoets (KU Leuven Belgium), Anouk Huisman-van Zijp (Kadaster, The Netherlands), Antonello Rizzo Naudi (Planning Authority, Malta), Anka Lisec (University of Ljubljana, Slovenia)

The 23rd series of e-learning courses from EuroSDR will begin with a pre-course seminar hosted by the National Land Survey of Finland, Finnish Geospatial Research Institute FGI, Espoo, Finland, from March 3-4, 2025.

EuroSDR PhD award

To enhance collaboration between European academia and NMCAs, as well as to engage young scientists in their research endeavours, EuroSDR introduced in 2016 an annual competition for the best PhD thesis in the fields related to geoinformation science. In June 2024, the call for applications for the 2024 EuroSDR PhD Award was announced. We received 10 applications from candidates holding PhDs from universities in Austria, Belgium and Morocco, Croatia, France, Ireland, Italy, Spain, Ukraine and the United Kingdom. The evaluation committee (Krzysztof Bakuła, Conor Cahalane, Joep Crompvoets, Julián Delgado Hernández, Anka Lisec, Jon Mills, Fabio Remondino, Jantien Stoter, and Markéta Potůčková) reviewed the applications, and the winner was announced in September 2024. The EuroSDR PhD winner in 2024 is:

Dr Kristina Wolf, with the doctoral thesis titled *Geospatial data infrastructure for multi-agency incident management*, defended at Newcastle University.

The winner gave a presentation on the key findings of her research during the 145th Board of Delegates meeting. More information is available at <https://www.eurosd.net/news/eurosd-phd-award-winner-2024>.

Workshop on Recruitment and Capacity Development Challenges in the Geospatial Domain

Europe is experiencing serious challenges concerning recruitment and capacity development in the geospatial domain. On the one hand, we see a very high demand for geospatial information experts. On the other hand, we observe that universities and other educational institutions are not being supported at the national level to meet this high demand or support the industry with life-long learning opportunities/capacity development. Moreover, the geospatial sector may seem less attractive to students and less trendy than others. This situation is not only a European-wide phenomenon but is being experienced further afield, for example, in North America and Australia. The main objective of the event, which took place in Ljubljana on November 19, 2024, was to have a better understanding of the current recruitment and capacity development challenges in the geospatial domain at the European level and to discuss potential solutions to tackle these challenges.

The programme, prepared by the programme committee (Anka Lisec, Erna Flogie Dolinar, Bénédicte Bucher, Conor Cahalane, Frédéric Cantat, Joep Crompvoets, Claire Ellul, Audrey Martin, Markéta Potůčková, Jantien Stoter and Mateja Urbančič), included invited lectures from different countries aiming to present recruitment and capacity development challenges in the geospatial domain in a country or at the European level. Altogether over 40 participants joined the hybrid event – 25 of them joined the team in Ljubljana in person. The summary of the presentations and break-out session will be published by the official EuroSDR publication in 2025.



EuroSDR workshop on Recruitment and Capacity Development Challenges in the Geospatial Domain took place at the University of Ljubljana on November 19, 2024.

References:

Crompvoets, J., Cantat, F.: Sustainable Business Models for Open Geospatial Data. EduServ22 training material, 2024.

Oštir, K., Fetai, B., Račič, M.: Remote Sensing and Change Detection with Sentinel Time Series Data. EduServ22 training material, 2024.

Weinmann, M., Haitz, D., Weinmann, M.: From traditional to AI-based 3D scene capture and modelling. EduServ22 training material, 2024.

Hyypä, J., Taher, J., Lehtomäki, M.: Point cloud processing with laser scanning. EduServ22 training material, 2024.

Research by National Mapping and Cadastral Agencies

Enhancing the Photogrammetric Height Accuracy in the Map Projection

After detecting systematic height differences between digital surface models (DSM) based on aerial image matching and ground truth data, BEV initiated an applied research project with TU Wien to clarify this issue.

Initial Situation

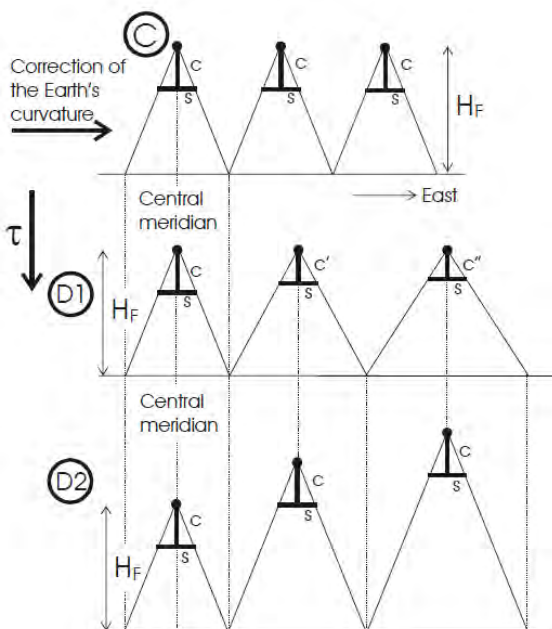
For more than ten years BEV has been deriving DSMs in the Austrian map projection system by image matching from aerial images collected every three years for a nationwide orthophoto data set. Comparing the heights of the DSMs with reference data showed differences exceeding one meter in higher regions of mountainous areas, especially at the border of the meridian strip. To clarify and resolve this issue a research project with TU Wien was set up using a real GNSS-INS assisted flight block (area of 3.000 km², terrain height between 500-2.200 m above sea level, nadir images with GSD 20 cm) and more than 200 GNSS-measured ground control and check points.

