

The growing role of Europe with high value datasets and the digital transformation of the spatial data and 3D.

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SUMMARY

Interoperability of geospatial data has been a target for many research and standardization activities since 1980. In recent years standards and tools have developed. Inspire-, Core data-, High Value data standards have been implemented and European monitoring shows that interoperability improves. More datasets are open and available. Using the OGC standards makes integration easier. The European Commission is supporting projects who implement these standards.

In this abstract I will go into more detail of 2 of these EU sponsored projects: GeoE3 (Geospatially Enabled Ecosystem for Europe) and OME (Open Maps for Europe). The project GeoE3 has developed an integration platform with a number of tools enabling utilization of geospatial data for a number of use cases like solar energy potential and energy efficiency of buildings. By using the OGC API features standard it is possible to view datasets crossborder like 3D buildings.

OME is using the latest standards of different data themes and harmonising them between countries. This large scale dataset containing many countries of Europe can be generalized into many small scale maps. Using a cloud based quality assessment tool developed by the project results in the same data quality within many countries.

This paper addresses how the data from European NMCA's and their services could become part of the European data spaces and how they could work improving data management, services and data integration with other data. The European data strategy with High Value Datasets are important aspects in this path and projects like GeoE3 and OME are supporting this goal.

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1. THE CHALLENGES OF EUROPE AND THE EU SPONSORED PROJECTS

The current energy crisis affects the whole Europe, making cross-border provision of climate data indispensable. Energy-related applications are thus becoming increasingly significant also for geospatial service development. Climate properties of the study areas are often critical for informed decisions in energy applications. Also the need for 3D geodata is increasing in various environmental and energy-related applications. This concerns in particular the content theme buildings. Cross-border provision of 3D buildings is thus an important research and development objective, as the challenges related to human settlements tend to traverse physical boundaries and need to be tackled in the international context.

Everything happens somewhere, and thus, geospatial data is driving many applications to realise social, economic and environmental benefits. Knowing where to find and access accurate, high quality, reliable High-Value Data is essential for governments and decision-makers making critical decisions that affect all of society.

The European Commission is sharing these goals and sponsoring projects that support these goals. Two examples are OME and GeoE3.

Open Maps for Europe (OME) has enabled five pan-European harmonised datasets to be made open and easily accessible through the Open Maps for Europe portal. It has achieved a significant increase in usage of the datasets by over 800%, users ranging from public sector organisations to academics, SMEs, and even private individuals. Services offered by Open Maps for Europe have been incorporated into European Commission systems, specifically by the European Environment Agency which are providing EuroRegionalMap as a selectable background map in their European Ground Motion Service. The United Nations have also accessed the authoritative data from Open Maps for Europe to support their humanitarian work in Ukraine. The project will also create a new production process to create quality harmonised, large-scale, panEuropean High-Value Geospatial Datasets (HVD) from EuroGeographics members, i.e. the NMCAs from across Europe. It will make it available to European and global decision-makers from both the private and public sectors to support policy objectives such as the open data directive and the green deal, support critical actions required to address the climate crisis, and the private sector to maximise the value of their own data. OME2 will significantly benefit the user of High Value Datasets. The new production process will create a dataset that means the user will no longer need to access the individual Member States portals for specific geospatial datasets or spend significant resources trying to connect the datasets. A harmonised pan-European view will be available.

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OME aims to provide harmonised; edge matched pan-European data created from the NMCAs high-value data, which the user can easily access and consume.

The Geospatially Enabled Ecosystem for Europe (GeoE3) project has commenced with the main goal to develop use case-oriented, cross-border and cross-domain geospatial services conforming to the second-generation interface standards. The five-nation project focusses on cross-domain integration of content by applying dynamic, service level methods for joining meteorological and statistical data with geospatial features. Various technologies have been tested for providing seamless, cross-border access to geospatial resources in context of the new Open Geospatial Consortium's family of service interface standards. The project Geospatially Enabled Ecosystem for Europe (GeoE3) has selected Energy and climate as important use cases involving five European countries. The cloud-based data integrations platform developed in the project facilitates harmonized access to climate properties provided by meteorological institutes in all of the participating countries. Various download and direct access methods are applied in getting the climate data to the platform, from which it is offered to the client applications via the OGC API Coverages service interface. The GeoE3 project has been developing a content integration platform for facilitating crossborder access to 3D buildings datasets from five European countries. The approach is based on the utilization of modern standards, like OGC API Features and CityJSON, and applies on-the-fly processing of datasets for improved coverage and harmonization.

