

# Annual Report 2025

# EuroSDR Annual Report 2025

## 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 (2025)

<b>Austria</b>	Wolfgang Gold	Bundesamt für Eich- und Vermessungswesen
<b>Belgium</b>	Eric Bayers	Institut Géographique National Belgique
<b>Croatia</b>	Saša Cvitković	Državna Geodetska Uprava (DGU)
<b>Cyprus</b>	Andreas Hadjiraftis	Ministry of the Interior, Department of Land and Surveys
<b>Denmark</b>	Katarina Ritz	Styrelsen for Dataforsyning og Effektivisering
<b>Estonia</b>	<i>To be confirmed</i>	Maa-amet
<b>Finland</b>	Antero Kukko	Maanmittauslaitos
<b>France</b>	Bénédicte Bucher	Institut National de l'Information Géographique et Forestière
<b>Germany</b>	Michael Hovenbitzer	Bundesamt für Kartographie und Geodäsie
<b>Ireland</b>	Guillermo Castro Camba	Tailte Éireann
<b>Norway</b>	Jon Arne Trollvik	Statens Kartverket
<b>Poland</b>	Anna Bober	Główny Urząd Geodezji i Kartografii
<b>Portugal</b>	Mário Caetano	Direção Geral do Território
<b>Romania</b>	Iuliana Pârvu	Centrul National De Cartografie
<b>Slovenia</b>	Mihaela Triglav Čekada	Geodetski Inštitut Slovenije
<b>Spain</b>	Julián D. Hernández	Instituto Geográfico Nacional
<b>Sweden</b>	Tobias Lindholm	Lantmäteriet
<b>Switzerland</b>	André Streilein	Bundesamt für Landestopographie
<b>The Netherlands</b>	Martijn Rijdsdijk	Kadaster, Data Governance Innovation & Projects
<b>United Kingdom</b>	Andy Gardiner	Ordnance Survey Great Britain

## Our Associate Members and their Representatives (2025)

<b>Digitaal Vlaanderen</b>	Jo Van Valckenborgh
<b>Esri/nFrames</b>	Nick Land & Konrad Wenzel
<b>Het Waterschapshuis</b>	Jeroen Leusink
<b>Hexagon</b>	Simon Musaeus
<b>ICGC</b>	Julià Talaya
<b>IGI</b>	Philipp Grimm
<b>RIEGL</b>	Peter Rieger
<b>PhaseOne</b>	Mohsen Miri
<b>Vexcel</b>	Bernhard Schachinger
<b>1Spatial</b>	Dan Warner

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# Message from the President

*André Streilein*



Dear EuroSDR friends,

It is my pleasure to present this report on behalf of EuroSDR for the year 2025. During the year, EuroSDR continued to fulfil its mission as a European network dedicated to applied research in spatial data, fostering close cooperation between National Mapping and Cadastral Agencies (NMCAs), academic and research institutions and industry. Our work remains firmly focused on supporting operational needs through scientifically sound and practically relevant research.

EuroSDR's activities in 2025 were based on the established commission framework, which continues to provide a stable and effective basis for addressing both long-standing and emerging challenges in the field of geodata. Through this structure, EuroSDR ensures continuity, thematic focus and responsiveness to the changing priorities of its member organisations.

EuroSDR is unique, above all because of the people who make up this organisation. And it is a vibrant organisation that is always able to welcome new people into its community.

At the 146<sup>th</sup> meeting of the EuroSDR Board in May 2025, Wolfgang Gold ended his term as president, and his leadership role in promoting increased collaboration between commissions, workshops and capacity-building activities was recognised. I would like to express my sincere thanks to Wolfgang for his commitment and foresight in guiding EuroSDR through the last two years. It will be difficult to meet the standard he has set in terms of expectations for a president.

We would thank Martijn Rijdsdijk (Kadaster) for all his work as Commission 3 chair and look forward to working with Claire Ellul (University College London) for the term of the new Chair. We also welcome Ivar Oveland (Current Commission 2 Chair, Norwegian Mapping Authority) as the new Prime Delegate for Norway (replacing Jon Arne Trollvik, Norwegian Mapping Authority), Andy Gardiner (Head of Research Technology, Ordnance Survey) as the new Prime Delegate for the UK, Joep Crompvoets (Current EuroSDR co-Vice President, KU Leuven) as the Academic Delegate for Belgium, Knut Jetlund (Norwegian Mapping Authority and Current EuroSDR Liaison with ISO/TC211) as coordinator of the 3D SIG and Markéta Potůčková in her first term as Scientific Editor.

The diverse range of activities across the commissions, workshops, expert meetings, and collaborative research activities provided important platforms for knowledge exchange between researchers and practitioners. These events enabled open discussion of challenges, sharing of best practices, and the development of common understanding across national boundaries.

I would like to express my sincere thanks to the members of the Board of Directors, the commission chairs, workshop organisers, researchers, and all contributing experts for their dedication and commitment throughout the year. Their collective efforts are fundamental to the continued success and relevance of EuroSDR.

Looking ahead, EuroSDR remains well positioned to address future challenges and opportunities in spatial data research. By continuing to foster collaboration, innovation, and scientific excellence, the organisation will further strengthen its contribution to high-quality, authoritative geospatial information services across Europe.

# Message from the Vice Presidents

*Jantien Stoter and Joep Crompvoets*



Dear EuroSDR friends,

2025 was another exciting and productive year for the EuroSDR community, marking our second year serving as vice-presidents. Once again, the organization reaffirmed its leadership and strong presence in the geospatial sector by organizing numerous scientific events and conducting multiple research activities for the benefit of the community.

Our main task during this period was to finalise the **EuroSDR Rolling Research Plan** for the coming years. The content of the plan was discussed extensively during several Executive Committee meetings (Leuven, Maynooth, and Espoo) and at Board of Delegates meetings in Zwolle and Tromsø. The final version was presented and approved at BoD 145 in Tromsø, Norway. It is worth noting that the plan is a “living” document and can be revised at any time as needed.

Two BoD meetings took place, in Tromsø (Norway) and Zagreb (Croatia), with very interesting national days and reports of ongoing activities.

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

- EuroSDR Workshop State-of-the-art 3D Mapping at national and regional mapping agencies, 22 - 23 January 2025 (IGN, Saint Mandé, Paris, France)
- EuroSDR Commission 1 Special Interest Group workshop: Data acquisition, processing and distribution within NMCA, 29 - 30 January 2025 (het Waterschapshuis, Amersfoort, The Netherlands)
- 4th EuroSDR Workshop on Point Cloud Processing, 6 - 7 February 2025 (Stuttgart, Germany)
- Joint EuroSDR/EuroGeographics Workshop: Geometadata Production and Usage, 7 February 2025, (IGN, Saint Mandé, Paris, France)
- Georeferencing in the digital era 2025, Joint EUREF and EuroSDR Workshop, 27 - 28 May 2025 (Gardermoen, Oslo, Norway)
- EuroSDR/EuroGeographics/IGN France Workshop on challenges in relation to the UN Framework for Effective Land Administration (FELA), 16-17 June 2025 (IGN, Saint Mandé, Paris, France)
- EuroSDR/ISPRS/FIG EuroCOW 2025, 16 - 18 June 2025 (Warsaw University of Technology, Poland)
- EuroSDR Workshop on Multispectral LiDAR, 23 June 2025 (Online)
- EuroSDR Forum – Launching The Digital Twin Cookbook Alpha, 22 October 2025 (Online)
- EuroGeographics EuroSDR - 5th International Workshop on Spatial Data Quality, 20 -21 November 2025 (Athens, Greece)
- EuroSDR GeoAI Special Interest Group Kick-off Workshop, 26 – 28 November 2025 (Kadaster, Rotterdam, The Netherlands)
- EuroSDR Workshop Beyond GNSS: Resilient positioning and aerial mapping, 2 December 2025 (Online)

In terms of **projects and research activities**, delegates focused on various topics, such as: Point cloud datasets; Research needs of NMCAs in data acquisition; GNSS; Uncrewed aerial vehicles for NMCAs; Spatial data (sharing) related to reference frames; GeoA; 3D mapping at NMCAs; Digital Twins; Linked data/Knowledge Graph; Geometabase; Open geodata; Volunteered Geographic Information; FELA – Framework for Effective Land Administration; Sustainable Business models; 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**, several workshop reports were published dealing with Historical and Time-Stamped Geodata for Sustainable Development Goals; Challenges in relation to the United Nations (UN) Framework for Effective Land Administration; Georeferencing in the Digital Era; AI in Core Business Processes of NMCAs; and Current Trends on Volunteered Geographic Information (VGI) in NMCAs

On the educational side, the 23rd edition of the **EduServ** course was offered in Spring '25 focusing on four topics:

- AI-based 3D scene capture and modelling
- Laser scanning point cloud processing
- Machine learning in Earth observation
- Spatial data quality.

The **PhD award** were assigned to **Dr. Kyriaki Mouzakidou** (EPFL, Switzerland) with the thesis titled "Concurrent Adjustment of Active and Passive Optical Sensors with GNSS and Raw Inertial Data" and **Dr. Weixiao Gao** (Delft University of Technology) with the thesis titled "Semantic Understanding of Urban Scenes from Textured Meshes". Both winners presented their research at the 147th EuroSDR BoD meeting in Zagreb, Croatia

Finally, the vice-presidents (re)presented EuroSDR at the Cambridge Conference (Oxford, 9 April 2025), General Assembly of EuroGeographics (Riga, 20 May 2025), and UN-GGIM Europe (24 June 2025).

# Report of the General Secretariat

*Conor Cahalane and Neasa Hogan*



## Meetings

### BoD 146 – Tromsø, Norway – 21-23 May, 2025.

The 146<sup>th</sup> Board of Delegates was hosted by the Norwegian Mapping Authority at the FRAM Center. 58 attendees were lucky to experience the ‘midnight sun’. The highlights of the events included the National Day sessions with topics ranging from satellite infrastructure, to geodesy to GNSS jamming. We were pleased to receive a keynote from Georg Gartner on Activities of the International Cartographic Association and from Nina Bujang Vaaja on the role of monitoring the Barents Sea. Talks on GNSS-less aerial surveying and an important breakout session to agree on scoping of the new GeoAI SIG were examples of the relevance of content in the EuroSDR sessions. We also relaunched the 3DSIG at this BoD (with Knut Jetlund approved as Chair at BoD 147).

### BoD 147 – Zagreb, Croatia – 12-14 November, 2025.

The 147<sup>th</sup> Board of Delegates meeting took place at in Zagreb in Croatia hosted by the State Geodetic Administration of the Republic of Croatia and the Faculty of Geodesy, University of Zagreb. 49 persons attended the meeting and we enjoyed a memorable walk around Zagreb in the evening. Highlights from the National Day include presentations on Open Data, GNSS interference, Mine Action and a number of talks on skills development, something Croatia is excelling at. The EuroSDR sessions introduced an interactive feedback component using mentimetre looking at a revamped Hype Curve, and important breakout session looking at the recruitment pipeline, again seeing how we could learn from Croatia. We were also delighted to hear presentations from EuroSDR PhD award winners, Dr Kyriaki Mouzakidou and Dr Weixiao Gao.

## Executive Management Team Meetings

In preparation for the two BoD meetings and directing the annual workplan for EuroSDR, the Executive Management Team held two hybrid planning sessions. The first one took place in FGI, Espoo (Finland) 3 and 4<sup>th</sup> March 2025 in parallel with the EduSERV pre-course seminar where we were also joined by the tutors and EduServ scholarship recipients. The second EMT took place in the Kadaster offices in Rotterdam from 9 - 10 July 2025.

## Appointments and Changes

### Members and Delegates

In 2025 at BoD 147 we were pleased to welcome a representative from industry, with Phase One joining the EuroSDR community as our newest Associate Member.

In 2025 the following appointments were approved - André Streilen (Swisstopo) assumed the role of President, and took over in this role from Wolfgang Gold (BEV) at BoD 146 in May 2025. We said goodbye to Jon Arne Trollvik in Tromsø with Ivar Oveland (NMA and Comm 2 chair) appointed as the new Prime Delegate for Norway. Joep Cromptvoets (KU Leuven) was appointed as the new Academic Delegate for Belgium and we welcomed Andy Gardiner (OS) as the new Prime Delegate for the UK. On the Executive management Team - Frédéric Cantat (IGN France) was re-appointed for a third and final term as Chair of Commission 4, while Anka Lisec (University of Ljubljana) was re-appointed for a third and final term as chair of Commission 5. Delegates are encouraged to approach both Chairs and discuss the possibility of assuming that role upon the completion of that final term – this is urgent, and is important to ensure continuity of our activities. Eija Honkavaara (FGI) was re-appointed for a second term as chair of Commission 1. Joep Cromptvoets and Jantien Stoter (TU Delft) were reappointed for a

second and final term as joint-Vice President. Claire Ellul (UCL) was appointed as the new Chair of Commission 3: Information Usage and Visualisation and assumed that role at the end of BoD 147 when Martijn Risdijk (Kadaster) stepped down in this role after six years leading in this role. Martijn stays part of the EuroSDR community as the Prime Delegate of the Netherlands.

