INSTITUTE OF GEODESY AND CARTOGRAPHY

POLISH NATIONAL COMMITTEE
FOR INTERNATIONAL CARTOGRAPHIC ASSOCIATION

CARTOGRAPHIC ACTIVITIES IN POLAND

2019–2022

NATIONAL REPORT

Presented to
the 19th General Assembly of the
International Cartographic Association
Cape Town, Republic of South Africa
August 2023

Warsaw 2023

POLISH NATIONAL COMMITTEE
FOR INTERNATIONAL CARTOGRAPHIC ASSOCIATION

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1. Introduction

The National Report on the cartographic activities in Poland from 2019–2022, addressed to the delegates of the 19th General Assembly of the International Cartographic Association in Cape Town, Republic of South Africa, is the thirteenth such a report that has been prepared by the Polish cartographers since the moment of the admission of Poland as a member of the Association in 1964. The previous reports were sent to the General Assemblies in New Delhi (1967), Moscow (1976), Tokyo (1980), Perth (1984), Morelia (1987), Barcelona (1995), Ottawa (1999), Durban (2003), Moscow (2007), Paris (2011), Rio de Janeiro (2015) and Tokyo (2019). The current Report, just as the above–mentioned items, has been mainly compiled on the basis of reports provided by the offices, research and educational institutions, organizations, libraries and publishers. The information, posted on the websites of these institutions and published in recent years on various occasions in different professional journals, as well as the documents of the conferences dedicated to the cartography, and to the related disciplines, have been used in this Report.

This Report has been prepared in the Institute of Geodesy and Cartography and the National Committee for International Cartographic Association.

The report contains information about the activities of various associations operating in the field of cartography and geomatics, about recent work in the field of official cartography, in particular about maps elaborated for the needs of the blind and visually impaired persons. Research and implementation work on innovative technologies in the production of topographic and thematic maps has been highlighted. The particular attention was paid to geographic names problems. On the other hand, information on the production of maps for school use has been limited to basic data.

A specific feature of all Polish national reports is the last part thereof: the selective bibliography of cartographical publications, which were released in the successive four–year periods. The bibliography closing this Report takes into account more important atlases and maps (most of all the official topographic and thematic maps), and then the selected academic textbooks, monographs and scientific articles as well as important conference papers to reflect the interests and research results of Polish specialists in various fields – from the history of cartography, through important conference submissions to the application of modern digital technologies and infrastructure of spatial information.

2. Participation of Polish cartographers in the International Cartographic Association (ICA)

The active participation of Polish cartographers in various forms of activity of the International Cartographic Association has a long, over half–century tradition. Poland was accepted into this prestigious organization as early as in 1964 and it has belonged to the most active ICA members since. In the past, two representatives of Poland – Prof. Lech Ratajski and Prof. Andrzej Ciołkosz – served as the Vice–Presidents of the Association, four Poles became the Heads of various commissions, and two – Prof. Stanisław Pietkiewicz in 1982 and Prof. Andrzej Ciołkosz in 2003 received the Honorary Membership of ICA. The Poles hosted the 11th. International Conference in Warsaw in summer 1982 and organized several meetings of commissions and working groups of the Association. We take an active part in various international, regional and thematic cartographic conferences and seminars,

regularly present our achievements at the accompanying exhibitions and make our contribution to the activity of numerous commissions of ICA.

Since the beginning, the Institute of Geodesy and Cartography seated in Warsaw has been the official national representative of Poland in the Association. The participation of Polish cartographers in various events and initiatives organized by ICA is supported and coordinated by the National Committee for ICA, which was established in 1976 at the Institute of Geodesy and Cartography. The Committee includes at present 31 members who represent the main cartographic institutions and organizations in Poland, whose activities are related to the cartography. Prof. Andrzej Ciołkosz had been a Chairman of this Committee by March 2015; currently Prof. Robert Olszewski from the Department of Cartography of the Warsaw University of Technology has been fulfilling this function. The Committee maintains the regular contacts and cooperates with the authorities of the International Cartographic Association, makes arrangements for the Polish participation in various cartographic conferences (by preparing national reports, motions, opinions, initiatives, exhibits for international exhibitions and competitions), it takes part in organizing international cartographic events in Poland. It is also a medium for the exchange of information related to the activity of the ICA commissions and working groups.

Polish delegation took part in the previous 18th General Assembly of the International Cartographic Association in Tokyo in July 2019. In Tokyo Polish cartographers presented 27 papers and 4 posters, while in Florence – 18 papers and 5 posters. Poland was also traditionally present at the International Cartographic Exhibitions, showing 5 maps, 2 atlases and 3 educational products in Tokyo, and 10 maps, 3 atlases, 2 digital products, 1 digital service and 2 other cartographical products (including 1 atlas for blind and visually impaired persons) in Florence. The Atlas of Poland's Political Geography and educational product Statistical Maps: Data Elaboration and Presentation were awarded the Third Price during International Cartographic Competition in 2019, while The Geographical Atlas of Belarus for the Blind and Visually Impaired was awarded the First Price during International Cartographic Competition in 20121 in Florence.

Polish children have participated in 2019 and 2021 in Barbara Petchenik Children's Map Competition. Polish cartographers participated in the conferences and workshops organized or co–organised by the Association, for instance in Joint ICA Workshop of ICA 'Usability 4All' of The Commission on User Experience, Commission on Cartography and Children, Commission on Maps and Graphics for Blind and Partially Sighted People and Commission on Open Source Geospatial Technologies in Curitiba, Brasil (2020), Joint ICA Workshop 'Visualization of Dynamic Phenomena and Processes on Web and Ubiquitous Mappings' of ICA Commissions on Maps and the Internet and the Commission on Ubiquitous Mapping in Florence, Italy (2021), Joint ICA Workshop of The Commissions on Cartography and Children and Maps and Graphics for Blind and Partially Sighted People, 'Cartography connecting schools' in Brasilia, Brasil (2021), ICA Webinar 'Mapping for a Sustainable World', Twente, Netherlands (2021), the 8th ICA International Conference on Cartography and GIS in Neseber, Bulgaria (2022), as well as The EuroCarto Conference in Vienna (2022).

Polish cartographers are active in the works of commissions and working groups of ICA:

- Commission on Cartography and Children;
- Commission on Cartography in Early Warning and Crisis Management;
- Commission on Cognitive Issues in Geographic Information Visualization;

– Commission on Cartographic Heritage into the Digital;
– Commission on Generalization and Multiple Representation;
– Commission on SDI and Standards;
– Commission on Map Projections;
– Commission on Maps and the Internet;
– Commission on Mountain Cartography;
– Commission on Open Source Geospatial Technologies;
– Commission on Topographic Mapping;
– Commission on Toponymy;
– Commission on Ubiquitous Mapping;
– Commission on the User Experience (UX);
– Commission on Visual Analytics.

Among ICA affiliated members there were one organization and one enterprise from Poland: Association of Polish Cartographers and Eko–Graf Cartographic Publishing House in Wrocław.

3. Organizational structure and tasks of the Geodetic and Cartographic Service in Poland

According to the Law of May 17, 1989 Geodetic and Cartographic Law, the Geodetic and Cartographic Service in Poland consists of:

1. Geodetic and cartographic supervision authorities:
   - Surveyor General of Poland;
   - governors performing tasks with the help of voivodeship surveying and cartographic inspectors in 16 voivodeships;
2. Geodetic and cartographic administration bodies:
   - voivodeships marshals performing tasks with the help of surveyors of the 16 voivodeships;
   - powiat (county) governors performing tasks with the help of powiat surveyors and communes heads and mayors.

The tasks of the Geodetic and Cartographic Service include, in particular:

1. Implementation of state policy on geodesy and cartography;
2. Organizing and financing geodetic and cartographic works;
3. Maintenance of the state geodetic and cartographic repertory;
4. Controlling offices, public institutions, entrepreneurs in the field of geodetic and cartographic law;
5. Maintenance of the national register of boundaries and administrative division units (areas of the country's fundamental three–level territorial divisions);
6. Preparation of topographic and thematic maps of the country and a base map;
7. Assigning and maintaining a register of professional qualifications;
8. Initiating scientific and research and development work in the field of geodesy and

cartography;

9. Cooperation with specialized national, international and regional organizations in the field of geodesy and cartography, as well as authorities and offices of other countries;
10. Maintenance of the State Geodetic and Cartographic Repertory, including spatial data sets of the spatial information infrastructure.

The Surveyor General of the country is the central government administration body supervised by the Minister of Development and Technology. Surveyor General of Poland performs his tasks with the help of the government administration office – the Head Office of Geodesy and Cartography (GUGiK), in which he serves as president. In the management of the office the Surveyor General is assisted by the Deputy Surveyor General of Poland, the Director General and the directors of organizational units. The term of office of the Surveyor General of Poland is five years, and he is appointed by the Prime Minister following a competition.

The State Geodetic and Cartographic Council and the Commission for Standardization of Geographic Names outside the Polish Borders, operate under the Surveyor General of the country. The State Geodetic and Cartographic Council is an opinion–giving and advisory body.

Spatial data in Poland is collected in its records by many central institutions and local government units at all levels. The largest and most important spatial data resources are collected in **the State Geodetic and Cartographic Repertory (PZGiK),** which is defined in the Geodetic and Cartographic Law. The PZGiK consists of data sets maintained by the authorities of the Geodetic and Cartographic Service, cartographic studies, registers, lists and compilations created on the basis of these data sets, documentation containing the results of geodetic or cartographic works or documents created as a result of such work, as well as aerial and satellite imagery.