2. OPEN MAPS FOR EUROPE

Within the Open Maps for Europe project, European Commission User requirements of official geospatial data were investigated. The main requirement is for a harmonised edge-matched pan European geospatial dataset that delivers key themes from authoritative sources. Users have been actively involved throughout the initial review process to ensure the proposed outcome can meet these. The main user requirement is pan European harmonised edge-matched large-scale data, in an easily accessible format with harmonised licensing. OME deliverables are practical implementations of the Open Data Directive. Data is made available as open in a machine-readable format and can be easily used and re-used without any limitations and free of charge. Data will be made accessible via the OME portal and through a standard harmonised open data licence allowing the user to accept one license, regardless of the source of the data. The themes to be delivered for large scale data are identified as potential High Value Datasets, and are the highest priorities identified by the end users. These are Administrative Boundaries, Hydrography and Transport themes, Cadastral data and GeoNames. The output datasets also support the FAIR principles (Findable, Accessible, Interoperable and Reusable). Data is at the very start of the value chain, before application, monitoring, reporting, decision-making, and action. There is a wide consensus that geospatial data are those that offer the widest set of opportunities for reuse, namely because of their combinability with other datasets, therefore OME specific objective to make

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geographical open data easily accessible for unlimited re-use in the European single market for data (data spaces) is crucial. The number of use cases is almost infinite, including the Covid-19 crisis, which reinforces the strategic importance of the wide availability of high-quality georeferenced data to track the epidemics and control the reopening. This is also supported from case studies that have been identified within the OME project, e.g. use of data for the External Action Force to support humanitarian work in Eastern Europe and the European Environment Agency plan to providing OME data within its European Ground Motion Service. In the wider scheme, geospatial data and maps, open for re-use via APIs, are known to be used to create machine learning applications used to monitor and report climate changes and support decision-making toward Sustainable Development Goals (SDGs). These outputs also clearly support the digital age and the green deal by providing easily accessible High Value Datasets.

There are some known challenges for Member States, linked to the implementation of the Open Data Directive, which can be due to political, technical or resource issues. In terms of political barriers, NMCAs in each member state have a national remit. Although they will comply with EU regulations this can take time due to current national policies. For example, NMCAs previously created income to support the activities required to collect data and produce datasets by charging a licence fee to use their data. They will be required to find sources of funding to cover this loss of revenue due to the implementation of the Open Data Directive to ensure their sustainability. OME2 addresses the issues of long-term sustainability and will also support NMCAs to mitigate and remove the remaining barriers so full coverage can eventually be achieved for these datasets. This will be done through engagement, knowledge exchange and capacity building activities to support members in opening up their data to make it easily accessible.

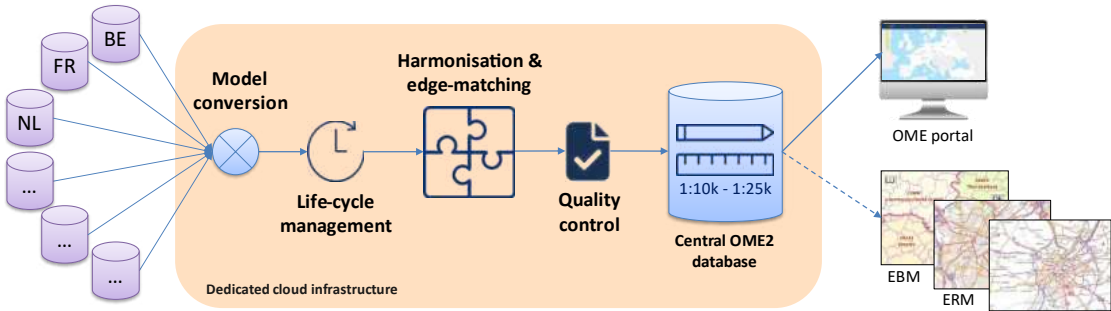


Figure 1: OME production process.