## Partnerships

EuroSDR continued collaborating with its key partner associations in 2025: including the Association of Geographic Information Laboratories for Europe (AGILE), EuroGeographics (the Vice President and Secretary General attended the EuroGeographics general Assembly in Riga, Latvia in Summer 2025. There was also strong support from delegates to propose an NMCA-focussed session for the International Society for Photogrammetry and Remote Sensing (ISPRS) congress in July 2026 and we can confirm that this has been accepted and reviewing of submissions completed. We welcomed a keynote from the President of the International Cartographic Association at BoD146, and also received detailed update from our ICO/TC211 representative Kunt Jetlund (NMA) at BoD 146 where he encouraged more buy-in from European members on developing standards. Collaboration also continued on FIG and with UN-GGIM Europe.

## Administrative and Logistics

### Accounts

In 2025 Delegates approved the first increase in membership fees since 2005, with an increase of 10% in the annual membership fee. The accounts and auditor reports for 2024 were approved by the delegates at BoD 146 in Tromsø.

### Social Media and Engagement

The EuroSDR LinkedIn page continued to expand its footprint in 2025 - 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 work for the new website also began in 2025, and we will have a draft version for review in early 2026. Work also began developing the EuroSDR 'infographic', a sharable graphical document that will be provided to Delegates highlighting the most current, key activities for external presentations or internal meetings to highlight the value of EuroSDR to your organisation.

### Office of Publications

The secretariat continue to support the work on EuroSDR publications - the importance of our publication series as an output was recognised by delegates approving financial support to Christine Ressler (OOP - BEV) to attend one BoD per annum and for Markéta Potůčková (Charles University) to attend one BoD per annum in her new role as Scientific Editor developing the EuroSDR policy for submissions and reviews, with a proposal approved at BoD147 in Zagreb.

### 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, ranking submissions for awards and scholarships etc in 2025. Finally - a number of important updates are coming from the Secretariat in Q2 2026 relating to an update of our 'rules and regulations' and to better define Director roles, answering queries from our members in 2024/25. There will be online info sessions in April 2026 to prime delegates before the vote to adopt these at BoD 148 in Paris.

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. Your timely responses to emails and on administrative matters makes our jobs much easier.

Conor and Neasa. February 2026.

# 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

In 2025, EuroSDR Commission 1 advanced its mission of improving platforms, sensors, and algorithms for primary geospatial data acquisition through workshops, collaborative initiatives, and research. A Special Interest Group on Primary Data Acquisition was launched, beginning with a kickoff workshop that brought together NMCA experts to identify priority topics for future work. Commission 1 also contributed to major international events addressing emerging opportunities and challenges for NMCAs, including EuroCOW 2025, UAV-G 2025, GEOBENCH 2025, and the webinar *“Beyond GNSS: resilient positioning and aerial mapping.”*

Research activities included progress in the EuroSDR-funded doctoral project on the use of multispectral LiDAR in national mapping, as well as the completion and analysis of a European survey on point cloud datasets. Overall, the year emphasized strengthening collaboration, improving data quality and standards, and enhancing the capacity of NMCAs to address emerging technological developments, operational risks, and future challenges in geospatial data acquisition.

## Special Interest Group on Primary Data Acquisition (COM1-SIG)



A Special Interest Group on Primary Data Acquisition (COM1-SIG) started its operation in 2025. Its aim is to foster active participation from NMCAs in Commission 1’s activities and to enhance information sharing and collaboration, while also supporting cross-commission consideration of challenges and opportunities in geospatial data acquisition.

The kickoff workshop, titled *'Data Acquisition, Processing, and Distribution within NMCA'*, was held on January 29–30, 2025, at het Waterschapshuis in Amersfoort, the Netherlands. The event brought together NMCA experts specializing in large-scale LiDAR and imagery programs and welcomed 35 participants from 13 countries. The aim of this workshop was to present and discuss different data-acquisition, -processing

and -distribution related topics, addressing the state-of-the-art and the challenges currently faced by NMCAs. Furthermore, the objective was to discuss about the research agenda for the next 2-5 years and discuss how to effectuate that. The organising committee consisted of the [EuroSDR Commission 1](#) chair Eija Honkavaara as well as Jeroen Leusink from het Waterschapshuis (the Netherlands) and Jo Van Valckenborgh from Digitaal Vlaanderen (Belgium). There were altogether 16 presentations from NMCAs, companies, and universities. They are published along with the workshop agenda in the EuroSDR web page [EuroSDR Commission 1 Special Interest Group workshop: Data acquisition, processing and distribution within NMCA | EuroSDR](#)

The key conclusion was that there is a need for collaboration in topics related to data acquisition. The working group agreed that a suitable meeting schedule would include virtual meetings approximately twice a year and an in-person meeting every second year. Several key themes were identified as topics for future development and co-creation, out of which the following were identified as the priority topics in the first phase:

- Establishing best practices for performance assessment of airborne imaging, particularly using Siemens star.
- Advancing EuroSDR specifications for aerial imagery and LiDAR data acquisition, including subcontracting practices.
- Developing open-source quality control (QC) tools.
- Improving radiometric processing and calibration methods for airborne imagery.
- Utilizing results from the EuroSDR PhD project on point cloud classification.

- Georeferencing challenges caused by GNSS jamming were highlighted as a relevant area for future focus.

## Workshops

### EuroCOW - European Workshop on Calibration and Orientation in Remote Sensing (Report by Prof. Krzysztof Bakula)



EuroCOW 2025 was held on 16-18 June 2025, in Warsaw, Poland. The event was jointly organized by ISPRS and EuroSDR, supported by the Polish Society for Photogrammetry and Remote Sensing, Association of Polish Surveyors and Warsaw University of Technology. The local Organizing chair was Wojciech Ostrowski and the Scientific Committee chair was Krzysztof Bakula. The workshop gathered 60 participants. It was supported by IGI and OPEGIEKA. It was the ninth EuroCOW workshop, but the history is longer, as it is a continuation of

the ISPRS workshops „Integrated Sensor Orientation” organized from 1995 to 2003.

Key presentations were presented by Ismael Colomina (GeoNumerics) and Jan Skaloud (EPFL) who organized EuroCOW events in the past. A total of 25 papers were submitted to the conference, of which 23 passed the preliminary review process, and 19 full abstracts were finally presented at the workshop. They covered a wide range of geoinformatics, photogrammetry and remote sensing topics. The largest group of papers was devoted to photogrammetry and aerial imaging in the field of data acquisition and processing. The second strongly represented trend was research using LiDAR technology. There was also an evaluation and comparison of the accuracy of different laser scanning systems, low-budget sensors; and the assessment of other navigation sensors, measuring systems. On the last day of the workshop, a facultative technical trip to Scientific and Educational Centre Józefosław – CENAGIS was organized.

Final programme is available: <https://www.eurocow.org/index.php/programme>

Publications in ISPRS Archives: <https://isprs-archives.copernicus.org/articles/XLVIII-1-W4-2025/>

### UAV-G Uncrewed Autonomous Vehicles in Geomatics



The Uncrewed Aerial Vehicles in Geomatics (UAV-G) 2025 conference was held in Espoo, Finland, from September 10–12, 2025. UAV-G is an ISPRS-supported biennial workshop series dedicated to presenting and discussing the latest scientific and technological advancements in UAVs and their applications in geomatics. The 2025 event brought together approximately 180 registered participants from 30 countries across five continents. The program featured four keynote lectures by world-leading scientists, 44 oral presentations, 26

poster presentations, an industry keynote, and a presentation from an industry representative.

On Thursday, a special EuroSDR-related session, entitled “Towards Safe and Scalable Wide-Area BVLOS Operations”, was held. The session was opened with the keynote “Autonomous BVLOS UAV Operations: From Research to Large-Scale Real-World Deployment” by Prof. Antonios Tsourdos (Cranfield University, UK). He presented a future vision on how the future aviation environment will operate in 2030, as well as the ambition future flight stakeholders should work towards. An industry presentation, “Hydrogen-Powered Autonomy: Scaling BVLOS UAV Operations in Practice”, was delivered by Kelluu Oy. Other presentations in this session focused on the use of UAV swarms and the collaborative planning of drone landing and launch sites. The day continued with sessions on “Drone Applications in the Built Environment”, including an industry keynote “Breaklines and Mass Points” by CTO Arttu Soininen (Terrasolid Oy), as well as presentations on UAV computer vision systems and algorithms. The full programme can be found in <https://uav-g2025.com/conference-schedule/>

From EuroSDR's perspective, the UAV-G 2025 conference provided valuable insights into the future of scalable and wide-area drone operations, efficient data processing techniques, and demonstrations of applications relevant to national mapping agencies. In particular, the EuroSDR-session on BVLOS (Beyond Visual Line of Sight) operations emphasized the importance of safe and scalable UAV deployments for large-area mapping projects and demonstrated that such operations are already feasible in a variety of environments. The conference

presented significant advances in autonomous navigation, exploration of unknown environments, the application of machine learning and artificial intelligence, and real-time data processing in UAV operations. Furthermore, methodologies for collaborative planning of drone launch and landing sites, along with developments in UAV computer vision systems, directly address the needs of national mapping and cadastral agencies. These developments reflect a major shift toward more efficient, accurate, and sustainable methods for geospatial data acquisition.

Final programme is available: <https://uav-g2025.com/conference-schedule/>

Publications in ISPRS Archives: <https://isprs-archives.copernicus.org/articles/XLVIII-2-W11-2025/>

Publications in ISPRS Annals: <https://isprs-annals.copernicus.org/articles/X-2-W2-2025/>

### [Geobench - International Workshop On Evaluation And Benchmarking Of Sensors, Systems And Geospatial Data In Photogrammetry And Remote Sensing \(Report by Prof. Krzysztof Bakula\)](#)

The 3rd GEOBENCH Workshop was held on 20–21 November 2025 in Wrocław, Poland, bringing together researchers and professionals to evaluate, benchmark, and calibrate geospatial sensors, systems, and data. The event was organized by the Wrocław University of Environmental and Life Sciences, the Technical University of Darmstadt, the Warsaw University of Technology, and the Bruno Kessler Foundation — under the auspices of ISPRS and EuroSDR, the Polish Society for Photogrammetry and Remote Sensing, and the Association of Polish Surveyors. The main organizers were Grzegorz Jóźków, Dorota Iwaszczuk, Fabio Remondino and Krzysztof Bakula. Event was supported by GISPRO, Esri Polska, Terrasolid, Geoline, YellowScan, WIZIPISI Vibe GIS-ing and Hexagon/Leica.

Approximately 80 participants attended the workshop, which included 8 technical sessions (incl. Bathymetry, Benchmarking sensors and AI methods, Forestry, Sponsor session, Point cloud processing, TLS / MLS, New benchmarks and LOD building modeling).

The program included invited talks by leading experts such as Uwe Sörgel, Gottfried Mandlbürger, and Rasmus Astrup, alongside a comprehensive set of oral presentations addressing current benchmarking challenges across platforms from UAVs to terrestrial systems. A total of 54 submissions were proposed, 11 were rejected, and finally 35 presentations were delivered, resulting in abstracts published in ISPRS Archives.

Final programme is available: <https://www.eurocow.org/index.php/programme>

Publications in ISPRS Archives: <https://isprs-archives.copernicus.org/articles/XLVIII-1-W6-2025/>

### [Beyond GNSS: resilient positioning and aerial mapping \(Report by Prof. Fabio Remondino and Prof. Krzysztof Bakula\)](#)

Intentional interference with Global Navigation Satellite Systems (GNSS) has increased in recent years, largely due to ongoing geopolitical conflicts. Because GNSS-based positioning is a cornerstone of modern aerial data acquisition, such interference can seriously affect all phases of the workflow, including navigation, data collection, and product generation. To address these challenges, the EuroSDR workshop “*Beyond GNSS: resilient positioning and aerial mapping*” was organized online on 2 December 2025. The event was organized by Krzysztof Bakula (Warsaw University of Technology, Poland), Anna Bober (GUGIK, Poland), and Fabio Remondino (FBK, Italy) in collaboration with Eija Honkavaara (EuroSDR Commission 1) and Ivar Oveland (EuroSDR Commission 2), and attracted 130 online participants.