Results of Research

Using these data, a typical off-the-shelf photogrammetric software for aerial triangulation (AT) by using common standard workflow and settings leads to height residuals in the map projection >100 cm. However, using the TU Wien in-house AT-software ORIENT showed that in the map projection actually a height accuracy of approx. 15 cm is achievable. For this result, the two main geometric distortions of conformal projections must be considered during the AT, which are earth curvature (EC) and length distortion (LD).

While EC is considered in typical off-the-shelf photogrammetric AT-software, the LD usually is not. The effect of LD is that with increasing distance to the central meridian the scales in the planar and height coordinates diverge.

The consequence is that the image footprints in the map projection increase despite of the same flying height measured by GNSS, as shown in the figure [© C. Ressler: "The Impact of Conformal Map Projections on Direct Georeferencing" in: "International Archives of Photogrammetry and Remote Sensing", Volume XXXIV / 3A (2002)].



There are two workarounds that allow to compensate most of LD's effect if only EC is considered: D1) shrink the focal length for the images with the distance to the central meridian. D2) increase the GNSS-measured heights of the projection centres with the distance to the central meridian (shift-and-drift approach). Since varying focal lengths are inconvenient to deal with, the shift-and-drift approach together with a proper vertical distribution of control points is more practicable to follow. This way a photogrammetric height accuracy in the map projection of 30 cm is achievable even with off-the-shelf

software for the considered data, which is acceptable in practice.

Resumé

It is possible to enhance the photogrammetric height accuracy in map projection systems with standard photogrammetric software significantly, if earth curvature is considered by the AT software and a variable correction of the GNSS-heights for each image is introduced during the AT.

Wolfgang Gold

BEV-Land Cover – An Open High Resolution Land Cover Dataset for Austria

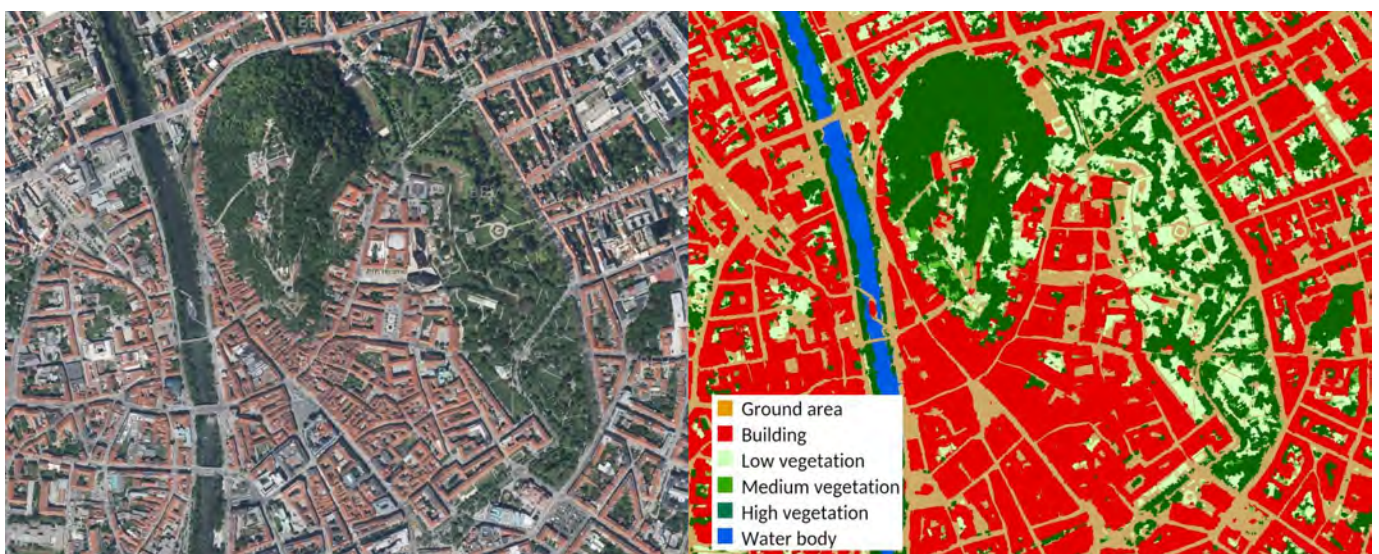
In autumn 2024 the BEV launched a new service allowing access to nationwide Land Cover information containing 6 classes (water body, high vegetation, medium vegetation, low vegetation, building and ground area) which is provided as download or via WMS. The dataset has a GSD of 20 cm and a planned update cycle of 3 years.

BEV-Land Cover – Why ?

The basic idea when developing this dataset was to digitize a core process of the BEV. The way from digital orthophoto data to the digital landscape model should become more accurate and easier. In discussion with some customers we realized that this dataset should not remain a product for internal use but has also great potential to support environment relevant questions such as detection and monitoring of soil usage or contribute to improve the accuracy of calculating greenhouse gas balance.

BEV-Land Cover – How ?