2.1 To increase the easy availability, quality and usability of public sector information in compliance with the requirement of the Open Data Directive

The project OME will increase the easy availability, quality and usability of public sector information in compliance with the Open Data Directive by building a new production system to provide quality harmonised, large-scale, pan-European High-Value Geospatial Datasets (HVD) in European countries. Their data is public sector information and is part of the geospatial domain defined by the directive on ‘Open Data and the re-use of public sector information’. OME will cover the themes, Administrative Boundaries, Transport and Hydrography, across 7-10 countries, harmonised and edge-matched across boundaries, available via an open data license. The Open Cadastral Map will be developed. These High Value Datasets will be easily accessible and available through the Open Maps for Europe portal and through APIs. The project will support the objectives of the Open Data Directive by making the data available as free for use and reuse through a harmonised machine-readable open data license. It will also link directly to work already completed within the United Nations Initiative on Global Geospatial Information Management (UN-GGIM) Europe on core datasets.

2.2 To boost the re-use and combination of open public data across the EU for the development of information products and services, including AI applications

OME2 will boost the re-use of the datasets by promoting them widely across key sectors, indicating the value of combining open geospatial data with other datasets to produce derived products and services. The data is a unique and an essential resource for economic growth, competitiveness, innovation, job creation and societal progress in general. The data comes from official sources and therefore is authoritative. It is critical for policy and evidence-based decision making. It will benefit both public bodies and private companies/users, in large sectors such as Health, Manufacturing, Agriculture, Finance, Mobility, Environment and Energy. The data is firstly focussed on the Green Deal data space, ‘GreenData4All’ initiative, but the project is very aware of the high demand for the public sector geospatial data in every data space envisaged in the European Strategy for Data. The project aims to increase the availability of datasets for the benefit of every single data space.

2.3 To support public administrations at local, regional and national level in increasing semantic, technical and legal interoperability and data portability of the High Value Datasets (HVDs)

The project is supporting public administrations with the High Value Datasets (HVDs) to the Open Data Directive namely: Geospatial, Earth observation and environment, Meteorological, Statistics, Companies and company ownership, Mobility. Semantic, technical and legal

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interoperability will be increased by creating a new production system to create harmonised pan European geospatial High Value Datasets, available under one standard open data licence.

2.4 The datasets generated will be discoverable and available through one or more open data portals for free and conditions for the publication and re-use of datasets must be machine readable and compatible with open standard.

The new datasets will be discoverable and available through open geo-portals, discoverable through the European data portal via API's on the metadata and available through the Open Maps for Europe portal (<https://www.mapsforeurope.org>) as downloads or as a service via APIs.

The new datasets will be available for re-use through a standard open data license. A proven procedure will be implemented in the Open Maps for Europe project. It allows the project to gain the permission of NMCA's to allow for combined datasets to be licensed under a harmonised open data license, regardless of the data's national source (see <https://www.mapsforeurope.org/licence> for the terms of the licence). The license will be made machine-readable via an XML schema, allowing search engines and other kinds of technology to read and understand it.

2.5 A concrete set of quality standards with a technical specification and required set of data quality attributes will be proposed to ensure crossborder interoperability for each dataset and its wider re-use on the EU level.

A new technical specification and production process will be defined to create these new datasets, which will harvest NMCA data (large-scale national data, 1:10,000 scale or similar), through a manual upload by the NMCA, depending on their situation. The data will be converted to the specified data model for the large-scale dataset for each theme. The data will then be harmonised across borders and edge-matched using the tools created by the project. The life-cycle of the data will be managed to allow for change only updates. Feasibility studies will be undertaken to create smaller-scale datasets through automatic generalisation and to assess the possibility of automatically harvesting NMCA national data to update the large-scale pan European dataset. A concrete set of quality standards and tools, including technical documentation, a clear list of attributes, formats, structure, semantics and various Quality Assurance tasks, will be applied to ensure the outputs meet the specified quality requirements.

2.6 Existing or newly developed Application Programming Interfaces (APIs) must be implemented to give access to datasets addressed.

All existing OME datasets (EuroGlobalMap, EuroRegionalMap, EuroDEM, Open Gazetteer, Open Cadastral Map and Imagery) will be accessible either as a download or as a download service via the current APIs. OGC (Open Geospatial Consortium) API standards will be investigated to ensure the APIs available to the end-users fit the purpose, and proposals will be made to improve these. The new datasets will be available as either a partial download (for example, by selecting area/theme) or as a service utilising these APIs. APIs will also allow the data to be discovered via the European Data portal.