The program of the workshop included 6 invited presentations from the Finnish Geospatial Research Institute (FGI) (Finland), the Ministry of National Defense and GUGIK (Poland), Kartverket (Norway), GUGIK (Poland), the University of Twente, Riegl, TU Vienna and IGI. The online workshop focused on challenges and solutions for resilient Positioning, Navigation, and Timing (PNT) in GNSS-disrupted environments, bringing together research, policy, and practical testing perspectives. Key topics included European initiatives for PNT resilience, insights from jamming tests, and advanced methods for spatial data acquisition, airborne laser scanning, and aerial navigation without reliable GNSS. Overall, the program highlighted current vulnerabilities of GNSS and showcased emerging technologies and strategies to ensure robust navigation and georeferencing under challenging conditions.

Important takeaway message from the workshop was that it is crucial to implement tools to mitigate the impacts of the GNSS interference. The topic will be in the agenda of the EuroSDR Special interest group on Data Acquisition (SIG-COM1) and further research will be conducted on the topic.

Final programme is available: <https://www.eurosd.net/workshops/eurosd-workshop-beyond-gnss-resilient-positioning-and-aerial-mapping>

# Research

## EuroSDR PHD-thesis (Report by Narges Takhtkeshha)

### 1 Introduction

With the advent of multispectral (MS) Light Detection and Ranging (LiDAR) systems, the use of laser-based 3D data is no longer confined to geometric information. MS LiDAR systems capture 3D data across multiple spectral wavelengths, enabling the simultaneous acquisition of spatial and spectral information. This capability facilitates fine-grained 3D mapping and single-source data generation by leveraging the synergistic spatial-spectral properties of MS point clouds.

Considering the ongoing developments in deep learning (DL) methods and the promising advantages that MS LiDAR data have demonstrated, it is imperative to leverage DL capabilities for processing these dataset. Although most DL models are not specifically developed to process MS point clouds, they can be modified to handle such data. On the other hand, designing new DL models that are tailored specifically for data is also essential to fully exploit the potential of this information. To date, no 3D MS LiDAR benchmark dataset exists to facilitate the development of DL models for processing MS LiDAR data.

The 3D spatial-spectral information of MS LiDAR data opens the door to precise material detection. Despite this, the potential of MS LiDAR data for material detection has received limited attention.

While 3D radiometric information is a key component of MS LiDAR data, radiometric calibration / correction is neglected in most existing studies. In the few studies that are conducted, radiometric calibration / correction relies on field data, which is often unavailable. Consequently, the main focuses of the third year of this PhD study are as follows:

- Adapting state-of-the-art DL models to process MS LiDAR data
- Exploring a new DL model (HyperPointFormer; HPF) specifically tailored to process MS LiDAR point clouds
- Preparing the first 3D forestry and urban MS LiDAR benchmark datasets by considering current and future needs of European National Mapping and Cadastral Agencies (NMCAs)
- Examining the potential of MS LiDAR data for material detection
- In situ-independent radiometric calibration of MS LiDAR data

### 2 Methodology

#### *DL-based MS LiDAR Data Processing*

Six state-of-the-art DL models (KPCovX, KPConv, SuperPoint Transformer, Point Transformer V1, Point Transformer V3, and SpUNet) are adapted to process MS LiDAR data with the desired number of spectral features. Additionally, the HPF model, a recently developed DL model specifically tailored for MS point cloud processing, is employed to process MS LiDAR data for the first time.

#### *Benchmark Datasets of MS LiDAR data*

Two benchmark datasets are prepared to support further developments in MS LiDAR processing, as summarized in the table below. One dataset covers forested areas (ForestSemantic-MS), while the other spans suburban regions (Loosdorf). It is worth noting that the suburban Loosdorf MS LiDAR benchmark dataset is prepared at two levels of detail to address the current (Level 1) and prospective (Level 2) needs of NMCAs, based on the EuroSDR questionnaire conducted with European NMCAs support.

Dataset	MS LiDAR system	Case study	Coverage	Classes
ForestSemantic-MS	HeliALS (1550 nm, 905 nm, and 532 nm)	Espoonlahti, Finland	0.7 ha	six (Ground, low vegetation, trunk, branches, foliage, and woody debris)
Loosdorf	VQ-1560i-DW (1064 nm and 532 nm)	Loosdorf, Lower Austria	170 ha	Level 1: nine (ground, water, low vegetation, medium vegetation, high vegetation, building, electricity infrastructures, bridge, and other)
				Level 2: 25 (asphalt, gravel, soil, paved road, dirt road, water, low vegetation, medium vegetation, high vegetation, clay tile roof, concrete tile roof, metal tile roof, façade, chimney, solar panel, car, lamp post, road marking, electric tower, cable, bridge, railway track, fence, sport area, and other)

### *Radiometric Calibration / Correction*

An in situ-independent radiometric calibration is proposed to eliminate the need for field spectrometry measurements. Sentinel-2 data are used to derive reference reflectivity information. Subsequently, the RadioCal module of the OPALS software is developed for this purpose. The potential generalizability of the proposed methodology is currently being explored.

### **3 Main Outcomes**

*Events:* Organizing of the online EuroSDR workshop on multispectral LiDAR, June 2025. It features more than 100 participants, various presentations on the topic and intensive discussions among the audience.

#### *Benchmark datasets*

- Takhtkeshha N, Bocaux L, Ruoppa L, Remondino F, Mandlbürger G, Kukko A, Hyypä J (2025a) ForestSemantic-MS Dataset: multispectral LiDAR forest point clouds for fine-grained forest semantic segmentation [dataset] <https://doi.org/10.5281/zenodo.17172162>.
- Loosdorf, suburban MS LiDAR data and orthophoto (coming soon)

#### *Publications*

- N. Takhtkeshha, A. Rizaldy, F. Remondino, J. Hyypä, and G. Mandlbürger, "3D LULC classification using multispectral LiDAR and deep learning," in review, 2025.
- N. Takhtkeshha et al., "3D forest semantic segmentation using multispectral LiDAR and 3D deep learning," PFG – Journal of Photogrammetry Remote Sensing and Geoinformation Science, 2025. DOI: 10.1007/s41064-025-00369-4.
- N. Takhtkeshha, G. Mazzacca, F. Remondino, J. Hyypä, and G. Mandlbürger, "Multispectral LiDAR data for extracting tree points in urban and suburban areas," 2025. Arxiv, DOI: 10.48550/arXiv.2508.19881.
- Z. Ma, B. Bocaux, N. Takhtkeshha, and F. Remondino, "Toward Detailed and Accurate Forest Inventory with Multi-Source Lidar Data," Photogrammetric Engineering Remote Sensing, 2025. DOI: <https://doi.org/10.14358/PERS.25-00153R2>.
- J. Taher et al., "Multispectral airborne laser scanning for tree species classification: A benchmark of machine learning and deep learning algorithms," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 233, 2025. DOI: <https://doi.org/10.1016/j.isprsjprs.2026.01.031>.
- L. Ruoppa et al., "Unsupervised deep learning for semantic segmentation of multispectral lidar forest point clouds," ISPRS Journal of Photogrammetry and Remote Sensing, vol. 228, pp. 694–722, 2025, ISSN: 0924-2716. DOI: <https://doi.org/10.1016/j.isprsjprs.2025.07.038>.

#### *Award*

Best poster presentation (3rd Place), May 2025, FBK PhD day, Fondazione Bruno Kessler (FBK), Trento, Italy.

### **4 Future Plan**

While the PhD is at his end and a thesis will be submitted in March 2026, some further research activities are envisaged:

- Evaluate the proposed situ-independent radiometric calibration methodology (field measurements will be collected in the coming weeks)
- Prepare a manuscript on in situ-independent radiometric calibration of MS LiDAR data
- Prepare a manuscript on laser shadow removal
- Explore the potential of MS LiDAR data for detecting woody debris

### **Report Point cloud dialects in Europe**

The results of the 2024 questionnaire "*Point cloud dialects in Europe*", which assessed the current state of point cloud datasets and explored the potential for national-level integration, were analysed and published in the EuroSDR report "*Inventarisation of Point Cloud Datasets and Their Quality Descriptors in Europe: Towards Greater Uniformity*." The questionnaire was prepared by Daan van der Heide, Jantien Stoter, and Jeroen Leusink, and the subsequent analysis and report were produced through a joint effort between Rijkswaterstaat, TU Delft, Het Waterschapshuis, and EuroSDR. Responses were received from 14 national mapping and cadastral agencies, and the analysis was complemented with publicly available information. The report summarizes the characteristics, specifications, and quality descriptors of point cloud datasets across Europe, providing a basis for improving harmonization and supporting future data integration.

# Report of Commission II – Modelling, Integration and Processing



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 was presented at the EMT meeting in Espoo March 2025. The focus areas are divided into three topics and reflected in the research plan approved at BOD 146.

**Processing: Extract and harvest geospatial information from data sources.** GEOAI: Using automatic approaches and AI to perform object detection, segmentation, attribute detection. Additional standardisation and sharing of AI training data, multi modal processing, embeddings and gaussian Splatting.

**Modelling: Generate digital representation of objects in a geospatial context, defined by sets of rules (e.g. machine readable, LoD, 2D, 3D, 4D, GeoBIM).** Also including 3D Modelling and Semantic models & Terminology Standardization.

**Integrating: Combine multiple observation and data sources to reach a higher level of information, time resolution and accuracy. This to ensure the right quality at the right time for the users.** Important topic is Geospatial data fusion, machine readable reference frame, Harmonizing and integrating diverse datasets, estimate reliability, geospatial change detection, automatic generalization of map objects and quality Control.

## GeoAI Special interest group (AI-SIG)

Artificial Intelligence (AI) is increasingly becoming a key element across all commissions, and Commission 2 is no exception. All initiative in this topic will be done in close collaboration with the AI-SIG. The kick-off for AI-SIG was in Rotterdam, Netherlands, Nov. 26-28, 2025, with a great outcome with establishing of multiple focus areas.

## Project - Ecological descriptors for vegetation and terrain estimated from Lidar

The project merging interests from forestry and environment sectors, research communities and mapping agencies. Where the goal is to standardize how to calculate ecological descriptors and to create a common understanding how to use them and what it could tell us and not. Furthermore, improve the impact of the ecological descriptors with a common understanding of the environmental variables

## Workshops (supported / founded by EuroSDR and commission 2)

**Georeferencing in the digital era 2025**, Joint EUREF and EuroSDR Workshop, Gardermoen, Norway, 27-28 May. The Workshop discussed the future of georeferencing – with a focus on user-friendliness, standardization, and international collaboration. 32 Participants from 7 Countries representing national mapping agencies, academia, industry, and software development. The workshop outcomes indicate a clear trend: an increasing use of EPSG codes to ensure machine-readable and unambiguous reference frame information.

**4th EuroSDR Workshop on Point Cloud Processing**, Stuttgart, Germany, 6 - 7 February 2025. The Workshop gathered experts from industry, academia and national mapping agencies to present and discuss the processing and automatic interpretation of area covering point clouds focusing on mapping purposes. The program

consisted of 20 presentation and 11 poster presentation. The workshop was overbooked with 129 participants. Founding for the 5<sup>th</sup> workshop has been approved by the BOD and the arrange comity has been established. **3D mapping at national and regional scale**, Paris, France, 22-23 January 2025. The main objective was to Exchange progress on 3D mapping and its use by customers. Furthermore, to identify challenges.

# Report of Commission III – Information Usage and Visualisation

*Martijn Rijdsdijk and Claire Ellul*

*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.*

The main focus of the Commission in 2025 was on workshops linked to ongoing projects on Digital Twins, GeoMetadata/Linked data, AI and 3D.

## Activities

### Survey: NMCA structures and involvement with Digital Twins

Aimed to improve understanding of the organisational variations among 20 EuroSDR member National Mapping and Cadastral Agencies (NMCAs), by capturing key aspects of their business models, operating environments, governance structures, approaches to research and development. This is then linked to an understanding of the interest in, and development of, Digital Twins

- 15 responses
- 9 dimensions of an NMCA descriptive framework identified
- Summary report created

### Workshop: Geo-Metadata (2-4 February 2025, Paris, FR)

Metadata is a key component to support data findability and reuse, to document quality and ensure trust in the decision made with data. There is room to improve the way different parties collect, produce, organize, share and use metadata, in particular metadata about geographical data. Challenges include making better use of metadata to support data discovery, making sure metadata is created/available, and supporting user-oriented discovery across resources from different domains.