BEV-Land Cover is based on digital aerial images with 20 cm GSD, from which digital orthophotos and a DSM (produced by image matching) are derived. Additionally, an ALS-DTM is used to provide normalized object heights to complete the input data. For the automatic classification process object-based image analysis with the software Trimble eCognition is used. To get an accurate separation of vegetation from other classes an NDVI threshold is determined individually for each block by analysing a few test areas. After the automatic processing gross errors are corrected manually as part of our quality control. An example of the final classification product is shown below (Graz city centre, 2021):



BEV-Land Cover – Resumé

We are aware of the fact that the potential of usage is limited with the current six classes, particular with a ground class not separating sealed areas from natural soil, gravel or scree. But the great asset is the very high spatial resolution which allows a detection of smaller objects - for example trees in built up areas - thus we can reach a more detailed level than with satellite data. BEV-Land Cover is an open BEV product and can be downloaded from data.bev.gv.at or used as WMS in any application.

Wolfgang Gold



My Cadastre: A User-Friendly Digital Environment for Landowners

My Cadastre (minu.kataaster.ee) offers landowners a clear, user-friendly platform for managing land data and operations. The name was chosen to ensure users feel comfortable and understand that the system is built to serve their specific needs. My Cadastre is not just a national information system but a user-centric tool that enables landowners to independently manage spatial operations related to their property and access real-time spatial data during processing. The My Cadastre application was launched for clients in April 2024.

Operating on the point-based cadastre system, My Cadastre is one of the most significant advancements in providing new e-services to landowners, surveyors, and other authorities involved in land management. Previously, stakeholders had to navigate a complex and time-consuming process, gathering necessary documents from multiple agencies and often relying on professional services. Now, most land management operations and easement area registrations can be conducted entirely digitally via the dedicated self-service environment, where each party can directly contribute relevant data.

Key Functionalities of My Cadastre

- Land consolidation planning – Landowners can define boundary changes in the mapping application and submit them for official processing.
- Easement area delimitation – Enables digital creation and registration of restricted property rights for access or land use.
- Survey data management – Surveyors handle cadastral surveys digitally, including interactions, result verification, and boundary modifications.
- Approval management – Required approvals and decisions are submitted digitally, with automated notifications to relevant parties.
- Processing oversight – Cadastre administrators ensure precise control where data is generated.

These services streamline land management operations, making them more efficient and user-friendly, enabling landowners to control their property data without bureaucratic complexity. A core principle of the system is that data should be validated at every stage, providing immediate feedback to users to enhance data quality. Additionally, the system ensures that all applications are processed faster and more seamlessly, automatically directing them to responsible officials and reducing manual workload and bureaucracy.

One of the most revolutionary aspects of the new system is the ability for landowners to independently draft land consolidation plans and submit easement proposals. Traditionally, this has been a complex process requiring professional assistance. However, the new system provides a sufficiently intuitive guided workflow, allowing even non-experts to prepare and submit land management operations.

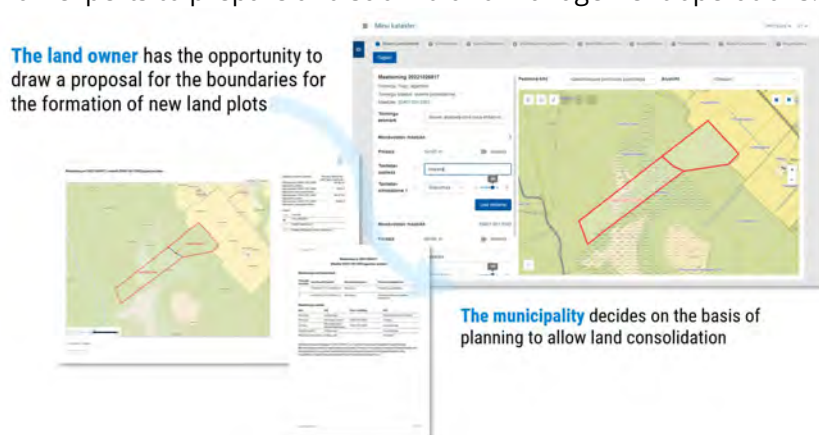


Figure 1 Preparation of a land consolidation border proposal

New e-services grant landowners greater control over their property management while making processes faster and more cost-efficient. Automated data exchange and system-based validation ensure compliance with regulations while reducing errors and disputes. Ultimately, these advancements make the cadastre system more user-friendly and modern, delivering effective and reliable solutions for both individuals and authorities.



Development of the Point-Based Cadastre Information System and Efficient Land Management

The point-based cadastre system accelerates and optimizes land management by utilizing precise spatial data from various registries, limited to the data extent necessary for implementing land procedures changes. This digital approach minimizes field measurements to only necessary boundary points, reducing surveyor workload. It streamlines land management and easement registration, making the process faster, more transparent, and user-friendly, allowing landowners to engage actively. The system was completed in early 2024 and gradually introduced to clients throughout the year.

Historically, The Estonian cadastre system has evolved gradually, but past procedures were slow and collected redundant data. The new approach addresses key issues:

- Boundary discrepancies – Legacy surveys and varying base maps caused misalignments as records relied on coordinate data from paper plans.
- Inefficient processing – Manual application handling and approvals delayed verification, requiring multiple follow-ups.
- Excessive workload – Full boundary surveys were mandated even for minor modifications.

The lack of partial measurement increased costs and processing time. The new system limits surveys to relevant boundary points, sourcing other spatial data from national registries. By automating data exchange and using real-time updates, it streamlines processes, reducing delays and bureaucracy for landowners.

To implement the new point-based cadastre system, amendments were made to the [Land Cadastre Act](#), [Land Consolidation Act](#), and [Land Register Act](#). The legal framework now enables decisions based on digital cadastral data. Administrators can determine boundary coordinates using national spatial data, with surveys limited to affected points. This foundation supports a dynamic, rapidly updated, boundary point-based cadastre system.