3. GEOSPATIAL ENABLED ECOSYSTEM FOR EUROPE

In an interoperable computing environment, every participating actor should gain benefits. This is the main guiding principle in the spatial data ecosystems currently being developed. A major action, Geospatially Enabled Ecosystem for Europe (GeoE3), has commenced to establish an ecosystem of use case-oriented geospatial services in five European countries. The action is part of the Connecting Europe Facility (CEF) programme advancing European transport, energy and digital infrastructure development. The project involves five national mapping and cadastral agencies, together with a few other governmental organizations and private companies. The main goals of the project include adaptation of modern geospatial APIs (Application Programming Interfaces), to establish cross-border services for renewable energy and urbanization related use cases and to use dynamic service-level mechanisms for cross-domain content integration. GeoE3 consortium membership includes the national mapping or cadastral agency from Finland, Norway, Estonia, The Netherlands and Spain. Furthermore, the consortium includes the national meteorological and statistical agency of Finland: Finnish Meteorological Institute and Statistics Finland, respectively. Private companies include Spatineo from Finland and Aventi Intelligent Communication from Norway. Open Geospatial Consortium (OGC) Europe participates in the project as a representative of the standardization community.

The main use cases identified by GeoE3 include renewable energy applications, specifically in the context of buildings construction and use. In particular, this involves solar energy potential, based on solar panels on rooftops. Wind energy and heating/cooling facilities of the buildings are considered too. The other use cases deal with traffic applications, in particular efficient use of electric cars, and with various urbanization challenges. The last one is considering urban expansion efficiency employing the United Nation's Sustainable Development Goal (SDG) indicator 11.3.1 'Ratio of land consumption rate to population growth rate'.

The GeoE3 project aims at establishing a set of use case - oriented services that enable content integration both across national borders and domain boundaries. The idea is to set up an integration layer on top of national services. The integration layer would provide modern service interfaces to the client side and accommodate various categories of source services on country level. The GeoE3 services are to be based on the OGC API family of second-generation, internationally standardized service interfaces. These include services like OGC API Features, OGC API Coverages and OGC API Records. Internally the GeoE3 platform will apply at least OGC API Processes for introducing analysis-based content layers to the clients and Table Joining Service (TJS) for content integration across domain boundaries. OGC API Environment Data Retrieval (EDR) interface will be used for requesting meteorological data, particularly for supporting transport-related applications.