The task of the state geodetic and cartographic repertory, according to the provisions of the Geodetic and Cartographic Law, is to serve the national economy, state defense, protection of public safety and order, science, culture, protection of nature and the needs of citizens. All PZGiK data form a spatial data infrastructure, which in turn is an element of the state's information infrastructure and supports building the information society.

Maintenance of the state geodetic and cartographic repertory is the responsibility of:

1. Surveyor General of the country – with regard to the central geodetic and cartographic repertory;
2. voivodeships marshals – with regard to voivodeship geodetic and cartographic repertories;
3. powiat (county) governors – in terms of powiat geodetic and cartographic repertories.

The geodetic and cartographic data collected in the PZGiK is also the basis (reference) for many state registers, whose objects are being located on the basis of geodetic data, e.g. registered parcels or address points.

PZGiK constitutes in particular:

- databases listed in Article 4, paragraph 1a of the Geodetic and Cartographic Law, which are created for the entire country and maintained in information and communication technologies (ICT) systems at 3 levels, i.e., central, voivodeship and powiat (county);
- General Geographical Objects Database BDOO;
- Database of aerial and satellite imagery and orthophotomap and digital elevation model;
- Database of Basic Geodetic Network;
- National Register of Geographical Names;
- National Register of Boundaries;
- Topographic Objects Database BDOT10k;
- Land and Buildings Register;
- Geodetic Register of Land Utilities Networks;
- Topographic Objects Database 1:500;
- Database of Detailed Geodetic Network;
- Register of Real Estate Prices and Values;
- Towns, Streets and Addresses Register;
- standard cartographic studies (registration, topographic and general geographic maps);
- Cartographic thematic and special studies (special thematic maps).

4. Activity of Polish cartographic organizations

The following cartographic associations operate in Poland:

- Cartographical Division of the Polish Geographical Society, whose history is the longest, as its origins date back to the Cartographic Commission of the Polish Geographical Society established in 1966;
- Polish Cartographical and Geoinformational Society, established in November 2022, due to the plans of dissolution of all thematic divisions of the Polish Geographical Society having the legal entity;
- Association of Polish Cartographers, it was established in 1999, when Poland became one of the countries where cartographers have their own independent professional organization;
- Polish Association for Spatial Information (PASI);
- Polish Cartographical and Geoinformational Society, established
- Team for the History of Cartography at the Institute of History of Science, Polish Academy of Sciences.

In addition, issues related to cartography are dealt with by the Polish Association for Spatial Information and the Commission of Geoinformatics at the Polish Academy of Arts and Sciences (PAU).

The Cartographical Division of the Polish Geographical Society cultivates the traditions of the former Cartographical Commission of this Society (1966–1999). By the end of 2022 the Division numbered 59 members. Since 2012, Professor Marek Baranowski from the Institute of Geodesy and Cartography has been the Chairman of the Division. The main aim of the Division's activity is the organization of cooperation and exchange of experience between research, educational and production centres which are engaged in cartography in

different areas and aspects as well as the popularization of cartography, especially among numerous teachers of geography, the members of the Society. The fulfilling of these goals is mainly possible due to the organizing national conferences, seminars and cartographic schools as well as by virtue of publishing of its own journal and other publications.

The national cartographic conferences have been organized, for the most part – annually, since 1968, in different cities of Poland in the partnership with the local cartographic training centres and other institutions and organizations related to cartography. There were three such conferences in the years 2019–2022:

- The 42nd National Cartographic Conference 'Generalization of maps in digital technology' held in Cracow in September 2019 (29 papers, 11 posters), organized in cooperation with the Faculty of Geo–Data Science, Geodesy, and Environmental Engineering of AGH University, The Commission of Geoinformatics of Polish Academy of Arts and Sciences (PAU);
- The 43rd National Cartographic Conference 'Cartography for all and for everyone' held in Warsaw in October 2021 (24 papers, 6 posters), organized in cooperation with the Department of Geoinformatics, Cartography and Remote Sensing, Chair of Geomatics and Information Systems of Faculty of Geography and Regional Studies at University of Warsaw, under the patronage of the Surveyor General of Poland;
- The 44th National Cartographic Conference 'Cartographic–Geomatic Relationships and Descriptions' held in Toruń in September 2022 (36 papers, 8 posters), organized in cooperation with the Toruń Branch of the Polish Geographical Society, Department of Geomatics and Cartography of Faculty of Earth Sciences and Spatial Management at Nicolaus Copernicus University in Toruń, under the patronage of the Surveyor General of Poland and the City Mayor of Toruń.

Abstracts of papers can be found in conference materials, while selected papers have been published in the 'Polish Cartographical Review'.

Since 2009, upon the initiative of the Division and in cooperation with various universities, annual competitions of master's theses in the field of cartography and geoinfomatics and geoinformation have been organized. There were three such conferences in the years 2019–2022:

- The 11th National Competition of Diploma Theses in the field Cartography, Geomatics and Geoinformation held in Warsaw in May 2019), organized in cooperation with the Department of Geoinformatics, Cartography and Remote Sensing, Chair of Geomatics and Information Systems of Faculty of Geography and Regional Studies at University of Warsaw;
- The 12th National Competition of Diploma Theses in the field Cartography, Geomatics and Geoinformation held in Lublin in October 2020), organized in cooperation with the Department of Cartography and Geomatics at the Maria Curie–Skłodowska University in Lublin;
- The 13th National Competition of Diploma Theses in the field Cartography, Geomatics and Geoinformation held in Warsaw in November 2022), organized in cooperation with the Department of Cartography of Faculty of Geodesy and Cartography at Technical University of Warsaw.

The Cartographical Division regularly publishes a professional journal, the quarterly 'Polish Cartographical Review'. It is published as the continuation of the periodical that was its precursor and had been issued in Lwów in 1923 – 1934 period under the same title. This new Warsaw edition has been distributed since 1969. Since 2014 the Quarterly has been publishing all its articles in English. In 2022 the volume 4 of the Bibliography of Polish Cartographical Review articles (2009 – 2020) was published.

Fig. 1. Polish Cartographical Review

Information about the Division and the report on its current activities are available on the website https://www.kartografia.org.

The Polish Cartographical and Geoinformational Society is a scientific organization embracing the cartographers being the members of the Cartographical Division of the Polish Geographical Society, and will continue the activities of this body in the case of it's dissolution by General Board of the Polish Geographical Society.

The Association of Polish Cartographers (APC) is a professional, scientific–technical organization uniting the Polish cartographers based on voluntary membership. By the end of 2022 the Association numbered 183 regular members and 4 supporting members. Ms Joanna Bac–Bronowicz, Prof. from the Department of Geodesy and Geoinformatics, at Wrocław University of Technology and Science, has been the Chairperson of the Management Board of APC since the very beginning of its existence.

The statutory objectives of the Association include representing the interests of designers and professionals actively involved in the cartographer profession in the country and abroad, protection of the profession and copyrights of cartographers, raising the level of knowledge, technical culture and professional qualifications of members of the Association, popularizing scientific, technical and economic issues in the field of cartography, cooperating with relevant units of state and local administration in the field of cartography and conducting exchange of organizational and scientific and technical experiences with related organizations abroad.

A Chapter was established in 2015 to honour the scientists and practitioners making a significant contribution to the development of cartography, and the rules laid down for

awarding the APC Medal, named after Professor Andrzej Makowski, professor at the Warsaw University of Technology who passed away in 2013. So far, the medal has been awarded, among others, to professors, who have been involved in ICA activities for several decades: Władyslaw Pawlak, Ewa Krzywicka–Blum, Janusz Gołaski and Izabella Krauze–Tomczyk, Jerzy Ostrowski, Jacek Pasławski, Wiesława Żyszkowska, Tadeusz Chrobak, Jan Krupski and Michał Stankiewicz.

The Association's activities are carried out through the participation of the Board and members in the work on the legal regulations concerning cartography in Poland together with the Head Office of Geodesy and Cartography, organization of conferences, symposia and other forms of exchange of information and views on the cartographer profession and the actual state of Polish cartography, as well as publishing articles and news on the quality of Polish cartography, protection of the rights of authors – cartographers, etc. Organizing competitions called THE MAP OF THE YEAR and THE INTERNET MAP OF THE YEAR.

In May 2019, the Association organized in Wroclaw the Academy of Cartography And Geoinformatics under the name of ‘Maps in the geoportals’. Co–organizers were the Head Office of Geodesy and Cartography, as well as the Warsaw and Wrocław Universities of Technology. Immediately after the Academy, the 8th National GIS in Science Conference was organized. Representatives of science, practitioners were invited to participate in both geoinformation meetings as well as the administration employees who deal with issues related to cartography on a daily basis. Monographic and scientific papers and posters were presented, preceded by short speeches by the participants. Articles have been published in point–rated magazines.

In 2022 APC prepared the session ‘Modelling and visualization of the modern civil topographic map of Poland’ during the National Cartographic Conference in Toruń.

The annual competition ‘The Map of the Year’, which has been organized regularly by the Association since 2000, is one of the most popular events among the Polish cartographers. Each year more than 10 leading cartographic publishers participate in the competition. The members of the Association vote in the contest for the atlases and maps submitted by the publishers in four categories: ‘tourists maps’, ‘city maps’, ‘the wall maps and atlases for schools’ and ‘other printed maps and atlases’. Since 2011 the competition ‘The Internet Map of the Year’ has been organized, and after the death, in 2013, of Dr Eng. Krzysztof Buczkowski – the distinguished academic teacher from the Warsaw University of Technology – the main prise of his name is awarded.