With the point-based cadastre, landowners can digitally submit applications for land consolidation and easements, providing only necessary data. The system enables partial boundary measurements, using existing data to avoid full resurveys. Automated validation mechanisms verify spatial data to detect potential inconsistencies and prevent errors from entering the cadastre. Event-based notification systems provide immediate feedback to users, reducing administrative burdens for both landowners and authorities.

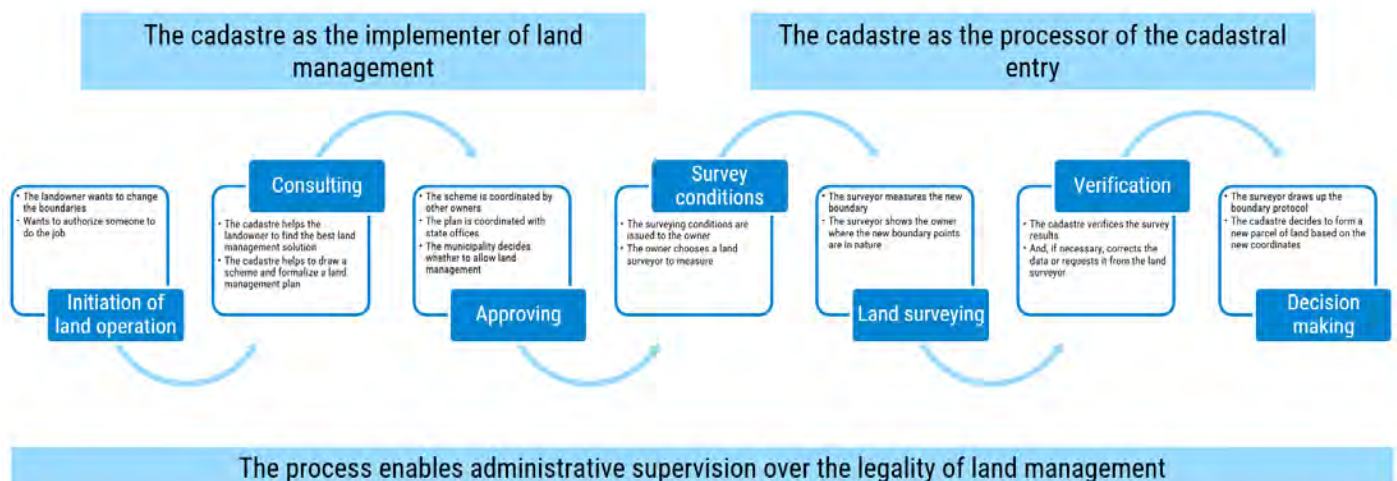


Figure 2 New cadastral registration process

Point-Based Cadastre Architecture

The point-based cadastre system transitioned from a monolithic to a microservices architecture, enabling scalable, independent updates. Adopting open-source solutions reduces costs and enhances future flexibility.

The database structure also underwent significant changes, replacing the previous Oracle database with PostgreSQL integrated with the PostGIS extension. Integration with other geographic information systems is facilitated through Geoserver and OpenLayers. Microservices communicate via REST API services, where each

service has its own database and independent application interface. The user interfaces have been standardized using Estonia's [Veera design system](#), ensuring a consistent user experience across all government systems. Data exchange with other registries occurs through Estonia's X-Road data exchange layer, ensuring legally valid data transactions. Additionally, the entire system architecture is designed to support cloud-based SaaS models. The development of the point-based cadastre information system represents a significant innovation that reduces surveyors' workload, accelerates processing, and allows landowners to actively participate in land management operations. The scalable system can accommodate new applications and modules that further enhance the quality of cadastral data.

FLAIR-INC: a multimodal remote sensing dataset designed for detecting land cover with artificial intelligence (AI) methods on a national scale

report by: Anatol Garioud, Nicolas Gonthier, Eva Bookjans IGN-F / SIMV (department for innovation, maturation and valorisation)

The French Mapping Agency (IGN-F) has invested in deep learning methods and technologies to accelerate the production of high-resolution land cover and land use layers as part of the French land use land cover product OCS-GE (read EuroSDR Annual Report 2023). This includes the creation of an extensive high resolution land cover dataset of annotated aerial images covering the diverse landscapes found in metropolitan France and with varying acquisition dates to reflect the territory's spatial and seasonal heterogeneity. In total over 2800 km² of aerial images were annotated by photo-interpreters which has enabled the IGN-F to train a robust semantic segmentation AI-model applicable on the national scale.

The availability of high-quality datasets is essential for training robust and reliable AI models, which are becoming increasingly relevant in environmental monitoring, land use planning, and resource management applications (e.g., change detection, forestry, hydrology, agriculture). To support continued innovation, the IGN-F has not only made this dataset publicly available but has recently augmented it with multi-modal data. In addition to the high-resolution aerial images (20 cm res.) and the corresponding land cover annotations (CoSIA labels), the multi-modal dataset FLAIR-INC includes SPOT satellite images (1.5 m res.), Sentinel-1 (SAR, 10 m res.) and Sentinel-2 (optical, 10 m res.) times series and historical aerial images from the 1950s. Crop type annotations (LPIS labels) were added to allow for more agricultural specific applications and the exploration of multi-task methodologies.