- Workshop held in Paris, February 2025
- Follow-up of EuroSDR-EuroGeographics activity on geodata discoverability as well as of EuroSDR activity on Linked (meta)data.
- 43 participants from 18 countries, 12 physically present, slides online.
- Two communities : GI and open data
- Scientific publication made and published:

### Webinar: Launch of the Alpha Version of the Digital Twins Cookbook, October 25th, Online

The Digital Twin Cookbook for NMCAs develops a shared resource that provides NMCAs with guidance on several key topics relating to NMCAs and DTs. A webinar was held to launch an alpha version of the cookbook to allow NMCA stakeholders to have input into both content and structure.

- 22<sup>nd</sup> October 2025, online
- Event explored the content and presentation option for the cookbook
- Current content includes:
  - Fundamentals of Digital Twins
  - Scaling and Connecting Digital Twins
  - How ready is your NMCA for Digital Twins (rate your NMCA's Maturity)
  - Developing Digital Twins Use Cases
- Survey opened to gather feedback (4 responses to date)

## Workshop: Special Interest Group on AI, November 24-26, Rotterdam, NL

AI, Deep and Machine Learning is not only experimental anymore,, and after lots of use cases we now have 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 cooperation with universities) already experimenting and working on it, and sharing knowledge will support innovations and development at this point.

- The workshop involved 26 participants of 12 countries, as well as separate input from the EuroSDR Commission Chairs
- Recommendations include
  - Focus on infrastructure
  - Sharing use cases and data
  - Sharing specifications for architecture

## Workshop: The way forward for 3D mapping at national and regional mapping agencies, January 21-22, London, UK

The growing strategic importance of 3D geoinformation across domains such as planning, energy, environment, and infrastructure demands a collaborative platform for knowledge exchange and innovation for National Mapping and Cadastral Agencies (NMCAs). NMCAs are investing in 3D models, tools, and services. At the same time, the research landscape is still rapidly evolving, with advanced acquisition and modelling techniques, new standards, open tooling, and increasing cross-domain integration. In 2025, the EuroSDR Workshop on *“the State-of-the-Art of 3D Mapping at National and Regional Mapping Agencies”* brought together nearly 70 participants from NMCAs. This workshop followed on from that event.

- Organised by the 3D SIG
- 45 participants
- Aim is to identify key issues and next steps for the SIG
- Key findings include:
  - Importance of pitching / explain the value of 3D to decision makers – use cases and examples are not enough
  - Need to understand/articulate the specific role of the NMCA – and national coverage – versus private providers who may just
  - Funding is a major challenge, as is the need for more frequent data collection
  - Change detection is an important technical challenge
  - A list of available data – e.g. high density point clouds – would be very helpful
  - There is strong interest in forming a vibrant community around this topic

## Workshop: 2D/3D Topology of Real Time Objects (postponed)

There is currently an under explored need to support real time 3D visualisation and generation of 3D cartography, as well as to link 3D map objects to 2D map objects and automatically combine datasets that are the result of individual surveys. Open questions include: 3D maps and datasets: how are 3D objects related to 2D data-sets; how to automatically combine datasets that are the result of individual surveys; how to manage the statistical errors that result from these combinations? what new ways of data storage, and also historical data storage, could help?

To address these questions, we need to work out how to manage (2D/3D) Topology of real-time objects. To kick start this project we plan a workshop to seek feedback from participants on the above concepts:

- What is the opinion at NMCA's about these research questions?
- What are the experiences of universities and NMCA's?
- To what extent do we need a uniform solution and more insight here?

The workshop is aimed at NMCA and other specialists in 2D / 3D data modelling.

*Workshop postponed to 2026, due to Kadastre staff availability.*

## Ideas and projects for 2026:

- Workshop: 2D/3D Topology of Real Time Objects
- 3D SIG
  - “Policy” report to be drafted by James Norris, International Policy Lead at Ordnance Survey, in collaboration with SIG team
  - ISPRS Annals Paper to be submitted to 3D GeoInfo 2026
  - Share workshop report and presentations
  - Workshop/event: June/July 2026 –proposed topic: “An Industry Perspective on 3D”
  - Other ad-hoc SIG activities – e.g. 3D data catalog; Teams resource site
- AI SIG
  - Second event to be organised in Spring 2026
- Digital Twins Cookbook
  - Updates on content, second webinar, possible integration of some of the requested resources from the first 3D SIG workshop; integration of use cases from municipalities
- Digital Twins research
  - Findings from the survey of EuroSDR NMCAs on Digital Twins – webinar in the first quarter of 2026
    - Summary report to be shared with invitation to event
  - Paper to be presented at ISPRS Congress, Toronto, July 2025, as part of the EuroSDR special session (focussed on methods to value data for Digital Twins)
  - Paper on NMCA framework dimensions to be written
- GeoMetadata and Linked Data
  - a survey to scope a future project relating to Linked Data and Knowledge Graph technologies for Spatial Data Infrastructures , including: publishing our data models and their links, developing conversational API above our data and docs; associating context to data in Digital Twins

# 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*

## 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 10<sup>th</sup> 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°74<sup>1</sup>). The second one was to lead a survey on the three following ones during spring 2024 (Data, Innovation and Standards – see EuroSDR Official Publication n°77<sup>2</sup>). The 2025 roadmap was packed for EuroSDR FELA project with several milestones, including the third survey on the 3 last FELA pathways (Capacity and Education, Advocacy and Awareness, and Partnerships) and an International Workshop on “*challenges in relation to the UN Framework for Effective Land Administration (FELA)*”.

### Survey Results - UN-GGIM FELA Pathways on Partnerships, Capacity and Education, Advocacy and awareness

16 organisations from 14 European countries participated to the survey (questionnaire during Spring 2025). The key facts are:

- 88% engage through international or regional expert networks
- 25% offer continuous professional development (CPD)
- 31% have no formal monitoring or evaluation of communication efforts

For UN-GGIM FELA Pathway: Partnerships, international and institutional networking is the most prominent partnership feature, with 87.5% of organisations engaging through international, EU, or regional associations and networks. High participation rates at the international and EU levels (both 62.5%) indicate that European land administration bodies are well embedded in cooperation structures. Private-sector participation is minimal (6.25%), indicating that innovation driven, cross-sector partnerships are far less developed than institutional and public sector cooperation.

For UN-GGIM FELA Pathway: Capacity and Education, efforts toward lifelong learning are evident, yet stronger institutional embedding are needed to focus on innovation and human capacity development across the land

<sup>1</sup> <http://www.eurosd.net/publications/official-publication-no-74-2023>

<sup>2</sup> <https://www.eurosd.net/publications/eurosd-official-publication-no-77-advancing-fela-ii-2024>

sector. Land administration education is well embedded in formal degree programs - yet continuing professional development remains limited, indicating a gap in lifelong learning after initial qualification.

For UN-GGIM FELA Pathway: Advocacy and awareness, main awareness activities are collaboration with educational institutions (62%), local workshops (50%) and use of plain language and visual aids (44%). Strategic, inclusive and evidence-based advocacy and awareness is weak. 31.25% of organisations lack formal monitoring and evaluation of communication, 56.25% rely on general information without targeted outreach to vulnerable groups - indicating that advocacy remains fragmented.

All the results and findings of the survey will be found in EuroSDR Official Publication Advancing FELA III will be released in 2026 in compliance with the new EuroSDR Publication Policy approved at 147<sup>th</sup> Board of Delegates meeting in Zagreb.

## International Workshop on “Challenges in relation to the UN Framework for Effective Land Administration (FELA)”

The EuroSDR International Workshop on challenges in relation to the United Nation (UN) Framework for Effective Land Administration (FELA) took place on June 16 and 17 2025, at IGN in Saint-Mandé (France). This events who had also the support of UN-GGIM: Europe and EuroGeographics brought together thirty participants from ten countries across Europe (and Americas for a remote keynote). The aim of the workshop was:

- To discuss the findings of the project on FELA, undertaken by EuroSDR, focusing on the results of the online survey component;
- To discuss how countries and current land administration systems can benefit from FELA;
- To discuss what are the main challenges related to the implementation of FELA principles/upgrade land administration systems;
- To look at examples of best practices in land administration and to explore how these innovations can be brought into practice in other countries, particularly in the context of national mapping and cadastral agencies;
- To discuss what are the future development trends of national land administration considering all nine FELA pathways;
- To discuss how EuroSDR, EuroGeographics, UN-GGIM: Europe and the broader geospatial international community can contribute to the development of contemporary land administration.

Over the course of the event, keynote, breakout sessions presentations and panel discussion allowed participants to have fruitful exchanges and return on experiences on effective land administration. They agreed on that FELA is an overarching guide, not an implementation document, and also a living document which could be used as a very useful compass for self-assessment. They expressed the wish to continue the discussions, particularly around the study of the standardization of a project self-assessment tool following the nine pathways of the FELA.

All the results and findings of the workshop can be found in EuroSDR Official Workshop Report *Challenges in relation to the United Nation (UN) Framework for Effective Land Administration (FELA)* (November 2025)<sup>3</sup>. A publication with a specific tribute, in remembrance of the Chair of the Board of Kadaster, Co-chair of UN-GGIM: Europe and valuable contributor to the workshop Frank Tierolff, 1968-2025.

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<sup>3</sup> See <https://www.eurosdrr.net/publications/workshop-report-challenges-relation-united-nation-un-framework-effective-land>



Participants at the EuroSDR International Workshop on challenges in relation to the United Nation (UN) Framework for Effective Land Administration (FELA) – IGN (Saint-Mandé, France) – June 16<sup>th</sup> 2025

## Geo-ethics project

### Context

In order to make an initial assessment of the state, EuroSDR initialized in April 2025 a small project on *Ethics in the production and use of geospatial data*<sup>4</sup>, aiming to assess the level of awareness and practice of Geo-Ethics in Education, data production and data reuse. The project's objective is also, as a first milestone of a potential new research action, to be able in the future to identify trends (in a barometer survey approach with a first round in 2025). The two first steps of the project stand in a survey (ran in 2025) and a workshop (scheduled on February 2026).

### Survey

The survey was web based, available online between June and September 2025. People working for a mapping and/or a cadastral agency, in the field of research or education, for a government body or a public organisation were targeted.

Among 32 respondents completed the survey, 44% are from NMCAs, and 22% are from Education field, 19% work for a government body or a public organisation and 15% are in the field of Research. One outcome of the survey is a worldwide inventory of 17 reports or documents dealing with Geo-ethics.

All the findings of the survey will be detailed during the workshop that will stand in Leuven (Belgium) in February 2026.

### Workshop

A part of second semester 2025 was dedicated to set-up a workshop on GeoEthics<sup>5</sup>. This EuroSDR event, will take place on 9 and 10 March 2026 at KU Leuven, Belgium. The aim of is to bring together National Mapping and Cadastral Agencies, researchers, educators, and industry representatives to discuss and share experiences on ethical issues in the production and use of geospatial data, and is supported by the Commission dealing with Professional Education of the International Federation of Surveyors (FIG – Commission 2).

<sup>4</sup> <https://www.eurocdr.net/research/project/ethics-production-and-use-geospatial-data>

<sup>5</sup> <https://www.eurocdr.net/workshops/eurocdr-workshop-geoethics>

The workshop will cover:

- State of the art / level of awareness of Geo-Ethics from Education
- State of the art / level of awareness of Geo-Ethics from the data producer's perspective (NMCAs, industrials etc)
- State of the art / level of awareness of Geo-Ethics from the data reusers perspective
- Best practices and lessons learned

All the findings and presentations of the workshop will be published on EuroSDR website in 2026.

## [Set-up of a joint Workshop on Sustainable Business Models for NMCAs](#)

### Context

National Mapping and Cadastral Agencies (NMCAs) have an important role, providing geospatial data and services 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.

For EU NMCAs's players, the European Commission implementing regulation 2023/138 laying down a list of specific high-value datasets and the arrangements for their publication and re-use published<sup>6</sup> in January 2023, has officially ratified the fact that NMCAs are enforced to provide geospatial data as machine readable open data since February 2025 (which was the ultimate deadline to comply with). This is at a cost to the National Government, which has to face since Early 2020s in many countries to delicate budgetary arbitrations. *"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!"* was one the main takeaways from the workshop on Sustainable Open Data Business Models for NMCAs led jointly by EuroSDR and EuroGeographics in 2024. And there was a general agreement *"on the necessity to take another look at the situation in two years (early 2026) with a repetition of this workshop"* (cf. Workshop Report<sup>7</sup> – EuroSDR's Official publication – 2024).

### Workshop

In accordance with the appointment made 18 months earlier in Leuven (Belgium), EuroSDR and EuroGeographics have worked in 2025 on the set-up of a repetition event. This led to an invitation to NMCAs, researchers and policy makers to present, discuss and share their experiences during a dedicated workshop scheduled on 9 and 10 February 2026 and hosted by NGI-IGN Belgium in Brussels.