Map contests of 2018, 2019and 2021/22 had been organized.

As it has already been mentioned at the beginning of the Report, since 2012, the Association of Polish Cartographers has been the affiliated member of the International Cartographic Association and cooperates with the ICA in the dissemination of information about conferences and other forms of activities of the organization.

The Association had also assumed patronage and took part in student seminars and other undertakings such as: GIS–Day 2018, 21 and 22, GIS Challenge 2018, awarded prizes for outstanding papers, posters, and diploma theses in the field of cartography and geoinformation. It has supported school competitions for students ‘Map Master’, whose goal is to broaden the orientation on the physical and political map of Poland and the world.

The Association has been participated in giving opinions on legal acts in a set agreement of all national geodetic and cartographic organizations. Programs and conference materials

as well as various information about the work of APC are published in the 'Bulletin of Polish Cartographers Society' (by the end of 2022, 29 issues were published). More information is to be found on the website www.polishcartography.pl.

The Polish Association for Spatial Information (PASI) is an interdisciplinary association whose objective is to support the development of geomatics for the effective creation and implementation of spatial information systems and ensure general access to spatial data in Poland. The Association pursues its objectives by supporting the development of geoinformation infrastructure, organizing and coordinating cooperation among interested entities, propagating knowledge, cooperating with other national and foreign organizations, and presenting the achievements of its members.

The main activities of the Association include organizing annual conferences, seminars, workshops, and training sessions, as well as publishing. From 2019 to 2022, the Association organized three conferences in the series Geoinformation in Poland' in Warsaw, focusing on the most current issues of geomatics, such as addressing global challenges in the context of geoinformation, emphasizing its interdisciplinary role, and establishing the legal, organizational, and technical foundations for the Polish spatial information infrastructure as part of the European infrastructure (INSPIRE). Recently, PASI's conference also discussed the significance of geoinformation in the Era of Global Threats.

During the reporting period, the Association published 16 issues of the 'Annals of Geomatics', a scientific periodical containing 39 papers. The articles included in the periodical can also be found in the Repository section of the Association's website (www.ptip.info). Additionally, the website's Lexicon section provides an online dictionary of geomatics, which includes nearly 1000 entries in both Polish and English, covering the rapidly developing terminology of geomatics with a particular emphasis on cartographic terms.

The Team for the History of Cartography is a scientific unit operating since 1974 at the **Ludwik and Alexander Birkenmajer Institute of History of Science, Polish Academy of Sciences** in Warsaw, according to the Institute Statute. The aim of the Team is to inspire, coordinate and help in researching the history of cartography, concerning in particular Polish land, both, the historical and contemporary, as well as the old Polish Commonwealth, to popularize knowledge in this field. The chairman of the team is from 2011 prof. Radosław Skrycki from the Institute of History and International Relations, University of Szczecin.

In 2019–2022, the Team for the History of Cartography at the Institute of History of Science of the Polish Academy of Sciences organized the following events:

- September 16–18, 2020, in Supraśl, the 33th Polish National Conference for Cartography Historians 'Map and text. Connections of cartography with literature and other texts of culture'. Co–organizers of the conference were: the University of Bialystok;
- on October 13–15 2022, in Toruń, the 34th Polish National Conference for Cartography Historians 'Fortifications on old maps'. The co–organizers of the conference were: the Nicolaus Copernicus University in Toruń, Maria Curie–Sklodowska University in Lublin;
- on December, 8, 2020, 1th open online seminar of the Research Team for History of Cartography 'Deformations of old maps';
- on March, 10, 2022, 2nd open online seminar of the Research Team for History of

Cartography 'Research and use of old maps'

- on February, 7, 2023, 3th open online seminar of the Research Team for History of Cartography 'Research and use of old maps'.

Selected papers from these conferences are published in subsequent volumes of the series 'From the History of Cartography' has been published since 1979.

The Commission on Geoinformatics at the Polish Academy of Arts and Sciences (PAU) has been operating since 1998 and is one of five commissions of the 4th Department of Natural Sciences of PAU. The Commission deals with methods of acquisition, analysis and visualization of geospatial data to address distributions and dynamics of various phenomena of the Earth system. The Commission consists of geographers, geologists, geophysicists, surveyors, photogrammetry and remote sensing specialists, representatives of mining sciences and IT specialists. The main task of the Commission is to share experiences among specialists from various disciplines in the field of geoinformatics and to stimulate the development of this scientific field. The activities of the Commission include monthly scientific meetings and seminars. The presentations and other contributions are published in the journal of the Commission[1].

In the years 2019–2022, the chairman of the board of the Commission was Professor Jacek Kozak. The current editor–in–chief of the journal Geoinformatica Polonica is Professor Anna Szafarczyk, who took over her duties in 2020.

In the years 2019–2022, 17 ordinary meetings took place. In addition, 4 seminars were organized: two dedicated to geoinformatics and archaeology (March – April 2021), one to COVID pandemics (November 2020) and one to history of geoinformatics in Poland (April 2022). Moreover, the Commission co-organized the 42nd Polish Cartography Conference (September 2019). The topics presented during the meetings of the Commission often refer either directly or indirectly to the problems of cartography.

In the years 2019–2022, four editions of the journal Geoinformatica Polonica were published (volumes 18, 19, 20 and 21). Full texts of articles (in English) are available at the journal website (http://www.ejournals.eu/GP/). The subject matter of the works covers a wide range of issues related to geoinformatics, including cartography.

5. Mapping and publishing activity

The Head Office of Geodesy and Cartography is responsible for the elaboration and publication of official topographic maps in Poland. Apart from the Head Office, maps and atlases for the needs of science and the state economy are also issued by research institutes – mainly Polish Geological Institute – National Research Institute and the Institute of Meteorology and Water Management – National Research Institute, various institutes of the Polish Academy of Sciences and universities as well as some of the science societies and cartographic enterprises. Many privately-owned companies and cartographic publishers operating in the Polish market publish general use maps, e.g.: school, road and tourist maps.

A separate important role in Polish cartography is performed by the geographical service of the Polish Army, operating in the organizational structure of the Ministry of National

[1] https://pau.krakow.pl/index.php/en/structure/classes-and-commissions/class-iv-natural-sciences/class-iv-commissions/geoinformatics

Defence. Currently, it is an independent organizational unit of the Ministry of National Defence as the High Command for Geospatial Recognition. Under its command are the Military Geographical Centre in Warsaw and specialized units in Komorów, Toruń and Leszno. The primary goal of the High Command for Geospatial Recognition is the elaboration and acquisition of analogue and digital geographic products, primarily topographic maps for the needs of the armed forces.

An important institution in the field of cartography is the Naval Hydrographic Office (HOPN); in accordance with the Act of March 21, 1991 (with later amendments) on the maritime areas of the Republic of Poland and maritime administration, it is an institution performing the tasks of the state maritime hydrographic service in the field of hydrography and marine cartography. One of its statutory tasks is to develop, issue and update: nautical charts, nautical publications and digital navigational charts. HOPN has represented Poland in the International Hydrographic Organization (IHO) since joining the body in 1926.

5.1. Activities of the Surveyor General of the Country in the scope of cartography

5.1.1. Free sharing of spatial data

The amendment to the Geodetic and Cartographic Law, initiated by the Surveyor General of the country in 2021, introduced provisions exempting the collection of fees for providing access to many datasets of the state geodetic and cartographic repertory (Article 40a, paragraph 2, point 1), making these data so–called **'open data'**, i.e. available free of charge for any use.

The data release applies to data sets maintained at all three levels of the state geodetic and cartographic repertory and includes, respectively:

1. At the central level:
   a. data of the national register of boundaries,
   b. general geographical objects database,
   c. data of the national register of geographical names,
   d. digital elevation model data,
   e. orthophotomaps,
   f. database of basic geodetic network,
   g. integrated topographic objects database.
2. At the voivodeship level:
   a. topographic objects database.
3. At the powiat (country) level:
   a. database of detailed geodetic network,
   b. geometric data of parcels – with basic descriptive attributes,
   c. geometric data of buildings – with basic descriptive attributes.

The basic form of sharing the released data is the possibility of downloading it at www.geoportal.gov.pl employing the indexes available in the **Data for download** section, which shows the various layers (fig. 2).