The dataset FLAIR-INC is available on the Hugging Face page of IGN-F (<https://huggingface.co/IGNF>) together with a set of pre-trained AI land cover segmentation models. The models are designed for classifying land cover on aerial images but can easily be fine-tuned on novel tasks thanks to the multimodal design of FLAIR-INC. FLAIR-INC facilitates the adaptation of the high-resolution AI model to different spatial scales (e.g. lower resolution satellite images), enables the fusion of different data sources to improve predictions (e.g. by leveraging Sentinel times series for vegetation or crop classification), and is suitable for multimodal self-supervised learning (an AI technique, which promises to reduce the need for new annotations while simultaneously improving a model's performance).

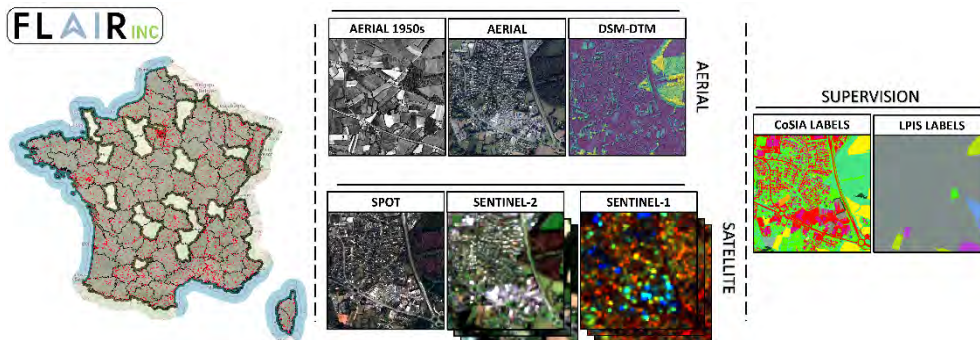


Figure 1. Overview of the FLAIR-INC multimodal remote sensing dataset

left: Red dots indicating the spatial distribution of the dataset
middle: Multimodal remote sensing data, including both aerial and satellite data
right: Landcover (CoSIA) and crop type (LPIS) supervision labels.

By publishing the FLAIR-INC dataset, codes and pre-trained models under open-access terms, the IGN-F is fostering reusability and innovation beyond the institute itself. This initiative has the goal to empower other NMAs and researchers by encouraging them to adapt and refine the tools for their unique contexts and to promote collaboration and the exchange of knowledge and data. This could potentially result in a shared European-scale dataset, which would benefit from an alignment of land cover classes. In summary, the combination of diverse spatial, temporal, and spectral resolutions within the FLAIR-INC dataset addresses complex domain shifts providing AI and geospatial communities with a valuable resource for addressing the current technological, socio-economic and environmental challenges.

Metsäkanta - Forest database

We designed and implemented software infrastructure for producing, storing, distributing, querying and online visualization of large quantities of individual tree data, forming the basis of future forest inventory.

Background

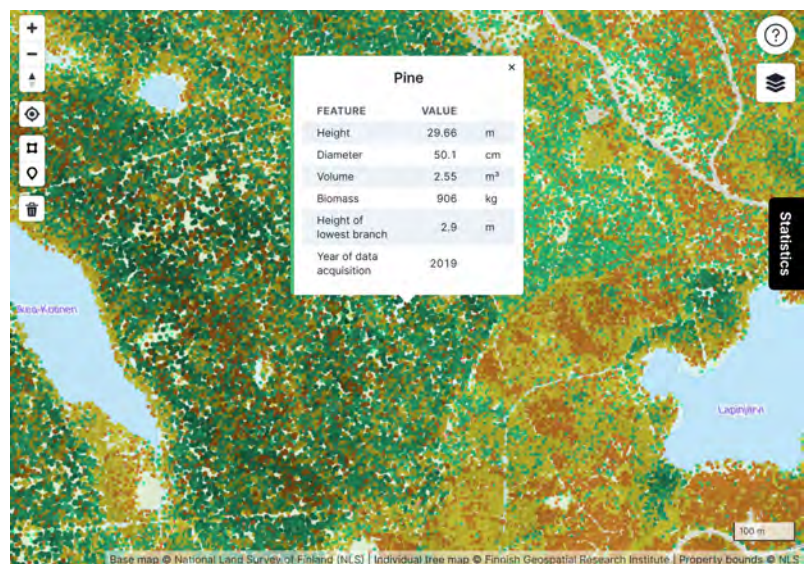
Forests provide a plethora of ecosystem services ranging from climate regulation, water supply and regulation, wild foraging, air purification, erosion control, and biodiversity preservation. They also yield significant economical benefits through the forest industry. Forest inventory forms the basis for decision-making, both in the forest industry and broadly in society. Most current forest inventories utilize area-based data, describing the forest stands as raster or at plot level. This hinders their utility in detailed management and analysis of forests.

Development & features

Utilising the 5p/m² point cloud data from the ongoing Finnish national laser scanning programme, we realized “Metsäkanta” (eng. Forest database), a system for single tree forest inventory data. Tree attributes (height, DBH, stem volume, biomass, economic value and stored carbon) are derived for each detected tree, based on estimation models calibrated with manually measured test sites.

We benchmarked the computation time and scalability of our raster-based segmentation algorithm, obtaining an average computation time of 1 1/2 min for a square kilometer of ALS data using a desktop system. For the larger trees (DBH over 20 cm), the estimated detection rate was over 90%, corresponding to the commercial value of 95% of all trees in the stands. The obtained RMSE and bias are low enough for operational forestry. Currently, we cover 5.8 billion individual trees, approximately 2/3 of Finland’s land area.