This activity seeks to provide an inventory of which Business Models NMCAs have implemented, are implementing or will plan to implement to adapt themselves to their environment:

- How do they handle with the entry in force of the HVD regulation?
- Do they have to find extra-funding (e.g. fundings that are not State subsidy for public service charge nor reuse fees)?
- Do they have to alter activities, stopping some activities, to start new ones or to adapt the way they operate others?
- Do they have to build partnerships with new actors?
- How do they manage to integrate new key competences?
- What is the initial assessment from the EC perspective and what are the possible evolutions on the Data Union Strategy, especially with the very recent release in November of Digital Omnibus EU Regulation Proposal<sup>8</sup> in order to amend several "data" directives /regulations?

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<sup>6</sup> [https://eur-lex.europa.eu/eli/reg\\_impl/2023/138/oj](https://eur-lex.europa.eu/eli/reg_impl/2023/138/oj)

<sup>7</sup> <https://www.eurocdr.net/publications/workshop-report-sustainable-business-models-national-mapping-and-cadastral-agencies>

<sup>8</sup> <https://digital-strategy.ec.europa.eu/en/library/digital-omnibus-regulation-proposal>

- Could the evolution of the international situation have an impact (on sovereignty or safety criteria for instance)? If yes, how?
- All the findings and presentations of the workshop will be published on EuroSDR website in 2026

## Intelligence on several Data European Union policies

During Year 2025 EuroSDR delegates were kept posted on several European Union policies on data.

- Inventory of High-value datasets from EuroSDR and EuroGeographics members (see Report of activities done during BOD146 meeting, extract below):

The slide features the EuroSDR logo (four stars above the text 'EuroSDR') and the text 'European Spatial Data Research'. The title is 'Inventory of High-value datasets from EuroSDR members'. Below the title is the subtitle 'EuroSDR members' High-Value inventory (2024)'. The table below lists categories and their counts for three criteria: CC BY 4.0 or equivalent licence\*, HVD requirements fulfilled\*, and Sufficient arrangements\*. A footnote indicates '\* Number of countries (out of 20)'. The website 'www.eurosd.net' is visible in the bottom right corner of the slide.

Category	CC BY 4.0 or equivalent licence*	HVD requirements fulfilled*	Sufficient arrangements*
Adresses	14	15	9
Cadastral Parcels	13	15	9
Buildings	12	10	4
AdminUnits	15	14	7
GeoNames	15	14	8
Hydrography	14	12	3
Orthoimagery	12	7	6
Industrial Production	3	3	0
Transport Networks	8	7	5

\* Number of countries (out of 20)

www.eurosd.net

- Feed-backs on EC Public consultation on the initiative GreenData4All - updated rules on geospatial environmental (INSPIRE, Open Data...)⁹ (see Reports of activities done during BOD146 & 147 meetings)
- Proposal for a Regulation of the European Parliament and of the Council on the simplification of the digital acquis amending several regulations and directives (Digital Omnibus for the digital acquis)¹⁰

⁹ [https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13170-GreenData4All-updated-rules-on-geospatial-environmental-data-and-access-to-environmental-information/public-consultation\\_en](https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13170-GreenData4All-updated-rules-on-geospatial-environmental-data-and-access-to-environmental-information/public-consultation_en)

¹⁰ <https://digital-strategy.ec.europa.eu/en/library/digital-omnibus-regulation-proposal>

## Report of Commission V – Knowledge transfer

Anka Lisec

The mission of Commission 5 is to provide educational services in the domains of geoinformation and geospatial technologies to support the transfer of knowledge from EuroSDR research projects, workshops and other EuroSDR activities to national mapping and cadastral agencies (NMCAs), academia and industry. The Commission also focuses on fulfilling specific NMCAs' demands for knowledge and know-how updates, collection and dissemination methodologies, tools and other research outcomes in the form of short on-demand courses, EuroSDR's (official) publications and EuroSDR's homepage.



### EduServ23 (2025)

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 to transfer knowledge from research to production. 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.

**The EduServ23 (2025) courses** addressed the current challenges and technological advances. The EduServ23 began 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**. The four two-week e-learning courses were scheduled from March to June 2024 on the following topics:

- ***From Traditional to AI-based 3D Scene Capture and Modelling*** (Tutors: Michael Weinmann from Delft University of Technology, Dennis Hartz and Martin Weinmann from Karlsruhe Institute of Technology), March 17-28, 2025.

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*** (Tutors: Juha Hyyppä, Josef Taher and Matti Lehtomäki from Finnish Geospatial Research Institute), April 7-18 – completed (32 participants).

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 the 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. An 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.

- **Machine Learning for Earth Observation** (Tutors: Hao Cheng, John Ray Bergado and Claudio Persello from University of Twente), May 5-16, 2025.

In recent decades, Machine Learning (ML), particularly Deep Learning (DL), has achieved tremendous success across various domains. This course began with a general overview of ML, followed by an exploration of key DL applications in Earth Observation and Geoscience, such as semantic segmentation and change detection using aerial imagery. Step-by-step practical exercises were provided using Python notebooks. The course was structured into four modules: (i) introduction to ML covering conventional classification methods such as Support Vector Machines (SVM) and Random Forest (RF), illustrated by land cover mapping; (ii) DL with an emphasis on Convolutional Neural Networks (CNNs), illustrated by CNN-based image classification model; (iii) advanced image analysis topics, including semantic segmentation, object detection, instance segmentation, panoptic segmentation, and polygonization; (iv) change detection with the application of neural networks for detecting changes over time.

- **Spatial Data Quality** (Tutors: Joep Crompvoets from KU Leuven, Antonello Rizzo Naudi from Planning Authority in Malta, Anouk Huisman-van Zijp from Kadaster, The Netherlands), June 2-14, 2025.

The geospatial landscape has experienced a significant transformation, with the volume of geolocated data expanding rapidly. However, data quality can vary widely. Key aspects like accuracy, completeness, and consistency are critical in minimising errors and maximising the value of spatial data across various applications. For national mapping and cadastral agencies, maintaining high standards of spatial data quality is crucial for ensuring the dependability of the information used. To gain better insights into spatial data quality, EuroGeographics Quality KEN and EuroSDR organise a course that is dedicated to this topic. Participants explored different data quality elements and methods, looked into visualisation challenges, and explored innovative technologies to determine spatial data quality. The course had four modules: (i) Basics of spatial data quality management; (ii) Spatial data quality management: specification, requirements and metadata; (iii) Quality assurance and evaluation, including measures, methods, usability, and trust; (iv) Visualisation of quality in dashboards and crowdsourcing.

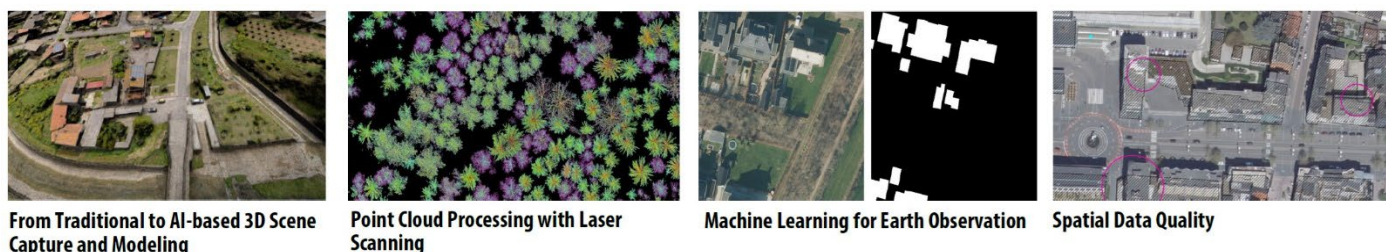


Figure 1: The EduServ23 (2025) courses in 2025.

A total of 65 participants registered, which is a higher number than in previous years. 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	
	participants	issued certificates
From Traditional to AI-based 3D Scene Capture and Modelling	25	16
Point cloud processing with laser scanning	32	21
Machine Learning for Earth Observation	46	19
Point cloud processing with laser scanning	27	11



Figure 2: The EduServ pre-course seminar took place at the National Land Survey of Finland, FGI, Espoo, from March 3-4, 2025.

## Evaluation of the EduServ courses

The participants were asked to share their opinions on the courses to improve our future EduServ courses, and to identify topics of their interest. The questionnaire was available after the official end of each course. We have collected 50 completed questionnaires. In general, the feedback was very positive. Although a very limited number of participants joined the pre-course seminar, it was well-received. The well-structured content, accessibility to teaching materials via Moodle and tutors' prompt responses were particularly pointed out. Among the topics of interest for the future EduServ courses, respondents named RPAS topics with positioning, quality assurance, standards; 3D modelling at the national scale; oblique image processing; hyperspectral data processing; machine learning/deep learning from remote sensing data; AI-based geospatial operations; data integration for combining remote sensing data within GIS platforms; AI-based geospatial analytics and change detection; mobile mapping and data processing; LiDAR data fusion and processing; geospatial digital twins and real time data integration; services for historical geodata archives etc.

## EduServ24 (2026) announcement

Based on EduServ participants' feedback from previous years and current research topics in the framework of EuroSDR, two new EduServ courses for 2026 were prepared and the new series of EduServ courses were announced. The 24<sup>th</sup> EduServ will start with a pre-course seminar hosted by **TU Delft, The Netherlands, from March 2-3, 2026**. The four two-week e-learning courses will be scheduled from March to June 2026 on the following topics:

- **Spatial Data Quality** (Tutors: *Joep Crompvoets*, KU Leuven; *Antonello Rizzo Naudi*, Planning Authority in Malta; *Anouk Huisman-van Zijp*, Kadaster), March 16-27, 2026.
- **Machine Learning for Earth Observation** (Tutors: *Hao Cheng*, *Raian Vargas Maretto* and *Claudio Persello*, University of Twente), April 7-20, 2026.
- **Fundamentals of Python Programming for Geospatial Applications** (Tutors: *Gottfried Mandlburger* and *Katharina Riederer*, TU Vienna), May 4-18, 2026.
- **3D City Modelling: Creation, Standardisation and Use in Urban Applications** (Tutors: *Ken Arroyo Ohori* and *Jantien Stoter*, TU Delft), May 1-12, 2026.

## EuroSDR PhD award

Since 2016, EuroSDR has recognised contemporary PhD theses that have significantly contributed to the development of geoinformation science in the context of national mapping and cadastral agencies (NMCAs). In 2025, we received 11 applications from candidates holding PhDs from universities in Germany, Italy, Norway, Spain, Switzerland and the Netherlands. After a rigorous evaluation by six independent experts (Conor

Cahalane, Joep Crompvoets, Julián Delgado Hernández, Anka Lisec, Jon Mills, and Markéta Potůčková), two exceptional theses were chosen for their scientific excellence, relevance to national mapping authorities, and quality of presentation:

- Dr **Kyriaki Mouzakidou**, with the doctoral thesis titled »*Concurrent Adjustment of Active and Passive Optical Sensors with GNSS and Raw Inertial Data*», Ecole Polytechnique Fédérale de Lausanne.  
Kyriaki's research introduces a unified optimisation workflow that integrates navigation and optical data, leveraging a novel image-to-LIDAR spatial constraint to significantly enhance the geo-referencing accuracy of 3D models.
- Dr **Weixiao Gao**, with the doctoral thesis titled »*Semantic Understanding of Urban Scenes from Textured Meshes*», Delft University of Technology.  
Weixiao's work advances the semantic interpretation of urban environments using textured 3D meshes, contributing valuable insights for urban planning and geospatial analysis.

Both winners presented their research at the 147th EuroSDR Board of Delegates Meeting in Zagreb, Croatia, on Thursday, 13 November 2025.



Figure 3: Dr Kyriaki Mouzakidou (left) and Dr Weixiao Gao (right) presenting their research at the EuroSDR Board of Delegates in Zagreb.

## Recruitment and Capacity Development Challenges

During the 147<sup>th</sup> BOD in Zagreb, we organised a Breakout Session on "*Competence Needs in NMCAs and How Higher Education Responds*". The participants were asked to discuss (i) how well current educational programs and professional training meet the evolving needs of the sector/NMCAs and (ii) how a network such as EuroSDR can support capacity building and academic/NMCA collaboration. The report will be published in 2026

## Workshops – PhD researchers cofunded by EuroSDR

In 2025, two workshops were organised in collaboration with other EuroSDR commissions related to PhD research funded by the EuroSDR:

- Juha Hyypä, Gottfried Mandlbürger, Fabio Remondino, Narges Takhtkeshha: *EuroSDR Workshop on Multispectral LiDAR* (June 23, 2025), and
- Jack Metcalfe, Claire Ellul, Jantien Stoter et al: *EuroSDR Forum - Launching The Digital Twin Cookbook Alpha* (October 22, 2025).