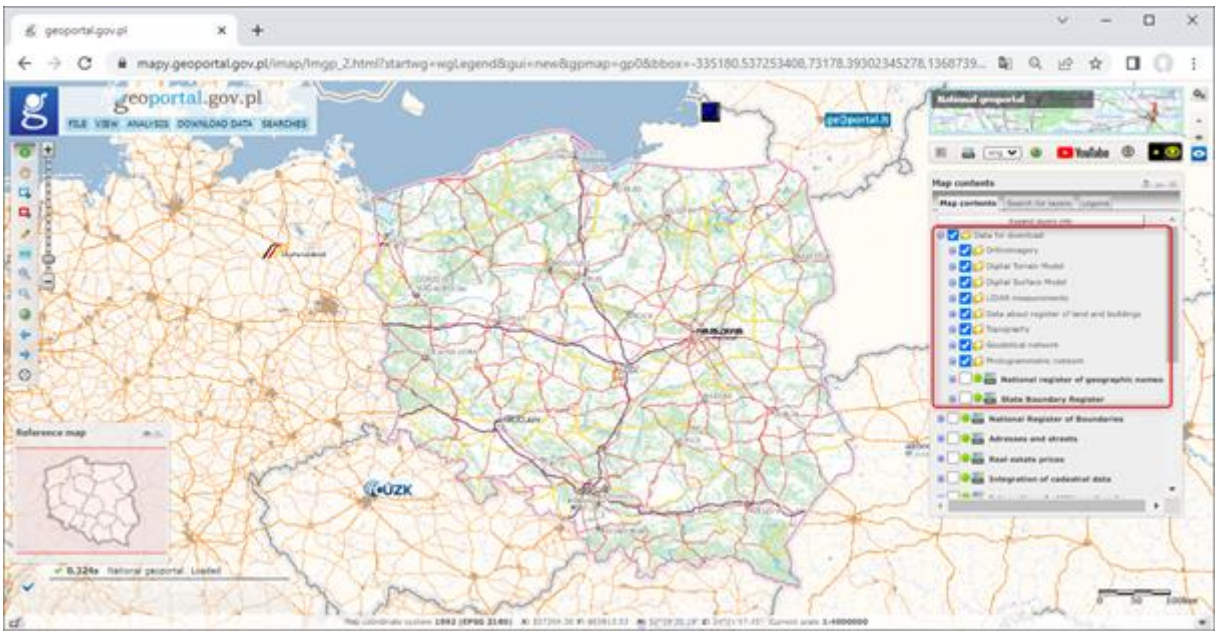

Fig. 2. Map window of www.geoportal.gov.pl with a group of layers with downloadable data highlighted

To download the data, it is necessary to turn on the corresponding information layer, and then to click in the area of interest. A detailed description of this data and its download options are available at: https://www.geoportal.gov.pl/dane.

The free data sharing efforts that have been undertaken have already resulted in a significant improvements and facilitation in access to this data, but also in benefits for the economy and administration as a whole. This is due to the ease of access and the possibility of mass use of spatial data, which translates into technological development and increased digital competence of society. Intangible benefits are also an extremely important effect of data liberation, such as increasing the innovativeness of private sector companies, meeting the public's expectations for the liberation of publicly sourced data, or increasing the role of scientific research work carried out by the education sector..

5.1.2. Source databases update

Spatial data, including data of the State Geodetic and Cartographic Repertory, are present in many areas of human activity, and their importance is growing very rapidly due to the ease of their acquisition and speed of processing. It is essential that spatial data made available by public institutions be:

- open data – available without any restrictions to all;
- up–to–date – updated periodically, according to market needs;
- high quality – reliable, with adequate accuracy and clearly defined quality model; many times the quality of spatial data largely determines the effectiveness of the services, the speed and precision of reaching the scene of an incident, and thus its quality has a direct impact on human health and life.

Updating the data sets of the state geodetic and cartographic repertory is a key element affecting the dynamic development of the country. The above is confirmed by the results of a survey of the needs of users reaching for data collected in the PZGiK. The results of the survey

unequivocally indicate that users expect cyclic updates of spatial data, especially for areas with high dynamics of change.

Current plans for acquiring this data can be reviewed on an ongoing basis at www.geoportal.gov.pl in the **'Data acquisition status'** layer group.

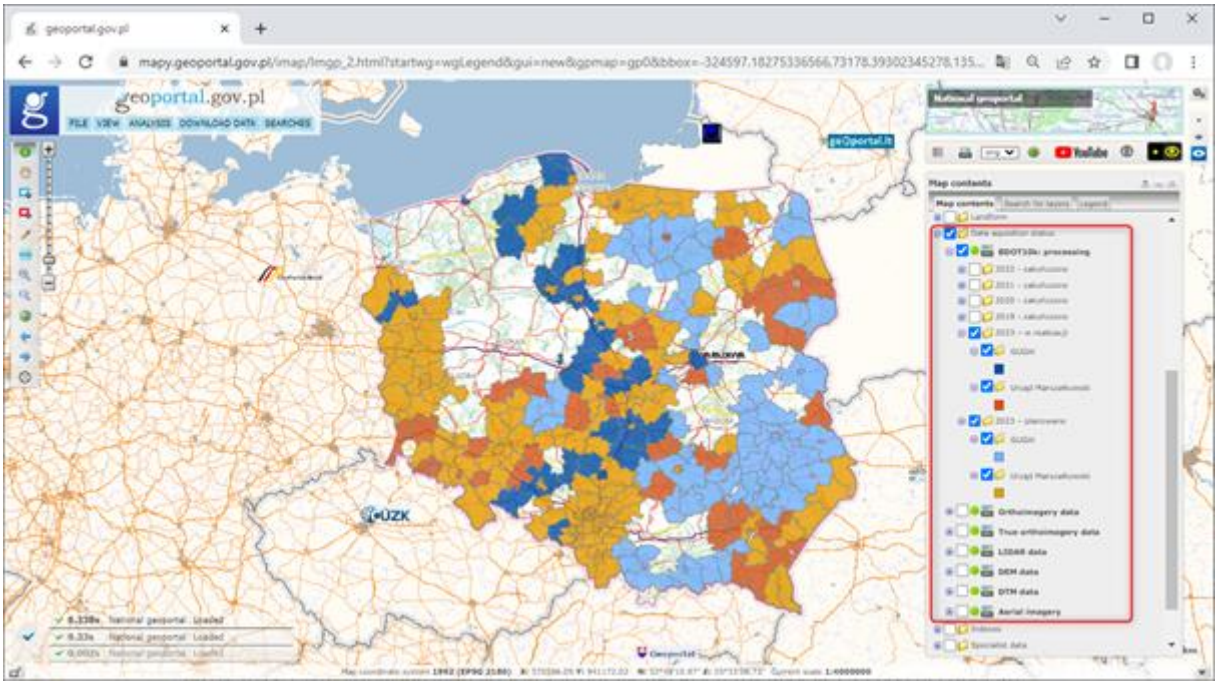

Fig. 3. Map window of www.geoportal.gov.pl with highlighted group of layers including data acquisition status

5.1.2.1. Database of Aerial and Satellite Imagery, Orthophotomaps and Digital Elevation Model

The basic requirements for updating the database of aerial and satellite imagery, orthophotomap and digital elevation model are contained in the Regulation of the Minister of Development and Technology on databases of aerial and satellite imagery and orthophotomap and digital elevation model. Details on the transfer of these data to the Central Geodetic and Cartographic Repertory (CZGiK) are contained in the guidelines for notification of photogrammetric works.

Aerial imagery is the source material for:

- Orthophotomaps,
- Digital Elevation Model (DEM),
- Digital Surface Model (DSM).

The the area of aerial imagery acquisition is closely correlated with the area of the orthophotomap to be created. At the same time, aerial imagery is the source material for the digital elevation model (DEM) in the process of creating the so–called 'classic' orthophotomap.

The sources for the creation of **orthophotomaps**, feeding the CZGiK are aerial imagery and DEM. Detailed information on orthophotomaps is available at: https://www.geoportal.gov.pl/dane/ortofotomapa.

Fig. 4. An excerpt from an example orthophotomap

The point cloud is a representation of the land in the form of measurement points with XYZ coordinates, which are acquired using airborne laser scanning technology (ALS). These measurement data is the source material for the study:

- Digital Elevation Model (DEM),
- Digital Surface Model (DSM),
- Intensity Images (OIs).

Detailed information on the point cloud is available at:
https://www.geoportal.gov.pl/dane/dane–pomiarowe–lidar.

Fig. 5. Example of point cloud visualized by RGB values

The sources for building the **Digital elevation model (DEM)** feeding the CZGiK are aerial imagery and ALS measurement data. According to the assumption of the study, DEM is element of the process of creating an orthophotomap and acquiring ALS measurement data. The study area of DEM is closely correlated with the area of the so–called 'classic' orthophotomap being created and ALS measurement data. Detailed information on DEM is available at: https://www.geoportal.gov.pl/dane/numeryczny–model–terenu.

Fig. 6. Example of DEM data with superimposed topographic objects

The source of the **Digital surface model (DSM)** feeding the CZGiK is aerial imagery and ALS measurement data. According to the adopted assumption of the study, the DSM is element of the process of creating so–called 'real' orthophotomap and acquiring ALS measurement data. The study area of DSM is closely correlated with the area of the so–called 'real; orthophotomap being created and ALS measurement data. Detailed information on DSM is available at: https://www.geoportal.gov.pl/dane/numeryczny–model–pokrycia–terenu.