PostgreSQL database server was used for storing the individual tree data, accessed over a developed API, providing an endpoint for querying statistical data of the trees. The statistical data includes the stem count, maximum height, average height, maximum DBH, average DBH, and the total stem volume, biomass and basal area. The Forest database system enables users to study the single-tree forest inventory data on an online map. Users can inspect the tree attributes and statistics about the trees can be visualized in a dashboard. The system is currently in test use by close to 50 organisations.



The development of Metsäkanta is described in more detail in: <https://doi.org/10.3390/ijgi13120424>

Future outlook

Based on the work, individual tree inventory is expected to become operational in Finland in 2026 as part of the third national laser scanning programme by the Finnish Forest Centre.

Real-Time GNSS Monitoring Project for Poland (RTGMS)



Since 2008, GUGiK has been maintaining the ASG-EUPOS system, which provides services for precise positioning based on GNSS signals. At the beginning this reference station system was dedicated for geodesy and land surveying purposes but during its existence GNSS receivers became available for wider group of users especially from construction and agriculture segment. Nowadays provision of precise correction data for RTK services are crucial for innovation and automation in growing segments like autonomous driving or high accuracy data acquisition from unmanned aerial vehicles (UAV). When in 2022 services of

ASG-EUPOS system was released free of charge number of users is continuously growing and monthly more than 15 thousand different logins are connecting to ASG-EUPOS services. It is important to provide reliable and high accuracy services but sometimes can occur interferences which decrease the performance of the GNSS receiver and could be source of errors in calculated position. Some of interferences could be natural like ionospheric signal degradation during the present extremely high solar activity period, but some of them has anthropogenic source. Considering the importance of the satellite navigation for economy and national security, the implementation of the nation-wide monitoring and early warning system analysing GNSS interference in Poland seems to be particularly necessary and justified.

In 2024 GUGiK in consortium with Institute of Telecommunication applied to European Space Agency in NAVISP-Element 3 Programme for financing of pilot project to develop system dedicated to monitoring interferences of GNSS bands in real-time manner. Project has been approved by ESA, has started in November 2024 and the end is planned in May 2026.

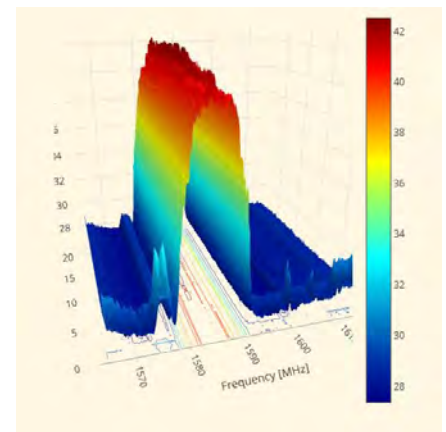
Project description

The RTGMS system, which GUGiK intend to develop will comprise both physical infrastructure spread across the country as well as a user inference in form of an online application. This online service will be publically available, so everybody interested will be able to take advantage of the system's resources and utilize the data it will provide. The key beneficiaries of the system will be the governmental institutions responsible for public security/safety and the entities whose operation depend on high-quality GNSS information.

In the course of the RTGMS project, the current architecture of the ASG-EUPOS stations will be reviewed in order to make decisions if the additional equipment which is necessary to facilitate those new features regarding identification of interference with early-warning and alarming functions. It should be underlined that regardless of the scale of modifications undertaken in this project, the present functionalities of the ASG-EUPOS system (RTK/DGNSS geodetic corrections) will remain intact and will continue to be available for their users. On the software side, the major output of the RTGMS project will be an online application that will present real-time data from each monitoring station to all interested users.

Therefore, at this stage GUGiK intend to develop a pilot installation comprising just several – but fully functional – monitoring stations in the most critical regions (along the eastern border of Poland, around the Kaliningrad Oblast of the Russian Federation and along Polish coastline). In the further perspective, the system may be successively expanded toward other regions of Poland.

Ongoing activities are focused to develop software to utilize existing GNSS high-end equipment already installed on ASG-EUPOS reference stations. The observation data provided from GNSS equipment will be in parallel processed in RTGMS software and in existing software of ASG-EUPOS system. In case of any alert from RTGMS system operators of ASG-EUPOS will be able to perform detailed analyses and decide about further steps to provide reliable and high accuracy services.



Research, developments and experiences which will be learnt during this project will be important for operators of similar reference station networks where interferences can occur.

Cartographic Visualizations of the Topographic Objects Database in 1:100 000 Scale