## Collaboration with other associations

In collaboration with *EuroGeographics*, we have offered an EduServ Course on Spatial Data Quality and prepared a joint workshop on Spatial Data Quality that took place in Athens, November 20-21, 2025.

Commission 5, together with other EuroSDR commissions, is actively involved in organising the EuroSDR special session at the ISPRS congress in 2026, which will take place in Toronto, Canada, in July 2026.

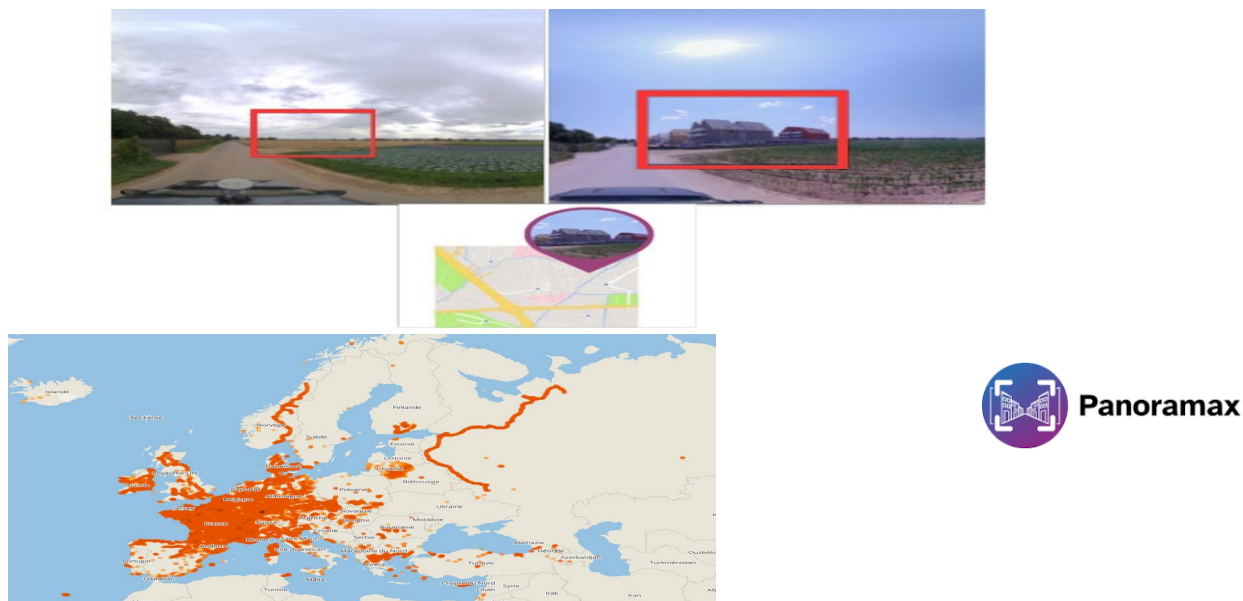
In December 2025, we were actively involved in the Digital Building Permit Conference 2025 in Vienna, Austria (<https://dbp25.conf.tuwien.ac.at/>). The initiative for the research in this domain came partly from EuroSDR with the EuroSDR GeoBIM project (2017-2020).

Research by National and  
Regional Mapping and Cadastral  
Agencies

## Geo referenced Change detection from Panoramax street view

Report by : Zeineb Haj Romdhane, Samy Khelifi, [samy.khelifi@ign.fr](mailto:samy.khelifi@ign.fr)

### Introduction: The Geocommons Panoramax



**Figure 1. Overview of Panoramax acquisitions at the end of 2025 and AI pipeline for change detection**

The French mapping agency (IGN-F) ambitions to promote GeoCommons, i.e. shared geo-referenced resources and / or data, governed collectively between public sector, civil society and private sector. A dedicated Factory supports the identification and development of specific resources that meet these criteria.

One project from that Geocommons Factory is a free and opensource street-level imagery free and open-source platform embedding AI models that can work for as many use cases as possible on a global scale (for anonymisation and road sign detection in particular). Panoramax is led by IGN-F in partnership with OpenStreetMap France. Panoramax enables anyone to share perspective or panoramic images, contribute to its free and open-source software, or deploy their own instance—public, private, or hybrid. Any entity can deploy it for public or private purposes. A meta-catalog allows public instances to be registered and federated through the Panoramax platform.

Currently, approximately 100,000 images are uploaded daily (reaching about 80 million images by the end of 2025). The application is available in 15 languages, and its user community continues to grow steadily.

To comply with the General Data Protection Regulation (GDPR), Panoramax relies on AI-based anonymization pipelines. Beyond this core requirement, both the community and research teams actively develop AI models for tasks such as traffic sign detection and other domain-specific applications.

### Detecting changes with Panoramax

IGN-F is currently exploring the potential of Panoramax imagery to enrich the IGN change-alert database. Our approach relies on matching image embeddings (Figures 2 and 3) in a three-dimensional feature space, using foundation models such as DINOv2. Feature differences are then warped back into the image plane to generate

a two-dimensional representation, which serves as input to an object-detection model (Figure 4). This model outputs bounding boxes corresponding to detected changes, along with associated confidence scores.

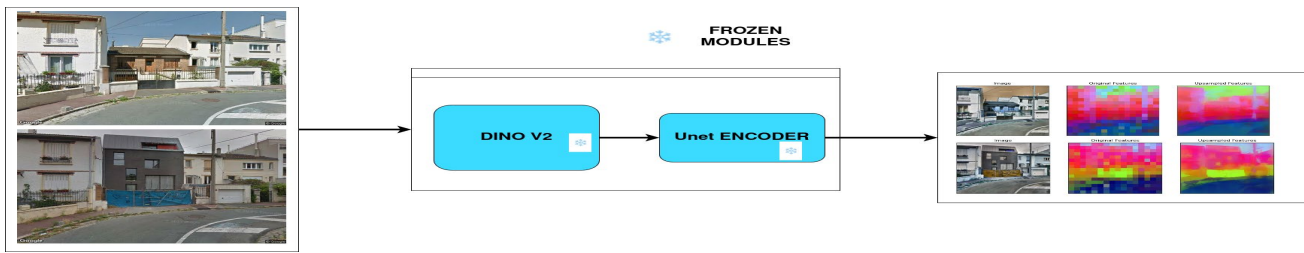


Figure 2. Extraction of image Embeddings with a Foundation model

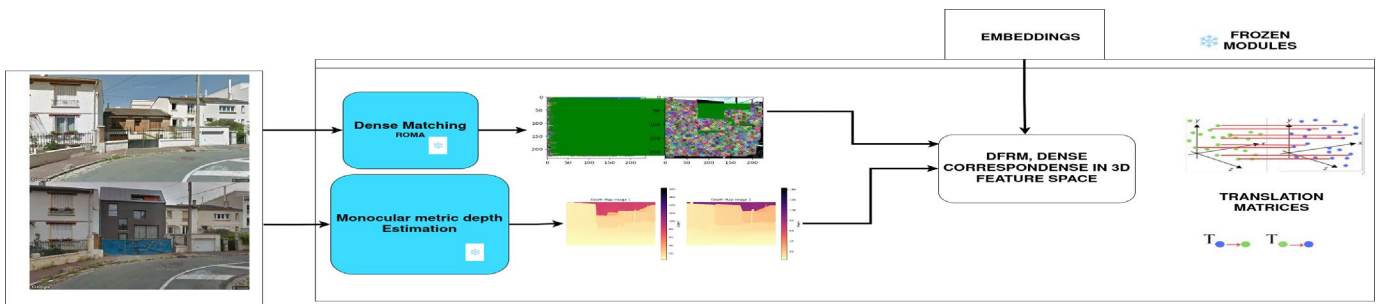


Figure 3. Dense correspondence in 3D feature space via a Differentiable module

To reduce false positives, several filtering strategies are applied. A geometric occlusion filter constrains the spatial search area, while an optional semantic occlusion filter excludes changes related to transient objects. Additionally, an optional semantic class-of-interest filter allows change detection to be restricted to inter-class variations (Figure 4).

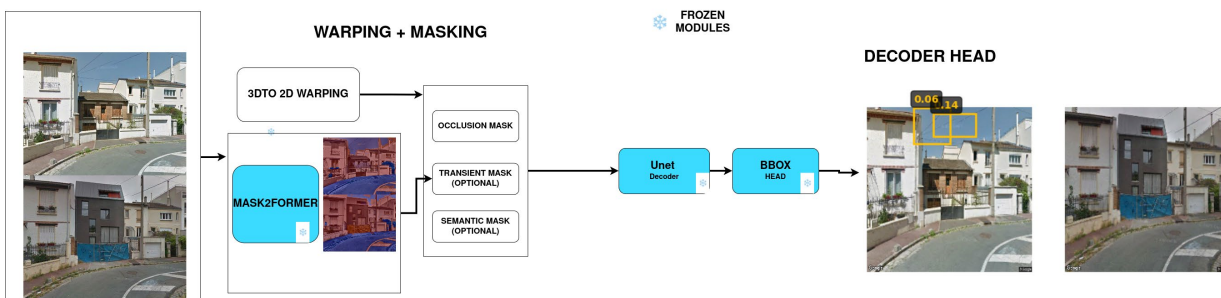


Figure 4. Semantic and occlusion masking

## Conclusion and prospects

Current results are encouraging when all filtering mechanisms are enabled. However, for real-world operational use, intra-class change detection remains essential—for instance, to identify building renovations or changes in road surface quality and markings. On our test datasets, we obtain F1 scores of 0.45 for inter-class change detection and 0.30 for intra-class scenarios, which is not yet sufficient for production deployment. A major limitation arises from localization inaccuracies, primarily due to GNSS and orientation estimation errors associated with low-cost sensors and challenging urban environments. Ongoing work focuses on specializing the model using synthetic datasets, with the dual objective of increasing operational performance and proposing a low-budget alternative to existing proprietary geospatial data solutions.

A collaborative effort at the European scale would be particularly beneficial, both to accelerate research and to improve production efficiency, especially as Panoramax continues to expand across Europe.



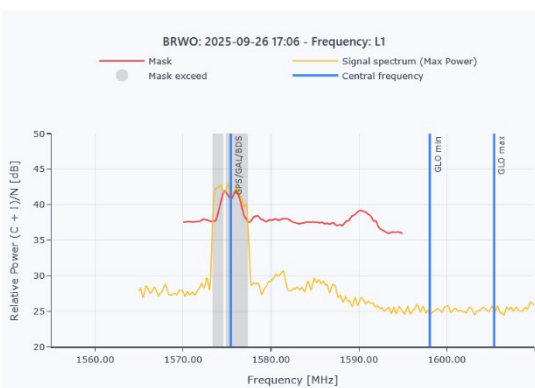
## Real-Time GNSS Monitoring Project for Poland (RTGMS)



The dynamic development of modern technologies, miniaturization and decrease in the cost of new GNSS receivers, as well as the cancellation of fees for correction data from the ASG-EUPOS system have resulted in a rapid increase in the number of users using GNSS technology in professional applications and in everyday life. GNSS services are a key element of critical state infrastructure, such as access to electricity, navigation in aviation, sea and road transportation, or time synchronization in financial services.

Since 2022, we have been observing a large increase in the number of GNSS signal interferences, especially in the region of northeastern Poland, and that is why we have started building a pilot system to monitor GNSS signal interferences. For the purposes of the project, we obtained funds from the European Space Agency, where together with the National Institute of Telecommunications we have applied for funding from a program intended for government institutions. The project budget of EUR 305 000 was approved and the RTGMS project started in November 2024. In accordance to the prepared and approved by ESA project, the main part of the system was built by the end of November 2025, which includes a detection algorithm with a web portal in which the results of the analyses are presented. The portal is available free of charge to all interested users at <https://rtgms.pl>. In addition, a notification system is being developed for registered users, which will inform users via e-mail about the disruptions that occur. Data from monitoring stations are transmitted to the calculation server, where a proprietary algorithm works that allows detecting interference on 3 levels:

Low	High	Site	City
○	●	BART	Bartoszyce
○	●	BIAL	Białystok
○	●	BTLG	Białograj
○	●	BOLE	Bolesław
○	●	BRPL	Biała Pod.
○	●	BRWD	Brendów
○	●	BYDG	Bydgoszcz
○	●	EIOL	Ełbląg
○	●	GDA1	Gdańsk
○	●	GIZY	Gizycko
○	●	GLDP	Gołdap
○	●	GMBL	Gorzów Kl.
○	●	HAIN	Hajnówka
○	●	INMR	Inowrocław
○	●	KATO	Katowice
○	●	KLBG	Kolobrzeg



**High level** – analysis and presentation on graphs of real-time data and archival data obtained from RTCM SC-104 and NMEA 0183 observation streams.