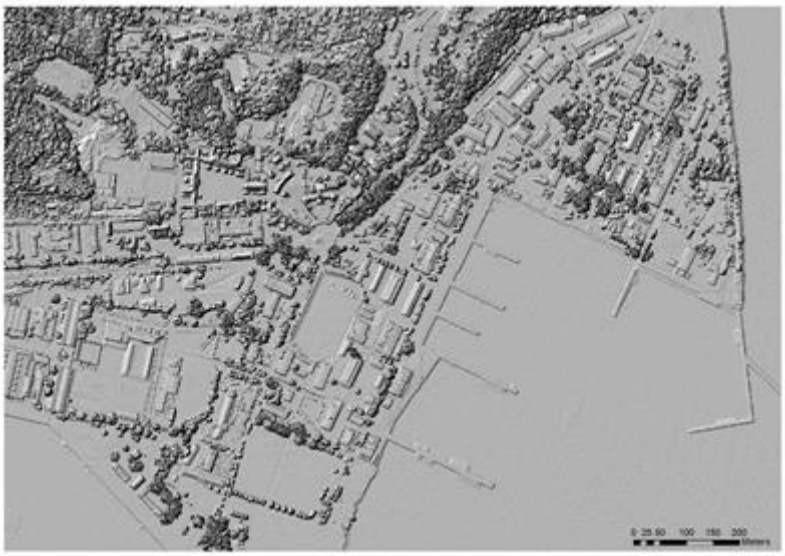

Fig. 7. Example of DSM data visualization

According to the adopted spatial data acquisition plan, the Head Office of Geodesy and Cartography (GUGiK) acquires the aforementioned data in two standards:

1) high–resolution photogrammetric data – for urban areas,
2) photogrammetric data (standard) – for non–urban areas,

according to the following table:

	HIGHT RESOLUTION PHOTOGRAMMETRIC DATA – for urban areas	STANDARD PHOTOGRAMMETRIC DATA – for non–urban areas	
	ALS + ORTO	ALS	ORTO
	goal: 2–year cycle	goal: 5–year cycle	goal: 2–year cycle
vertical aerial imagery	0.05 m	–	0.25 m
„classic' orthophotomap	0.05 m	–	0.25 m
point cloud	12 p/m^2	4 p/m^2	–
DEM	1.0 m	1.0 m	5 m
DSM	0.5 m	1.0 m	–
Intensity images (OI)	0.25 m	0.50 m	–

Fig. 8. Data acquisition standards

It should be noted that high–resolution photogrammetric data are acquired in a single raid. Photogrammetric data for non–urban areas are acquired in two separate raids:

- as part of the creation of the 0.25 m orthophotomap (ORTO),
- as part of the creation of 4 p/m2 LiDAR elevation data (ALS).

High–resolution data are obtained on a 2–year cycle. Standard ORTO data are also acquired on a 2–year cycle, with standard orthophotomap (ORTO) products being created also for urban areas. This means that for urban areas the orthophotomap is obtained on an annual cycle (one year in high–resolution, and the following year as standard one).

5.1.2.2. General Geographic Objects Database (BDOO)

The General Geographic Objects Database (BDOO) is a vector (object) database containing the spatial location of the most important topographic objects along with their basic descriptive characteristics. The content and detail of the BDOO database corresponds to a general geographic map at a scale of 1: 250,000, and the thematic scope includes information on:

1. watercourse network,
2. transport network,
3. utility networks,
4. land cover,
5. buildings, structures and equipment,
6. land use complexes,
7. protected areas,

8. administrative division units,
9. other objects.

Currently, there are 298,815 objects in the BDOO database, and the cartographic image of this database is used as background material in various map services, including www.geoportal.gov.pl, where BDOO is the background material at scales from 1:100,000 to 1: 8,000,000.

Fig. 9. Map window of www.geoportal.gov.pl with visible visualization of BDOO data

The detailed scope of information collected in the BDOO, the organization, procedure and technical standards for creating, updating, verifying and providing access to data are specified in the Regulation of the Minister of Development, Labor and Technology of July 27, 2021 on the topographic objects database and the general geographic objects database, as well as standard cartographic studies (Journal of Laws 2021, item 1412).

The general geographic objects database was created for the entire country as a result of quantitative and qualitative generalization of the topographic objects database BDOT10k. As of 2021, the BDOO creation process is a fully automatic process.

Work on preparing processes for automatic generalization of the BDOT10k database to BDOO began in 2015. The first version of the processes was semi–automatic, i.e. the BDOO database required manual editing after the generalization process was performed. From the beginning, Safe Software's FME Desktop software was used to build automatic generalization processes.

Subsequent versions of the processes used ESRI's Python – arcpy library, which expanded the range of available tools used for generalization. Subsequently, the nesting of processes in processes was reduced to two, that is, the main-control process and the processes called by the control process. Efforts were also made to reduce the number of processes, simplify their construction and increase readability while maintaining good process construction practices. Some processes were created from scratch. The number of PythonCaller transformers containing scripts written in Python was reduced to a minimum. All of the above-mentioned efforts were dictated by the need for efficient maintenance of processes and easy debugging of

these processes. As an additional convenience, the manufacturer of the software introduced object caching in FME Desktop, which made it possible to analyze the input and output data of each transformer without restarting the entire process. The whole thing was complemented by the exceptional stability of the FME software, which is very important when building such complex processes.

As a consequence of the ongoing work, the first fully automatic process of generalizing BDOT10k to BDOO was implemented in production in 2021. This process is run on FME Server for one or multiple (maximum of 16) datasets that cover the voivodeship. The main-control process, consists of the following transformers:

- transformers that read BDOT10k data (along with pre–selection of objects) from the Oracle database and write the results to .ffs files,
- transformers designed to trigger generalization processes for particular classes of objects,
- transformers designed to run the processes of preparing and saving the results in .gml format.

The main process outsources sub–processes to FME Server, where tasks are queued and, using multiple engines, executed in parallel. It currently takes 3 days to perform automatic generalization for all voivodeships of the country.

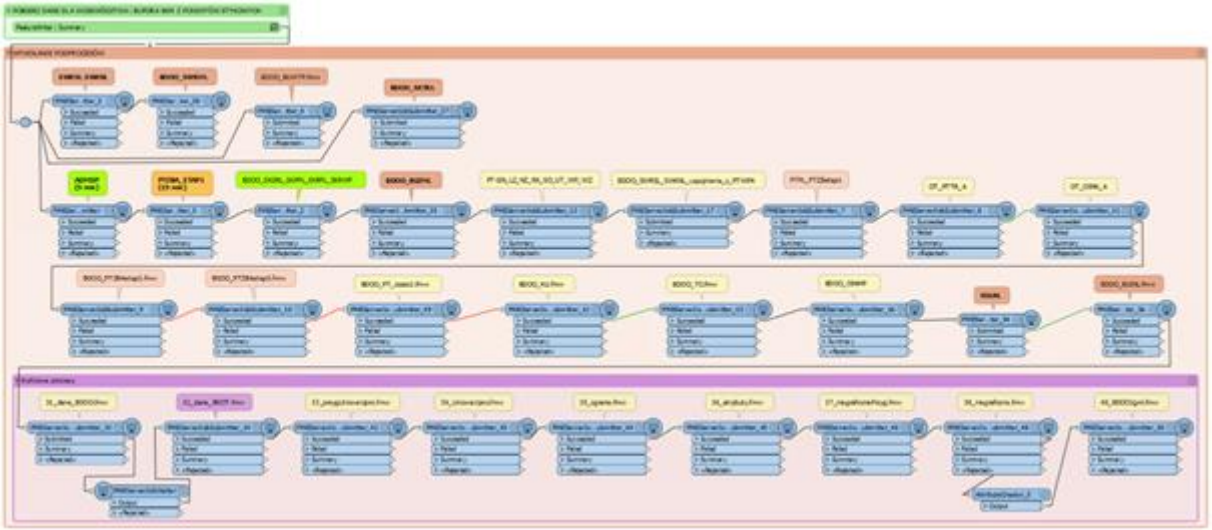

Fig. 10. FME processes

The resulting data of the processes are saved in .gml format compliant with the GML application schema published in the Regulation of the Minister of Internal Affairs and Administration of November 17, 2011 on the topographic objects database and the general geographic objects database, as well as standard cartographic studies. The data are then imported into the National BDOT Management System (KSZBDOT), where they are subject to automatic checks before being loaded into the production warehouse. BDOO data is stored in the warehouse with historical objects preserved, i.e. the objects are versioned. The data are then automatically transferred to a replica where they are made available to other domain systems available at the Head Office of Geodesy and Cartography – for example, for WMS, WMTS services of portal www.geoportal.gov.pl.

Currently the generalization effects from 2015, 2021 and 2022 are available. An excellent tool for visualizing and analyzing BDOO data is the free QGIS software. Due to the wide

thematic scope of BDOO data, it is best to use the **BDOO_GML** plug–in developed and provided by the Head Office of Geodesy and Cartography for its import and presentation, which allows to obtain a presentation image of the downloaded BDOO set that is similar to a traditional general geographic map, as shown in the fig. 11.