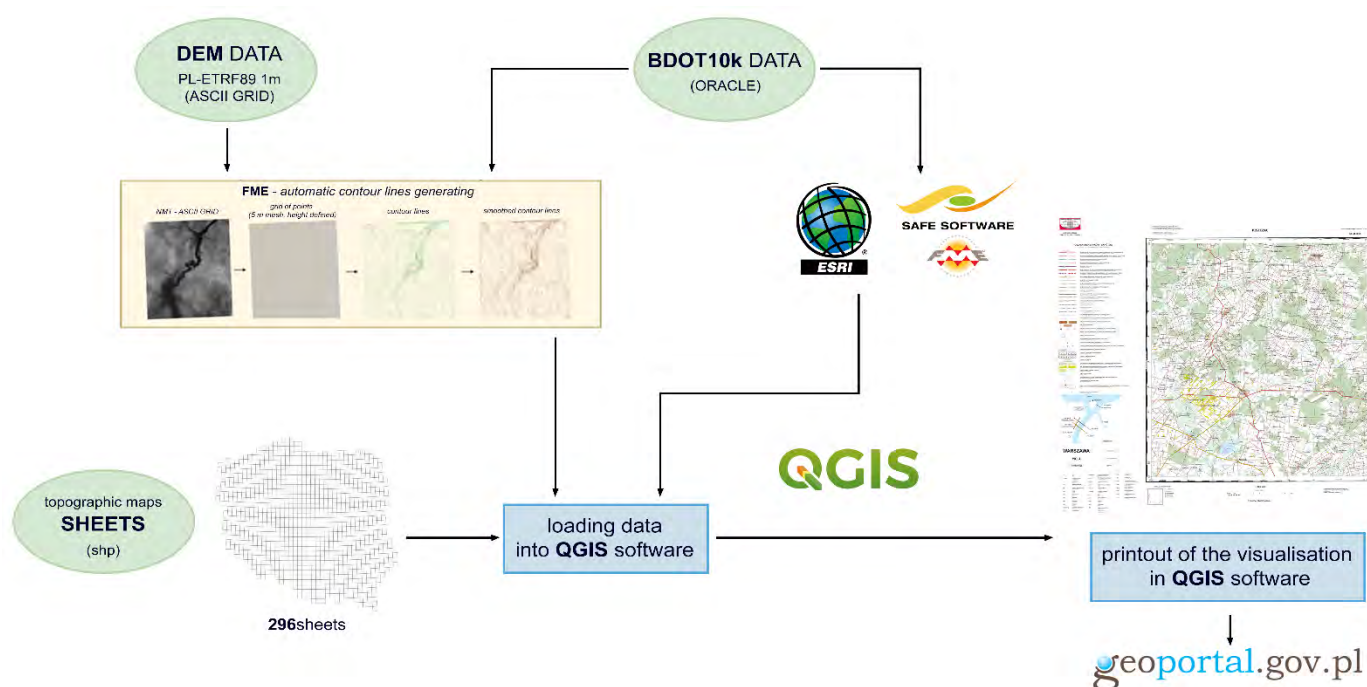
The cartographic visualization of the topographic object database – BDOT10k is an example of implementation of the research and development works in the field of geodesy and cartography carried out by the Head Office of Geodesy and Cartography as commissioned to the Chief Surveyor of the Country by the Geodetic and Cartographic Law.

In 2024 the work was undertaken to develop methods and tools enabling the automatic generation of cartographic visualizations of the BDOT10k topographic objects database at a scale of 1:100,000. It is a part of project aimed at developing tools for automatic generation of topographic maps in different scales, uniform for the whole country.

As part of the work:

- logical components were developed to automate both the generalization of objects from BDOT10k, as well as the generation of cartographic objects, editing of cartographic content, generation of out-of-frame elements, cartographic grid, relief elements, descriptions and map layout;
- processes, source codes, symbol libraries, design files, results of automatic generalization and cartographic editing in the form of PDF and GeoTIFF files, as well as descriptions of the prepared processes along with instructions were provided.

Cartographic processes are implemented in Safe Software's FME software, also using Esri's ArcPy library. The final visualization in PDF and GeoTIFF files is prepared in free QGIS software.



The source data are up-to-date, available in the state geodetic and cartographic resource: Topographic Objects Database BDOT10k, digital terrain model NMT, State Register of Geographic Names PRNG, State Register of Borders PRG.

Generating true-orthophotos for all the cities in Romania

The national project for high resolution image acquisition and true-orthophotos generation in Romania was conducted between 2022-2025. The quality control works have been done by a team with expertise in photogrammetry from the National Center of Cartography. In the table below are displayed some quality metrics of the products (aerial images, digital surface model and true-orthophotos).

	Image resolution (cm)	True-orthophoto resolution (cm)	True-orthophoto accuracy (cm)	DSM resolution (cm)	DSM accuracy (cm)
Bucharest	4/6	6	± 15	10	± 20
Big cities	4	5	± 12	10	± 20
Medium cities	9	10	± 15	12.5	± 25
Small cities	15	12.5	± 20	20	± 30

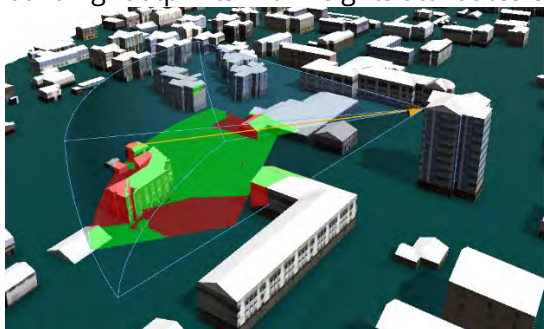
Oblique image dataset of Bucharest

In the spring of 2023, aerial images, with 4-6 cm spatial resolution, were acquired for Bucharest using the oblique camera UltraCam Osprey 4.1. In order to fulfil the needed quality, a LiDAR scan of the area was performed. The 160 TB dataset was processed using the Skyline software and products like, 3D mesh were developed.



3D mesh of Bucharest

A project, at CNC, for this year is **3D building modelling** using the above photogrammetric datasets. To demonstrate the importance of precise geospatial 3D models, we created for a study area the 3D model using building footprints with heights attributes extracted from the normalized digital surface model.



Some important applications, using the 3D building model generated, are:

- Precise measurements of buildings in 3D environment;
- Visibility analysis in different spot points;
- Planning future buildings and green areas, considering the surrounding area;
- Evaluation of energy efficiency of buildings.