**Medium level** – the module provides access to GNSS observation data from RTGMS monitoring stations and presents the results of analyses of recorded GNSS observations in relation to the number of predicted observations extracted from satellite ephemeris files.

**Low level** - the module presents the results of the analysis of spectral data transmitted from monitoring stations. On the basis of data from the proprietary RTGMS detection algorithm, the table and the map view present the status of individual monitoring stations in colour with a specification of the band for which interference occurs.

During the last stage of the project until May 2026 are planned tests of the system with the use of the mobile laboratory of the National Institute of Telecommunications, which can generate various types of interferences for GNSS signals. Tests conducted in the last stage of the project will allow to determine the levels of alerting and make corrections to the detection algorithms.

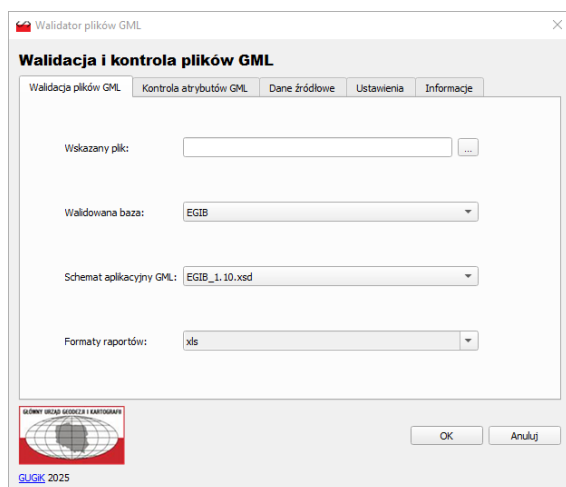
Please note that the information presented on the website is for illustrative purposes only and cannot be treated as official data. Users using the portal should take into account which receiver they are using to perform

measurements and analyse the signals tracked by their receiver. Interferences at frequencies other than tracked by the receiver usually does not affect the quality of observation at other frequencies.

We would like to thank the National Institute of Telecommunications for their excellent cooperation during realization of the project.

## Spatial Data Validators

As part of its own work, the Head Office of Geodesy and Cartography has developed a tool both for validating gml/xml files for compliance with the GML application schema and for the comprehensive quality control (attribute checks) of selected spatial data sets. The tools are available at <https://walidator.gugik.gov.pl/> and on GitHub and in the QGIS plugin repository under the name "GML File Validator."



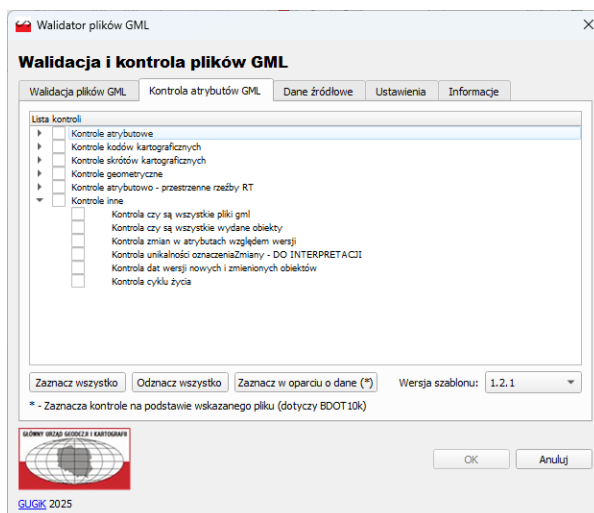
Currently, the plugin enables verification of data from key state registers and databases, including: EGiB (Land and buildings register), GESUT (Utilities network), BDOT500 (Topographic Objects Database 500), RCN (Register of Real Estate Prices), BDSOG – Detailed Control Network Database, PRNG (National Register of Geographical Names), BDOT10k (Topographic Objects Database 10k), BDOO (General Geographic Objects Database), MGR (Soil and agricultural maps) and KARTO10k.

The validation process includes several types of tests. First, the validator checks metadata compliance through the GetCapabilities request by verifying whether layer names and titles follow current legal requirements. It specifically analyzes the presence of required phrases in the name and title attributes. Next, the validator verifies the correctness of service responses

using GetFeatureInfo (for WMS) and GetFeature (for WFS) requests. In this step, the system checks whether the attributes and their values comply with the application schema of the respective database. For WMS services, the query coordinates are provided by the user, except in the case of the EGiB database, where validation is performed automatically based on the county's TERYT identifier. For WFS services, the system automatically retrieves one object from each required layer for analysis.

The widest functional scope concerns BDOT10k data, for which the application performs nearly 800 defined controls using QGIS Expressions and Python functions, including verification of attributes, geometry, and spatial relationships. Some analyses are based on the BDOT10k source data and available reference sets used in the update process. The controls are grouped into six main areas: attribute checks, cartographic code checks, cartographic abbreviation checks, geometric checks, attribute-spatial terrain relief checks, and others, which focus on ensuring data completeness and object lifecycle accuracy.

As result, the validator's operation returns a report summarizing the validation for the compliance with the GML application schema – an XSD file – and the results of attribute checks in the following formats: TXT, CSV, PDF, XLSX, and as spatial layers generated in QGIS, indicating objects that do not meet the adopted rules. TXT reports are used by the Land and Building Register maintenance software to facilitate data corrections in the register itself. This approach helps to support users in data analysis and correction, as well as documenting the validation process, simultaneously ensuring the consistency and reliability of spatial data in state registers and geodetic databases.



The RCN Validator is a separate, automated tool dedicated to verifying GML files of the Real Estate Price Register. It performs validation of XSD schema compliance, logical relationships between data elements, data completeness, and geometry correctness. The tool is available both as a web application and as a desktop (offline) version. The validator checks the data structure and required fields according to the XSD schema, verifies relationships between objects (transaction → property → parcel, building, or premises), detects duplicate identifiers and incorrect references, identifies missing or invalid geometries, and assesses compliance with statutory deadlines. One of the key advantages of this tool is the combination of technical, logical, spatial, and legal validation within a single process. It provides ready-to-use validation presets adapted to different stages of

the workflow and generates detailed reports with the option to export errors to CSV or Excel files. Additionally, it can operate in offline mode.

Using the RCN Validator improves the quality and completeness of RCN data, reduces the number of corrections and returns, significantly speeds up file verification, and ensures compliance with applicable regulations and standards. In practice, this results in a cleaner and more consistent database, less need for manual verification, ready-made reports for audits and communication with contractors, and reliable data for analysis and publication.

## CARMINE (Climate-Resilient Development Pathways in Metropolitan Regions of Europe)

The HORIZON-CL5-2023-D1-01 – Climate sciences and responses – CARMINE project was started in February 2024 as a European research and innovation action funded by the Horizon Europe Programme. The project brings together more than 30 partners, including the National Centre of Cartography (CNC).

The main objective of the project is to enhance the climate change adaptation capacity of metropolitan communities across Europe through the co-design and implementation of effective adaptation and mitigation strategies, addressing increasing climate variability and uncertainty. For Romania, the case study is represented by the metropolitan area of Braşov. The area was selected considering its exposure to multiple climate-related challenges, such as droughts, floods, water scarcity, and heat waves.

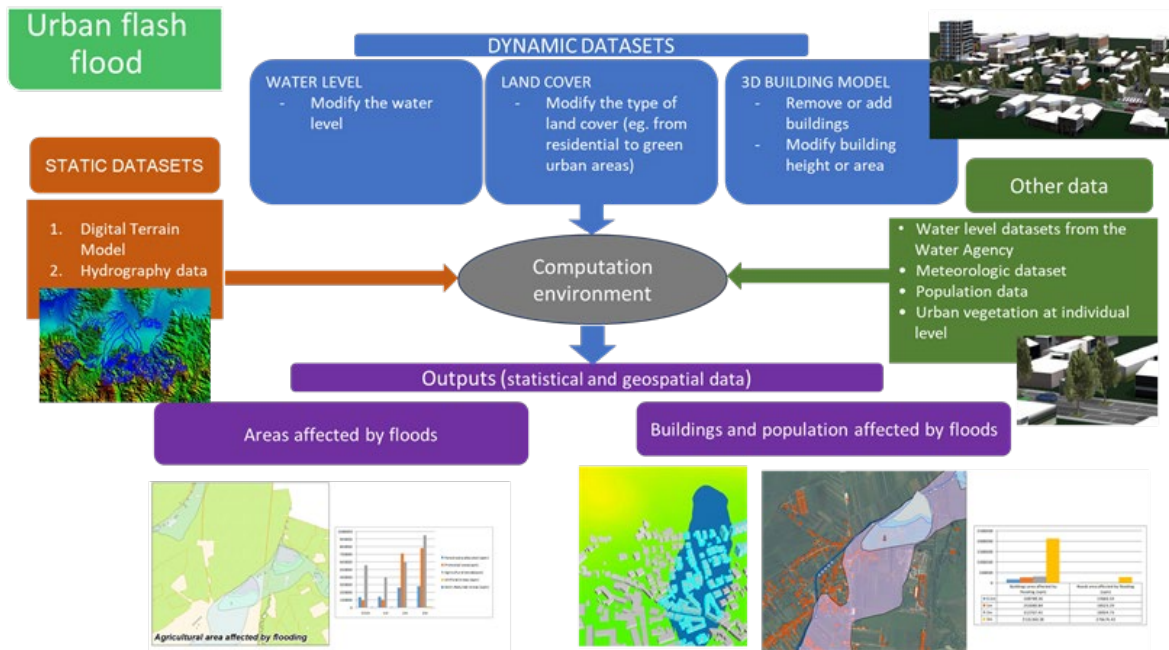
The main activities performed by the CNC team in 2025, include:

- Generation of flood maps and statistical datasets for the Braşov metropolitan area using four scenarios based on the water levels increase;
- Calculation of the Sky View Factor (SVF) for urban microclimate analysis, supporting heat island assessment;
- Generation of a 3D building model for a selected district in Braşov;



3D building model

- Development of a workflow for the generation of a Digital Twin specific to the CSA Braşov.



These activities contribute directly to the assessment of climate risk exposure, scenario comparison, and the development of evidence-based adaptation measures, supporting the overall objectives of the CARMINE project.

## WATER CADASTRE PROJECT

In 2025, the national project **Realization of Water Cadastre** was started and the beneficiary is the Romanian Water Administration (ANAR). The project is funded within the National Recovery and Resilience Plan and has the deadline in March 2026. The project aims to provide accurate and standardized spatial data to support water management activities at national level. The project includes aerial image acquisition with 20 cm spatial resolution at national level (238.000 sqkm) and airborne laser scanning (LiDAR) with a density of 5 point/sqm for 50.000 sqkm, including the surface of 15 dams in different areas. The products include orthophotos, classified point clouds (8 classes: ground, vegetation, buildings, points on water, bridges, low and high noise and unclassified), DTM, and DSM.

Based on the national law, the quality control of the delivered data are performed by a technical commission from CNC.

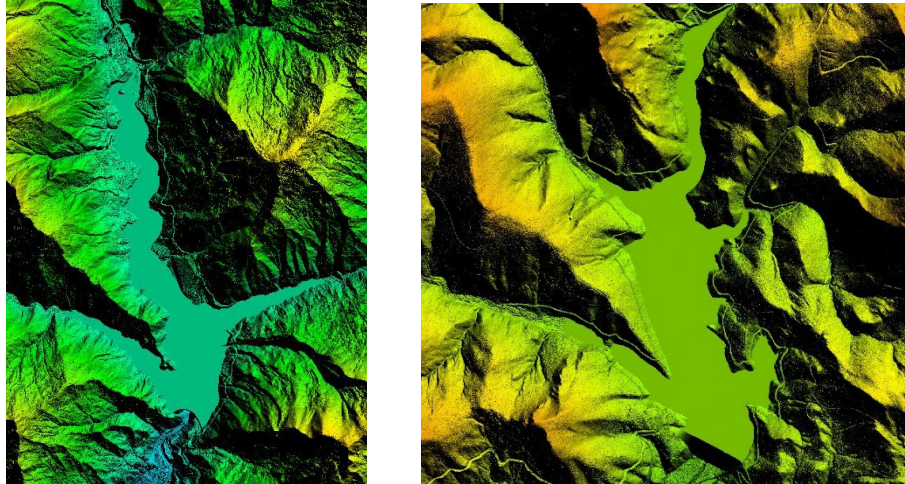
### Photogrammetric data QC

- a. Verification of aerial image acquisition, focusing on spatial, spectral, and radiometric resolutions, images overlap, and visual quality of the images (eg. cloud cover, shadows, overexposure);
- b. Verification of the aerial triangulation process and results, including the reconstruction of the photogrammetric block, measurements in the 3D environment of control and check points, and assessment of horizontal and vertical accuracy using statistical indicators;
- c. Verification of orthophotos, ensuring compliance with horizontal accuracy requirements, radiometric and geometric consistency of the products, and proper connection with adjacent blocks.