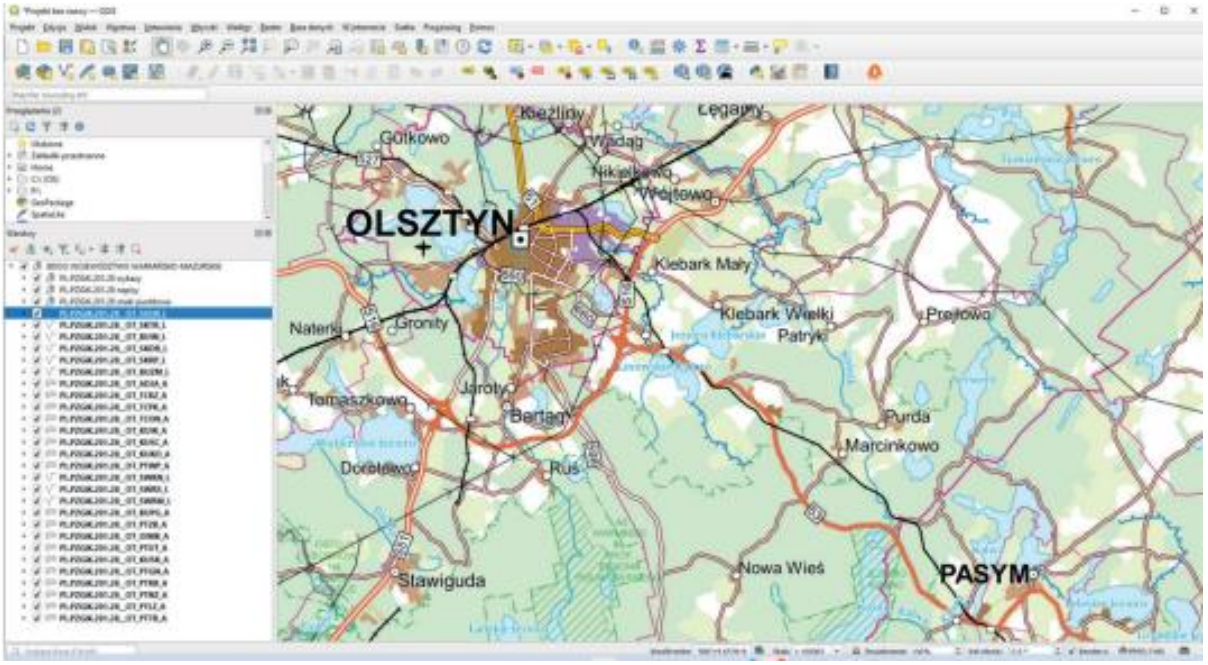

Fig. 11. Visualization of BDOO data in QGIS software

BDOO data is available free of charge and for general use, and can be downloaded from www.geoportal.gov.pl. In the **'Data for download'** section, it is possible to see the **'Topography'** group**,** and there the **'BDOO data'** layer. After activating the said layer and clicking on any area of Poland, there will be available for download in .gml format, the data appropriate to the place of clicking, for the voivodeship or the whole area of Poland:

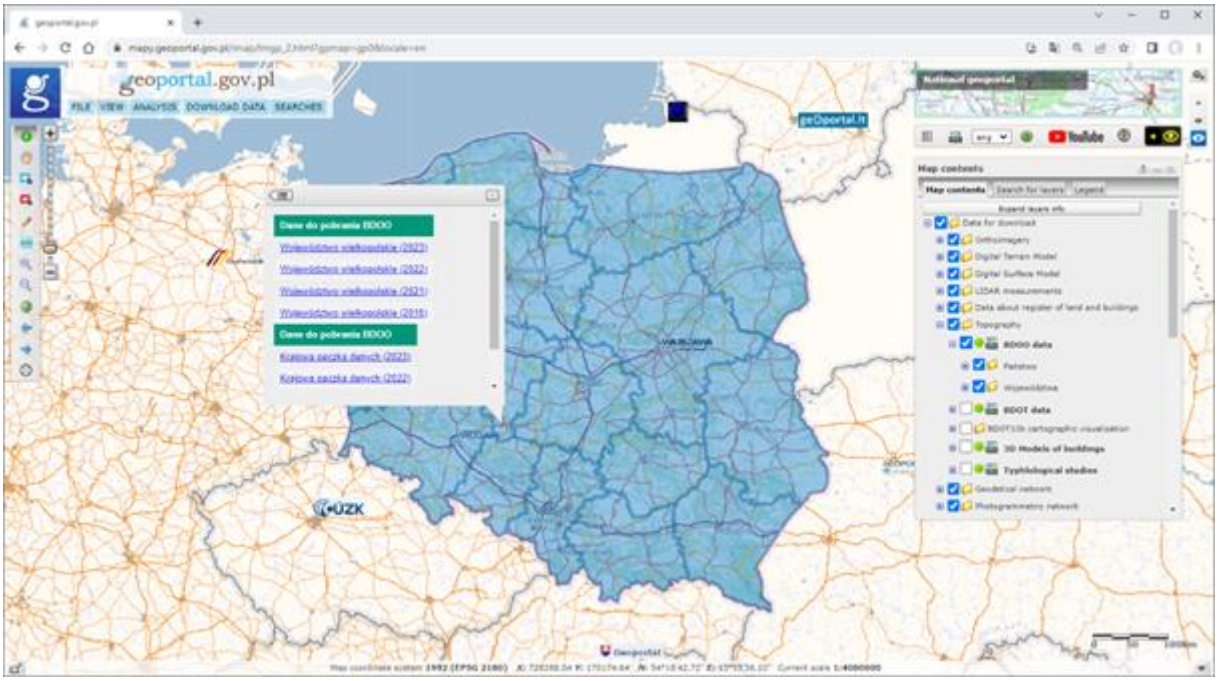

Fig.12. Map window of Geoportal service with BDOO data download service visible

The download of BDOO data is implemented by the WMS service available at: https://mapy.geoportal.gov.pl/wss/service/PZGIK/BDOO/WMS/PobieranieBDOO, specifically by the GetFeatureInfo function, which provides, as and attribute, a link to download the corresponding BDOO data file, i.e. the corresponding data package (voivodeship and national), at the point of clicking. Connecting the service to a QGIS or other WMS-enabled software, we can also perform BDOO data downloads directly in this software. Downloaded BDOO data can be loaded into GIS software, e.g. open source QGIS using a dedicated plug-in provided by GUGiK called **BDOO_GML**, which will give us an appropriate graphical presentation and ease of managing individual layers.

5.1.2.3. Topographic Objects Data Basis (BDOT10k)

The Topographic Objects Database (BDOT10k) is a vector database containing the spatial location of topographic objects along with their basic descriptive characteristics. The content and detail of the BDOT10k database corresponds in general to a traditional topographic map at a scale of 1: 10,000. The thematic scope of the Topographic Objects Database includes information on the following topics:

1. watercourse network (SW),
2. transport network (SK),
3. utility network (SU),
4. land cover (PT),
5. protected areas (TC),
6. administrative division units (AD),
7. buildings, structures and equipment (BU),
8. land use complexes (KU),
9. other objects (OI).

The subject matter of BDOT10k overlaps with that of the BDOO database described earlier, but the BDOT10k database is characterized by greater detail and currently contains about 60 million objects. Introduced as of July 31, 2020, the release of BDOT10k data means that today anyone can easily use the data for any purpose. An excellent tool for visualizing and analyzing BDOT10k data is the free QGIS software. Due to the wide thematic scope of BDOT10k data, it is best to use the **BDOT_10k_GML_SHP** plug-in provided by the Head Office of Geodesy and Cartography, which provides a data presentation image similar to a traditional topographic map at a scale of 1: 10,000, as shown in the fig. 13.

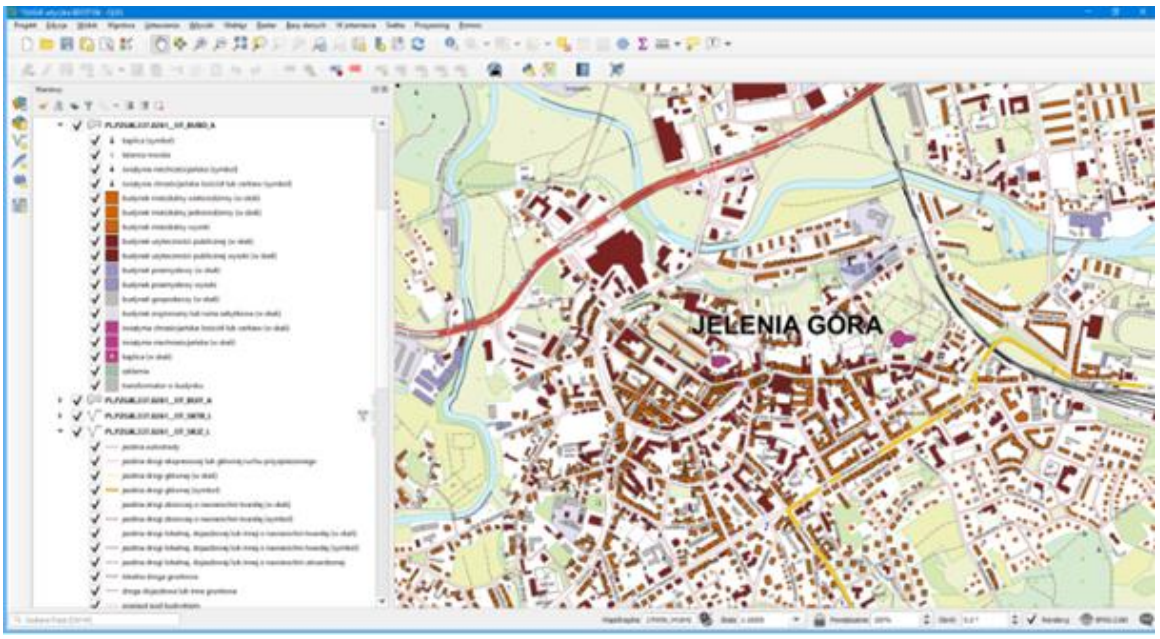

Fig. 13. Visualization of BDOT10k data in QGIS software

The priority goal is to keep the BDOT10k database 2-3 years up–to–date. Planning of the area to be updated is carried out on a 2-year cycle in the area where the orthophotomap was updated in the previous year. Topicality of BDOT10k data, as of the end of 2022, is shown in the map below.