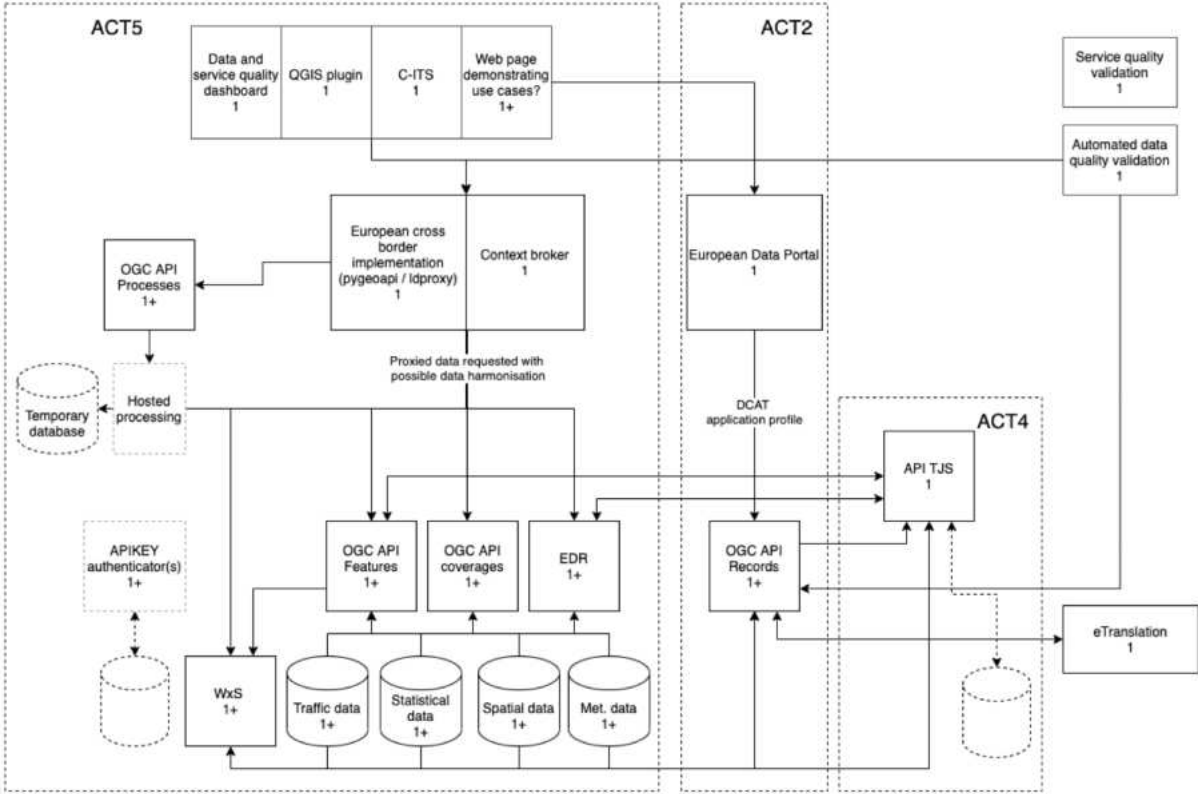


Figure 2. The preliminary GeoE3 service architecture.

The illustration in Figure 2 shows the envisaged GeoE3 service architecture. The WxS box in the left bottom corner represents all the country level data resources that will mostly be accessed through service access points conforming to the OGC standard interfaces, like WFS, WCS and the OGC API family of services. The databases at the bottom emphasize the GeoE3

goal of integrating spatial data with statistical and other tabular data sets. All the data resources will be made available via modern interface standards and be integrated in a cross-border manner by the GeoE3 integration platform. Metadata records of all GeoE3 services will be stored into the European Data Portal (EDP) and also be available from the OGC API Records service interface maintained on the GeoE3 platform. An implementation of the TJS standard is an essential component of the GeoE3 service architecture. It will be responsible for joining tabular data sets with geospatial features. The resulting combined resource is then made accessible to client applications via OGC API Features services.

3.1 Dynamic Integration of Climate Properties with Geospatial Data for Energy Applications.

Consistent cross-border delivery of harmonized climate data has become indispensable with the current energy crisis ravaging whole Europe. It is particularly important to provide access to climate properties in connection of geospatial services, for example to support energy-related decisions in spatial planning and in the construction industry. Buildings are an important factor in energy-saving endeavors and it is thus critical to provide climate properties readily connected with building data. The Geospatially Enabled Ecosystem for Europe (GeoE3) project has been developing a cloud-based service platform for cross-border and cross-domain integration of geospatial data resources. Climate data has been selected from the beginning as one of the key data sources in the project. Renewable energy is one of the three use cases of GeoE3, making buildings a central content theme for the project. GeoE3 involves five European countries: Finland, Estonia, Norway, the Netherlands and Spain. National Mapping and Cadastral Agencies (NMCAs) of each country are participating as members of the project consortium. Crossborder access to 3D building models has been one of the main goals of the project. This goal has been quite successfully achieved, as 3D buildings from all members countries are now available from the GeoE3 integration platform. The national meteorological institute is present in the project consortium only in case of Finland. However, open Application Programming Interfaces (APIs) have been made available by the Norwegian, Dutch and Spanish national meteorological institutes. Dedicated access modules have been developed for the integration platform to accommodate the varying meteorological APIs available. Climate data is made available to client applications from the platform via the modern Open Geospatial Consortium's (OGC) OGC API Coverages access interface that also enables climate properties to be attached to individual buildings.