## LiDAR data QC

- a. Verification of LiDAR acquisition, focusing on flight conditions, strip overlap, average density of points;
- b. Verification of the point cloud processing, including correctness of point cloud classification (based on a sample consisting of 10% of the data set and identifying incorrectly classified points for each class), accuracy of the point clouds: horizontal accuracy (evaluated in profile points situated on building roofs), relative vertical accuracy (evaluated in smooth surfaces on overlapping areas), and absolute vertical accuracy (evaluated in check surface points situated on hard surfaces);
- c. Verification of DTM and DSM, ensuring compliance with vertical accuracy requirements, geometric consistency of the products, and proper connection with adjacent blocks.



DTM for Paltinu and Bolboci dams

# The Surveying and Mapping Authority of the Republic of Slovenia

Partners:



Co-financing:



## Applied research project L2-50090: Geodetic marks as material witnesses of the geodetic networks development in Slovenia

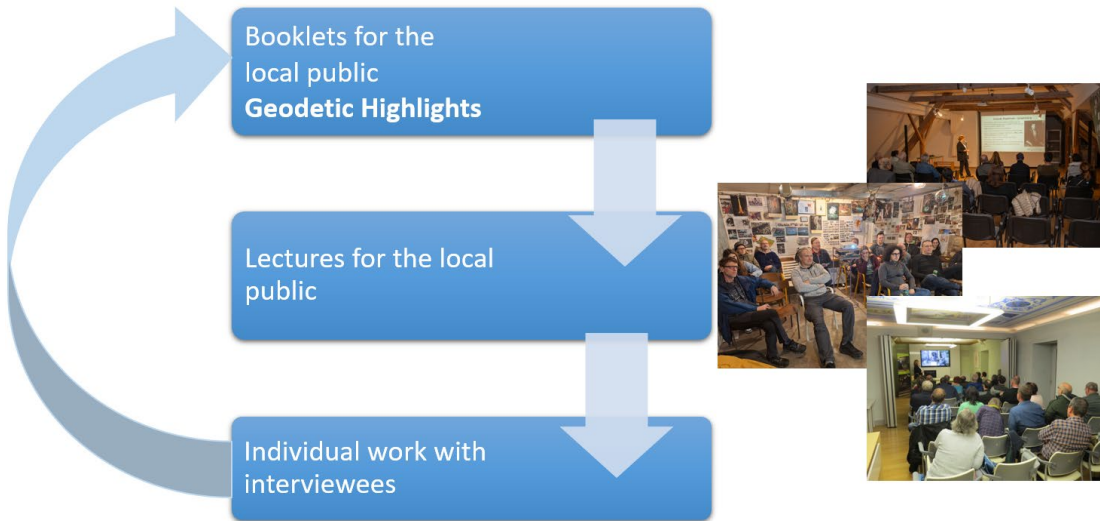
Project page: <https://gis.si/en/l2-50090-geodetska-znamenja-kot-materialni-pricevalci-razvoja-geodetskih-mreza-na-slovenskem/>

As part of this applied research project, we are conducting interviews with laypersons and specialists of different professions who are very familiar with their local environment and could be aware of older geodetic marks still being preserved there. Based on the analysis of the information obtained about preserved older geodetic marks and detailed study of literature and archival sources, we have prepared case studies, which we have also presented to the local public by lectures. There we got acquainted with new potential interviewees enabling further research. Our studies connected geodetic history, administrative history and mythical narratives connected with such old geodetic marks. We published results in scientific papers as well as in special booklets intended for local public entitled Geodetic Highlights, which are available at local mountain huts or local museums and online (<https://gis.si/en/geodetski-utrinki/>). With the help of lectures for local public and Geodetic Highlights we hope to increase public awareness of geodetic points of different kind as they present our common heritage and should be preserved in situ.





The cover pages of Geodetic Highlights published in the scope of this project.



Workflow of applied research project.

## Further reading

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Triglav Čekada, M., Hrobat Virloget, K. (2026). Old boundary locations preserved from the former estate boundaries and their mythical symbolism: the example of southwest Slovenia. *Geoheritage*.

Triglav Čekada, M., Bratož - Ježek, B. (2025). The remains of the former Venetian border hidden in the cadastral municipality boundaries on the Kraški rob plateau around Črnotiče. *Geodetski vestnik*, 69(4), 457–499.

Triglav Čekada, M., Kozorog, E., Premrl, B. (2025). The Jama (Luegg) estate boundary marks in the forests of Hrušica, Slovenia. *Geodetski vestnik*, 69(2), 180–204.

Triglav Čekada, M. (2025). Column from Kozina – from the cadastral municipality boundary mark to the gravimetric point. *Geodetski vestnik*, 69(1), 69-74.

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## Advances in the National PNOA-LiDAR Coverage: High Resolution and Artificial Intelligence

The National Geographic Institute of Spain (IGN) completed the new high-resolution national PNOA-LiDAR coverage in 2025, thereby accomplishing for the third time the three-dimensional modelling of the entire Spanish territory using LiDAR technology.

Data acquisition was carried out using Optech Galaxy T2000 sensors, achieving a homogeneous density of 5 points per square metre and recording up to 8 returns per pulse, with a vertical accuracy of 10 cm. This improvement in data resolution enables the identification of increasingly smaller elements within the point clouds and provides a level of detail significantly higher than that of previous coverages.

The semantic classification of the point clouds is performed using advanced Artificial Intelligence techniques, based on Deep Learning algorithms and cloud computing infrastructures. The implementation of this methodology has made it possible to substantially increase the number of identifiable classes, reaching more than 20 types of geographic features at the highest processing level (NPC3). At this level, reliability values exceed 90% for 13 basic classes (NPC2) and are above 70% for the remaining additional classes.

As a key new feature, once data acquisition and metric quality control have been completed for each region, IGN immediately publishes an initial provisional version of the point cloud. This product is automatically classified into 5 classes (NPC1), with a statistical reliability of 90%, allowing users to access up-to-date LiDAR information within a very short time frame. Although provisional in nature, with lower accuracy and a quality control process based on sampling, it is suitable for a wide range of applications.

With these improvements in the capabilities and technical specifications of the classified point cloud products (NPC), IGN responds to the needs expressed by the user community and significantly broadens the potential uses of LiDAR information across different fields.

In parallel, the new AI-based classification methodology implemented in 2025 includes the training of specific models adapted to the different terrain types present across the territory (urban, rural, mixed, coastal and mountainous), as well as specialised models for certain types of elements, such as vehicles, power lines and roof typologies. The objective is to develop a catalogue of inference models that reflects the geographic diversity of the country and addresses the various expected use cases, both for the current coverage and for future acquisition campaigns.

To train these models, representative samples are being selected and labelled across all regions of the country. This approach is based on the definition of numerous small-sized areas, labelled with a high level of detail and continuously incorporated into the learning process. As a result, increasingly complete and reliable inference models are obtained. Validation is carried out by analysing metrics derived from independent samples manually

	Evaluation	Reliability
		f1 (%)
<b>NPC1 Automatic Classification</b>	Class 2 - Ground	90,0%
	Classes 3, 4, 5- Veg Low/ Medium/high	90,0%
	Class 6- Buildings	90,0%
<b>NPC2 Basic Classification</b>	Class 2 - Ground	95,0%
	Classes 3, 4, 5- Veg Low/ Medium/high	95,0%
	Class 6- Buildings	95,0%
	Class 9- Water	90,0%
	Class 14- Power lines	90,0%
	Class 15- Electricity Pylons	90,0%
	Class 17.- Bridges	90,0%
	Class 64- Vehicles	90,0%
	Class 67- Solar Panels	90,0%
	Class 68- Wind Turbines	90,0%
Class 70- Antennas	90,0%	
<b>NPC3 Advanced Classification</b>	Class 65- Walls/Enclosure	85,0%
	Class 69- Dams	85,0%
	Class 71- Flat Building Roof	70,0%
	Class 72- Sloped Building Roof	70,0%
	Class 73- Green (vegetated) Building Roof	70,0%
	Class 74- Façade	70,0%
Class 75- Inner Courtyard	70,0%	

labelled by IGN. In addition, further refinement processes are being developed to enable the automatic detection and assisted correction of isolated classification errors.

Finally, to ensure the quality of the data made available to users, IGN maintains point clouds labelled using its own resources, which serve as final test areas for the evaluation of the classified data prior to dissemination.

## National historical LC/LU database

Julián Delgado, Samuel Parada

The national historical land cover/land use database (SIOSE-H) is a Spanish project led by the National Geographic Institute of Spain (IGN) to build a harmonized historical geodatabase with nationwide consistency, and fully aligned with the current national LC/LU products (SIOSE and HR SIOSE). The approach combines two complementary pathways: semi-automatic extraction from scanned historical cartography and, where available, the adaptation of pre-existing historical datasets produced by regional authorities, so that heterogeneous sources are standardised into a single coherent national output. The primary data source is the Spanish National Topographic Map at 1:50,000 scale (MTN50), using scanned and georeferenced historical sheets. Additionally, when interpretation is ambiguous due to typical constraints of historical cartography (e.g., dense labelling, mixed symbolisation or difficult patterned areas), the workflow is supported by selected historical aerial imagery from the Spanish National Aerial Orthophotography Plan – Historical Archive (PNOA-H), with particular relevance of the so-called 1956 “American flight” series. The resulting dataset is intended to enable consistent long-term land-change analyses and to provide a traceable historical baseline for institutional and scientific use.

Methodologically, SIOSE-H is implemented as a reproducible pipeline that converts MTN50 sheets into structured LC/LU information through a raster-to-vector workflow. First, a pre-processing step is applied to ensure that variability in scanning and sheet condition does not propagate into extraction outputs. The cartographic content is then decomposed into four ink layers (red, green, blue and black) which act as the thematic backbone for subsequent processing. Ink separation is a key step, as it isolates the main thematic layers of the map and reduces interference between symbols, labels and background content. Moreover, a dedicated text and toponymy removal implementation detects map labels, converts them into georeferenced vector footprints, and masks them from the ink layers to prevent systematic noise in downstream extraction. In a second stage, the separated ink layers are converted into vector candidates and refined through dedicated, theme-specific routines optimised for operational use (e.g., blue for hydrography continuity and cleaning, red for built-up features and settlements, green for vegetated and crop-related areas, and black for transport and other linework) and continuity between adjacent sheets is enforced through edge-matching procedures to obtain seamless national coverage. Building on QGIS prototypes developed in a 2023 pilot, the workflow has evolved into streamlined Python tools that support batch execution, reduce manual parameter handling and minimise human error, with operator review applied where needed in ambiguous or complex cases. Work is also ongoing on more advanced treatment of complex textures (e.g., agricultural and shrub patterns) using object-based and deep-learning approaches to further reduce manual delineation in the most challenging map situations.

In 2025, the project advanced from initial methodological design to an operational workflow, supported by pilot work on representative areas and cartographic conditions. At the time of reporting, the methodology and pilot validation are in their final stages, and the next step is to scale up towards nationwide production, delivering a harmonised historical LC/LU geodatabase ready to be published and accessed by a wide range of users across administrations, academia and the private sector.

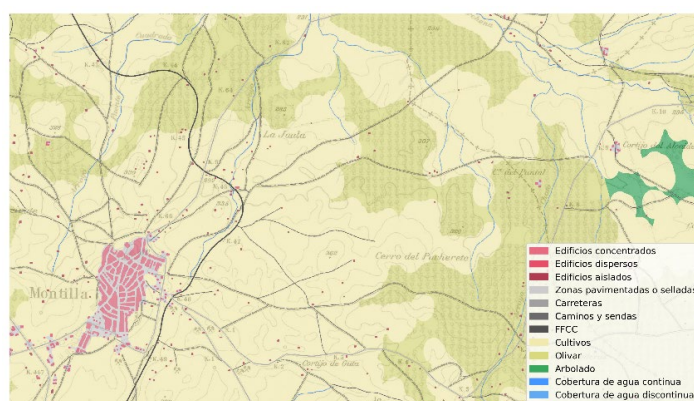


Figure 1: SIOSE-H classification result over Montilla (Córdoba - Andalucía) area.

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