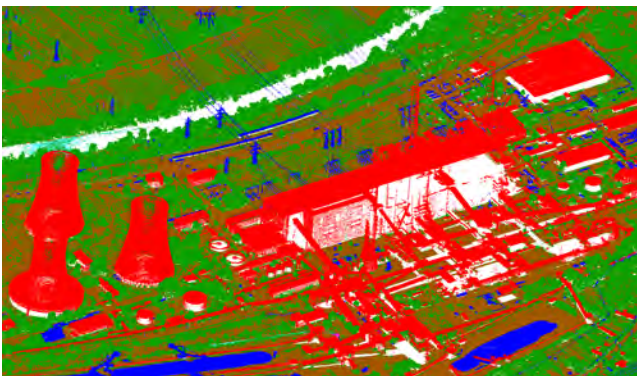
Geographic information for the environment, climate change and EU integration (LAKI III)

The laser scanning project, of the National Agency of Cadaster and Land Registration, for 50.000 sqkm in Romania is conducted since 2023. The quality control works is done by a small team with expertise in LiDAR technique from the National Center of Cartography. The required density of the point cloud is 5points/sqm. The products developed in the project are digital terrain and surface models and contour lines. This project uses Environment, Adaptation to Climate Change and Ecosystems Source of funding: Financial Mechanism of the European Economic Area (EEA) 2014-2021 and it is a continuity of LAKI II. The area of the two projects is displayed below.

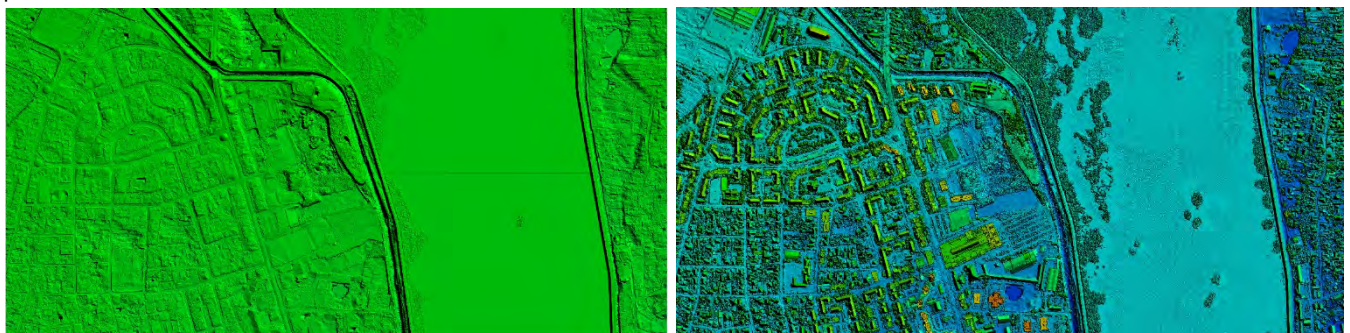


Classified point clouds and digital terrain and surface models

- the point clouds are acquired with the scanner VQ-1460 produced by Riegli;
- the point clouds are classified in 8 classes, as follows: ground, vegetation, buildings, points on water, bridges, low and high noise and never-classified;
- the digital terrain (DTM) and surface (DSM) models have a 50 cm spatial resolution;
- for the DTM generation a hydro-flattening method is conducted;
- the quality assessment is done using points on the ground and profile points situated on building roofs.



Classified point cloud



DTM and DSM



Automatic acquisition of 3D buildings from dense point cloud for the purposes of real estate cadastre and GeoBIM

Geodetic Institute of Slovenia, Ljubljana, Slovenia

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

Igea, d.o.o., Ljubljana, Slovenia

Research project V2-2385, financed by the Slovenian Research and Innovation Agency and the Surveying and Mapping Authority of the Republic of Slovenia (2023-2025)

Project page: <https://gis.si/v2-2385-avtomatski-zajem-3d-stavb/>

The research project focuses on the automatic acquisition of 3D building models from dense point clouds to support mainly the transition of Slovenian cadastre into 3D form. Conducted within the Target Research Program 2023, the project aims to enhance also cadastral data accuracy and efficiency by developing automated methodologies.

The study is structured into four main work packages: the first focuses on defining the conceptual model for automatic 3D building acquisition, the second establishes methodologies for implementation, the third tests the concept and methodology, and the fourth ensures dissemination of findings. Utilizing advanced computational techniques and machine learning, the project seeks to optimize cadastral data acquisition, enhance spatial planning, and improve integration with GeoBIM systems.

The integration of 3D geospatial data allows for a more precise representation of property ownership, urban planning, and land administration. Additionally, the project aligns with ongoing legislative updates, including the national Real Estate Cadastre Act (ZKN) and the Building Act (GZ-1), which mandate digital documentation of key structures. By leveraging periodic aerial and LiDAR scanning under the national Cyclic Laser Scanning of Slovenia (CLSS) initiative, this research aims to establish a robust, automated framework for maintaining and updating 3D cadastral data for buildings.

The operational development proposes two tiers. The first will assure 3D building models for the entire country as an open data register, the second will provide a legal and technical framework for the input of individual official cadastral data for the owners who expect to secure ownership with precise and detailed 3D data where LoD 2.1, 2.2 and 2.3 are the options studied. The relation to topographic model is also an important topic which remains to be solved, where certain tests are in progress.

Keywords: real estate cadastre, buildings, 3D data, topography, lidar.

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