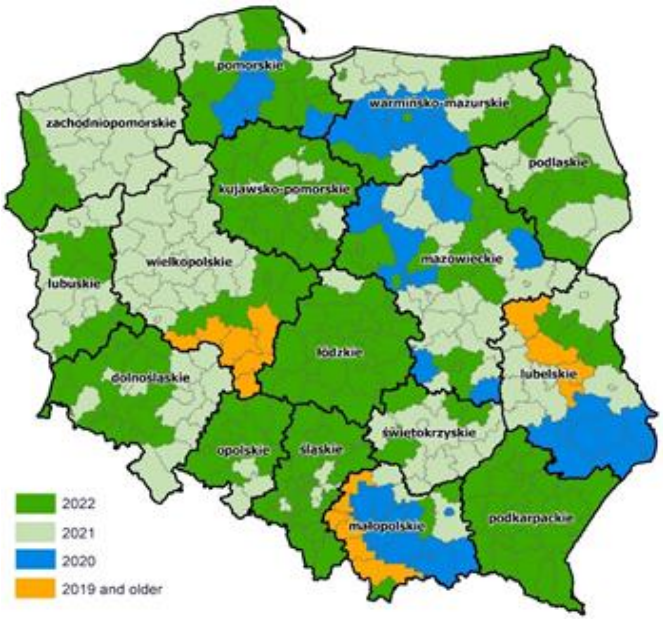

Fig. 14. Topicality of BDOT10k data at the end of 2022

In addition, a new Regulation of the Minister of Development, Labor and Technology on the topographic objects database and the general geographic objects database, as well as standard cartographic studies, was signed on July 27, 2021. The most important changes introduced by the new regulation were:

- simplifying the structure of the BDOT10k database and reducing the scope of information collected in the BDOT10k database and BDOO database by removing object classes or attributes of little informational significance or lack of reliable source data

necessary to keep them up to date;

- adding to the BDOT10k database model the categories of relief objects that will be obtained when updating the BDOT10k database and used in the automatic generation of cartographic studies;
- arranging regulations for creating, updating data;
- removing GML application schemas for BDOT10k and BDOO database data from the regulation and transferring them to the interoperability repository;
- introducing web services as the primary forms of publishing and sharing data.

Detailed information on the BDOT10k database and how to download it is available at: https://www.geoportal.gov.pl/dane/baza–danych–obiektow–topograficznych–bdot.

5.1.2.4. 3D Models of Buildings

The 3D building models are representation of a significant portion of the buildings of the BDOT10k database. The resulting 3D building models were created by compiling three data sources, that are:

- 2D outlines of buildings from the BDOT10K database from the BUBD_A object class;
- LiDAR point cloud data (building class) acquired by airborne laser scanning technology (density of 4 pts/m^2 and 12 pts/m^2 – depending on the area type);
- a digital elevation model (1 m grid size).

The 3D models of the buildings were created by the Head Office of Geodesy and Cartography:

- in the CityGML 2.0 standard – at the LoD2 level of detail as part of the 'Construction of 3D building models' task in the Center for Spatial Analysis of Public Administration (CAPAP) project for 236 powiat (counties) covering an area of 10 voivodeships (dark blue on the map below):

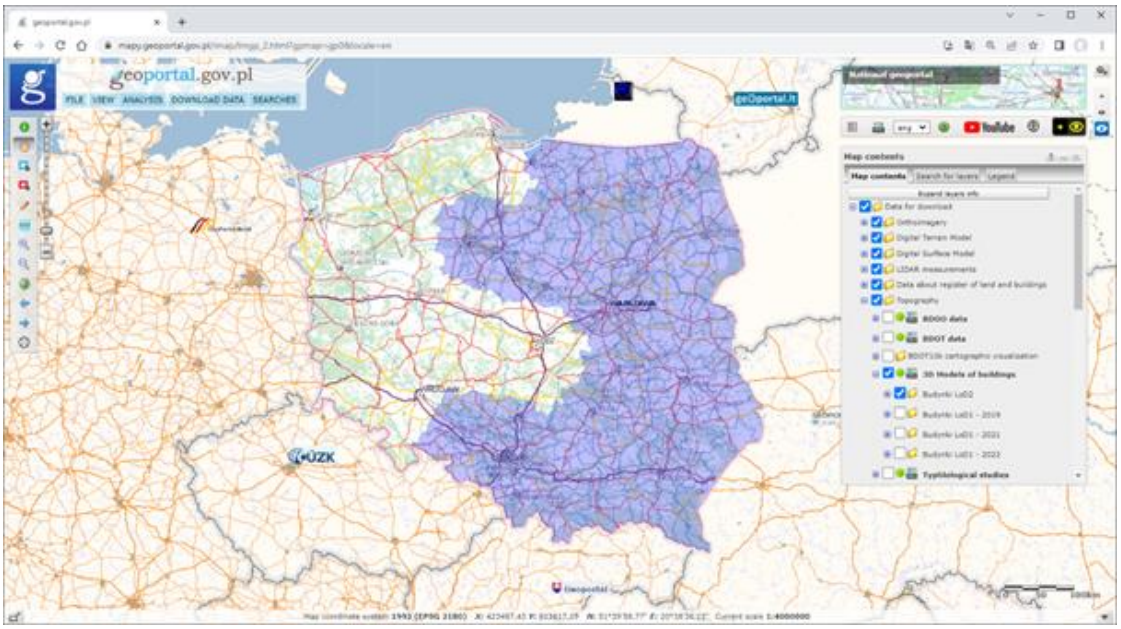

Fig. 15. 3D models of buildings in LoD2 standard

- in the CityGML 2.0 standard – at the LoD1 level of detail, within the framework of internal work for the entire country (Figure 15); the LoD1 standard for the presentation

of buildings uses prisms with a base corresponding to the 2D outline of the building taken from BDOT10k (class BUBD_A) and the height extracted from LiDAR point cloud data (class building) as the median of the points in the building outline.

3D models of buildings at a detailed level are available in three layers:

- Buildings LoD1 2019 – created on the basis of source data available in the central geodetic and cartographic repertory as of 2018/2019;
- Buildings LoD1 2021 – created on the basis of source data available in the central geodetic and cartographic repertory as of 2021;
- Buildings LoD1 2022 – created on the basis of source data available in the central geodetic and cartographic repertory as of 2022.

3D models of buildings in the LoD1 standard are available in powiat (county) packages. They have been generated automatically on the basis of current data available in the state geodetic and cartographic repertory, with the following assumptions:

- the height of the ground plane was determined as the height of the lowest point of the building, determined from the intersection of the outline of the building from the topographic objects database BDOT10k (class BUBD_A) with the digital elevation model (DEM) in the elevation system PL – EVRF2007–NH;
- the height of rooftop surface is determined from the median height calculated from LiDAR point cloud data (building class) located in the ground contour;
- type of building geometry was assumed as Solid, flat roof;
- each 3D building model has the following attributes:
  - BDOT10k object identifier (buildingId),
  - BDOT10k object namespace (przestNazw),
  - BDOT10k object version (versionId),
  - source of roof geometric data (zrodloDach):
    - ALS_I – if ALS data with a nominal density of 4 pts/m^2 or 6 pts/m^2 is used;
    - ALS_II – if ALS data with a nominal density of 12 pts/m^2 and higher is used;
  - the up–to–dateness of the geometric roof data of the ALS point cloud data source (aktZrodla);
  - roof type 1000 – flat roof (bldg:roofType).

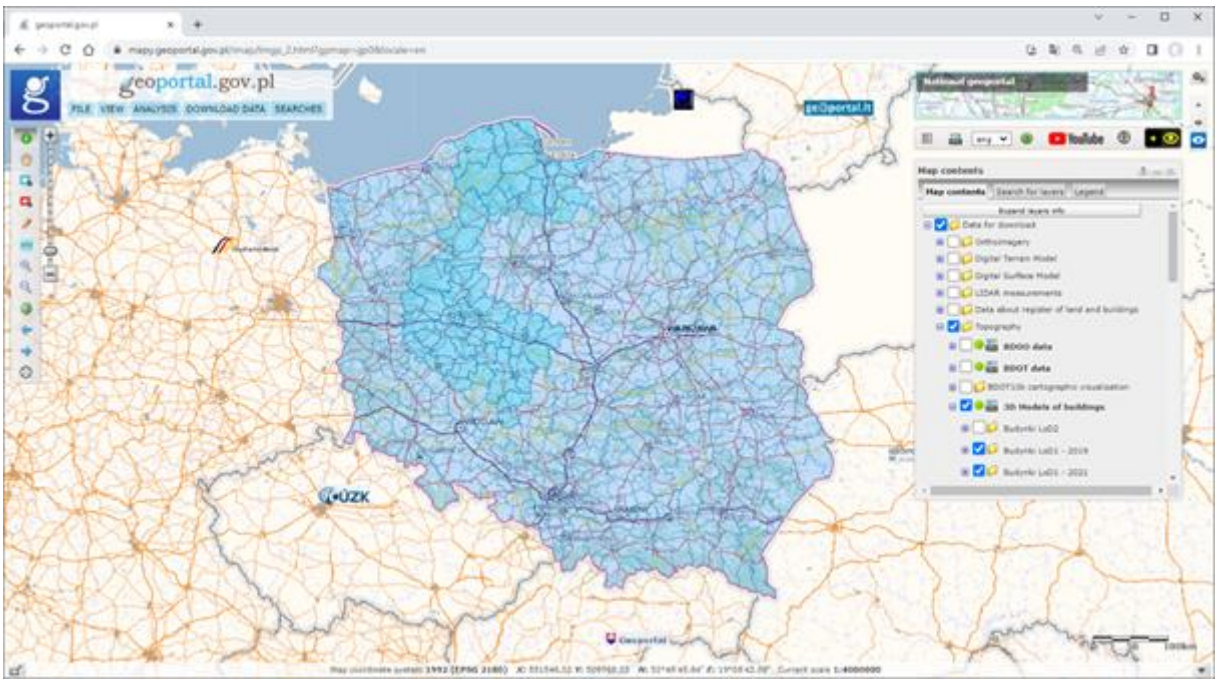

Fig. 16. 3D models of buildings in LoD1 standard

All 3D models of LoD2 and LoD1 standard buildings can be viewed on Geoportal 3D.