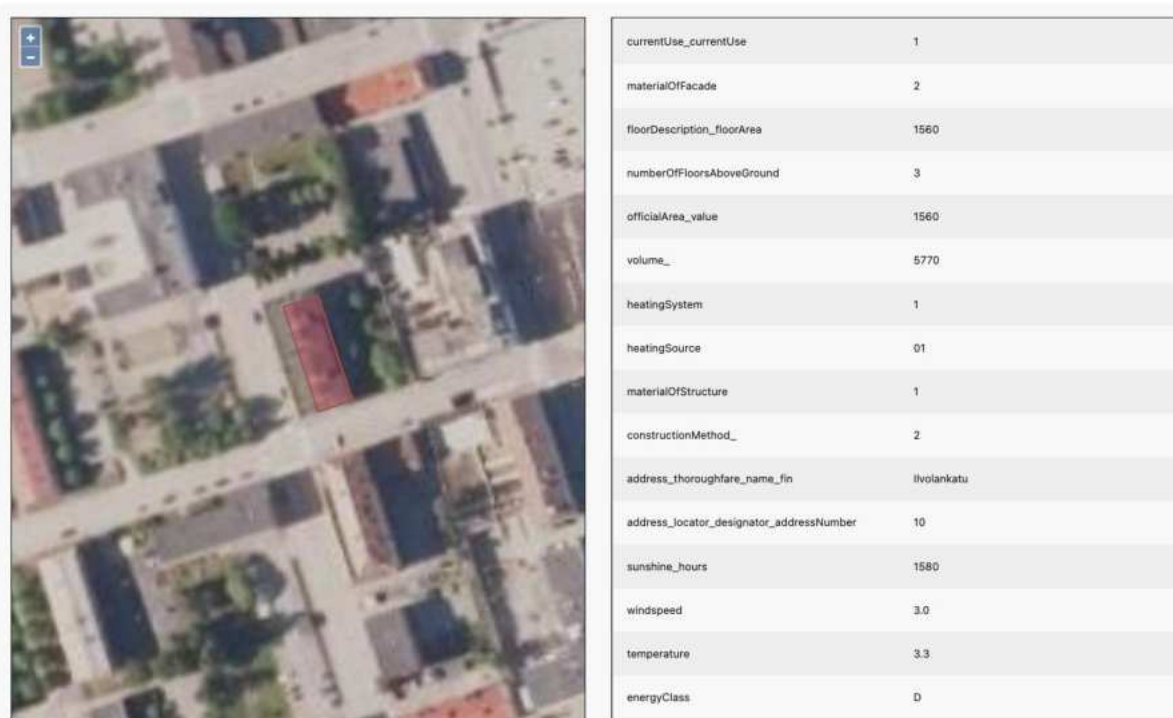


Figure 3. A selected 2D building shown with the climate-related attributes.

3.2 Cross- border Delivery and Web-based Visualization of 3D Buildings.

Cross-border provision of 3D geodata is a new and challenging task for the Pan-European Spatial Data Infrastructure development. The provision of nation-wide 3D data is in early stages and related standards are currently in rapid development phase. First examples of genuine cross-border 3D geodata services are just being developed. The GeoE3 project has been working on cross-border interoperable provision of 3D buildings. Although the approach selected by the NMCAs vary drastically from country to country, the GeoE3 project has managed to set up consistent access to 3D buildings from all the participating countries.

3D buildings are accesses from various different legacy sources from the bottom level and provided from the integration platform via OGC API Features service end point. According to the general approach adopted in the GeoE3 project, all the available country-specific datasets are configured as individual data collections inside a single OGC API instance. This way a simple but powerful solution for content integration can be achieved. Individual country's dataset can be accessed by querying the appropriate collection. Cross-border data requests are supported naturally with the so called cross-collection query, supported in the OGC API Features standard. The new CityJSON encoding standard for 3D geodata representation is adopted for the transfer of 3D buildings.



Figure 4: On the fly 3D buildings crossborder The Netherlands and Germany.

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BIOGRAPHICAL NOTES

Dorus Kruse is a senior manager at the Netherlands' Cadastre Land Registry and Mapping Agency (Kadaster) with over fifteen years of professional experience in project management and five years as Geo manager. He has worked for the Dutch Tax Office for more than ten years as an IT consultant and IT project manager. For Kadaster Dorus was project manager for the Topographical Key Registry and responsible for implementing NSDI web services. Dorus was involved with the innovative project of implementing a Government Geo portal. He was responsible for the programme Public Services on the Map (PDOK), as part of the Dutch spatial data infrastructure. He is currently responsible for the department where the functional maintenance of all applications of Kadaster Netherlands is in operation. For Kadaster International Dorus managed projects in Turkey, Croatia, Northern Macedonia, Serbia, Kosovo and Montenegro.

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