Fig. 17. 3D Geoportal module

Moving closer to the area of interest it is possible to view 3D models of buildings from different perspectives (figure below).

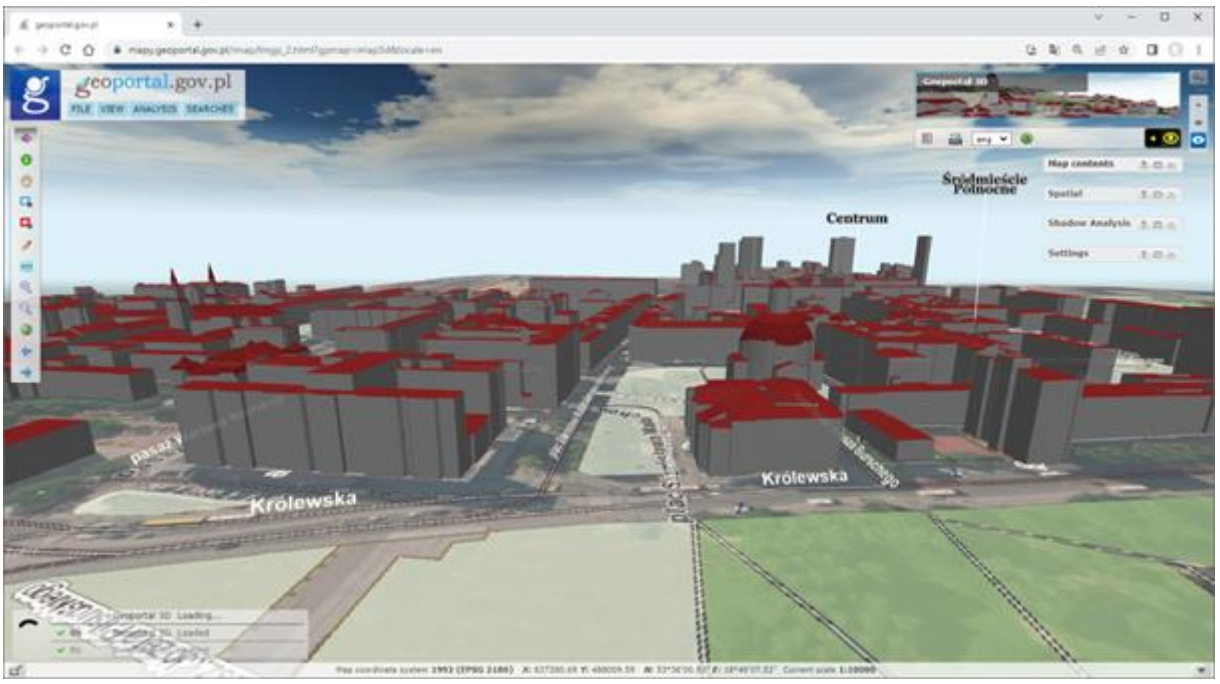

Fig. 18. 3D models of buildings in Geoportal 3D service

In addition to viewing 3D models of buildings, simple shading analyses can also be performed using the available **'Shadow Analysis**' function:

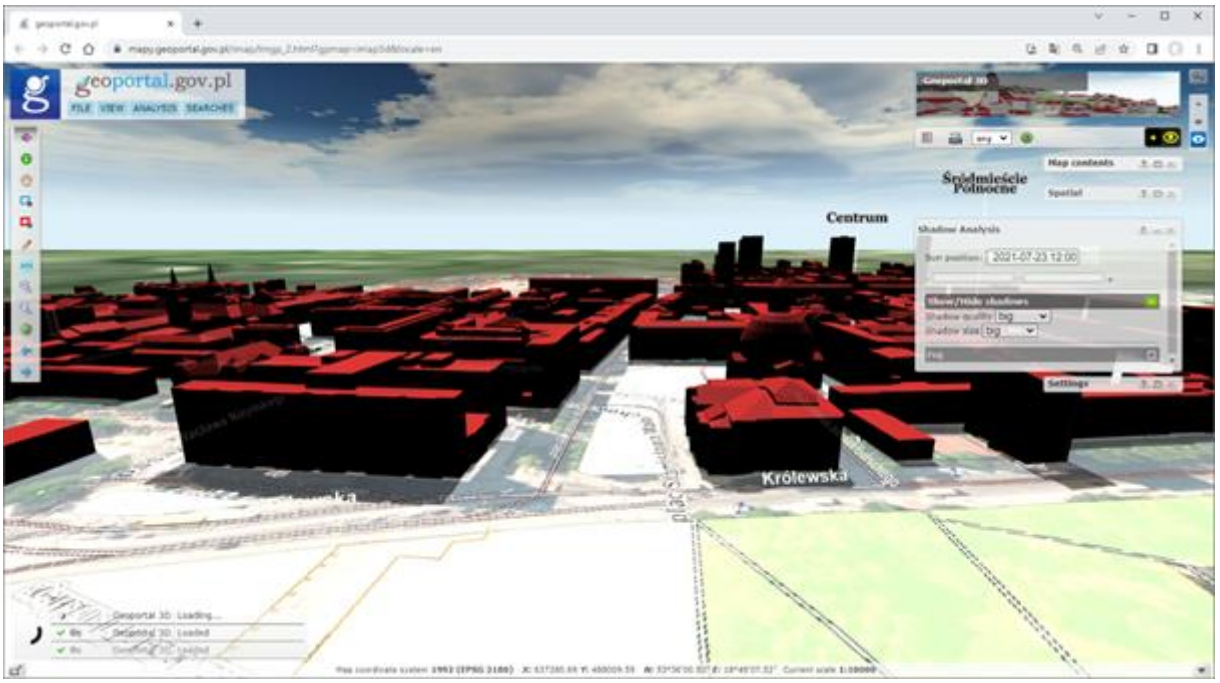

Fig. 19. Shadow analysis in Geoportal 3D service

3D models of buildings are available free of charge and can be used freely. Downloading the data is possible from www.geoportal.gov.pl, where in the '**Data for download**' section it is possible to see a group of layers '**Topographic 3D Models of buildings'** and there, in turn, four layers:

- LoD2 Buildings,
- LoD1 Buildings – 2019,

- LoD1 Buildings – 2021,
- LoD1 Buildings – 2022.

Using the identification tool, it is possible to click on the map within the boundaries of the powiat (county) for which the user want to obtain data. This will bring up a list of available layers (fig.20)**.**

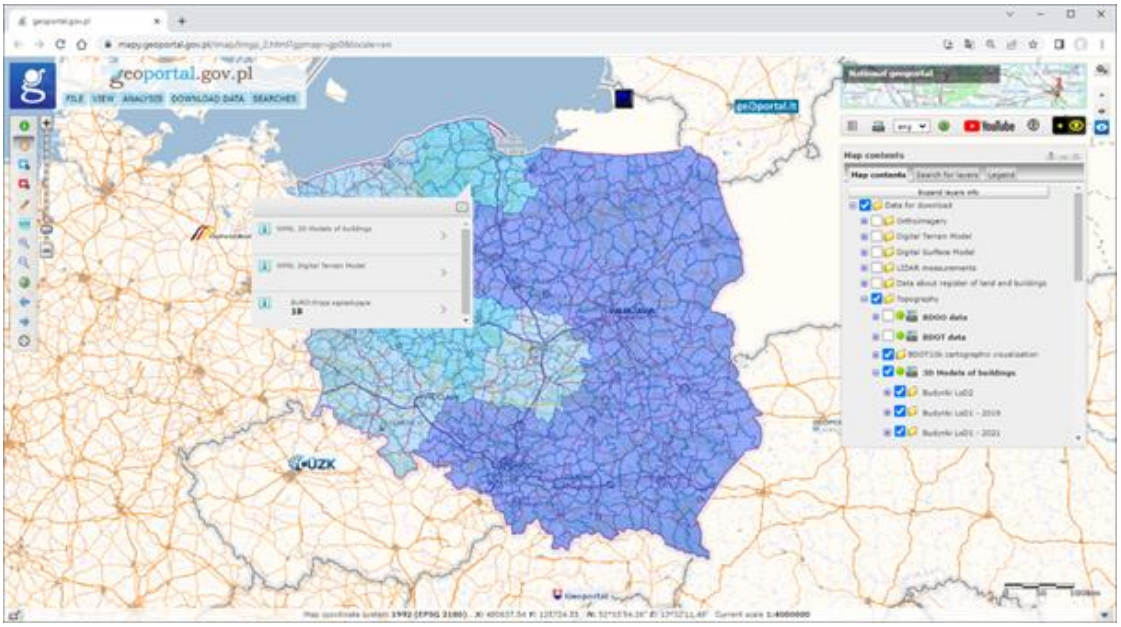

Fig. 20. Viewing layers with the identification tool

Next, from the list of available layers, the item **'3D Models of buildings'** can be selected. In the information window (fig. 21), the data for the selected powiat (county) will appear, as well as a link to proceed to the package download.

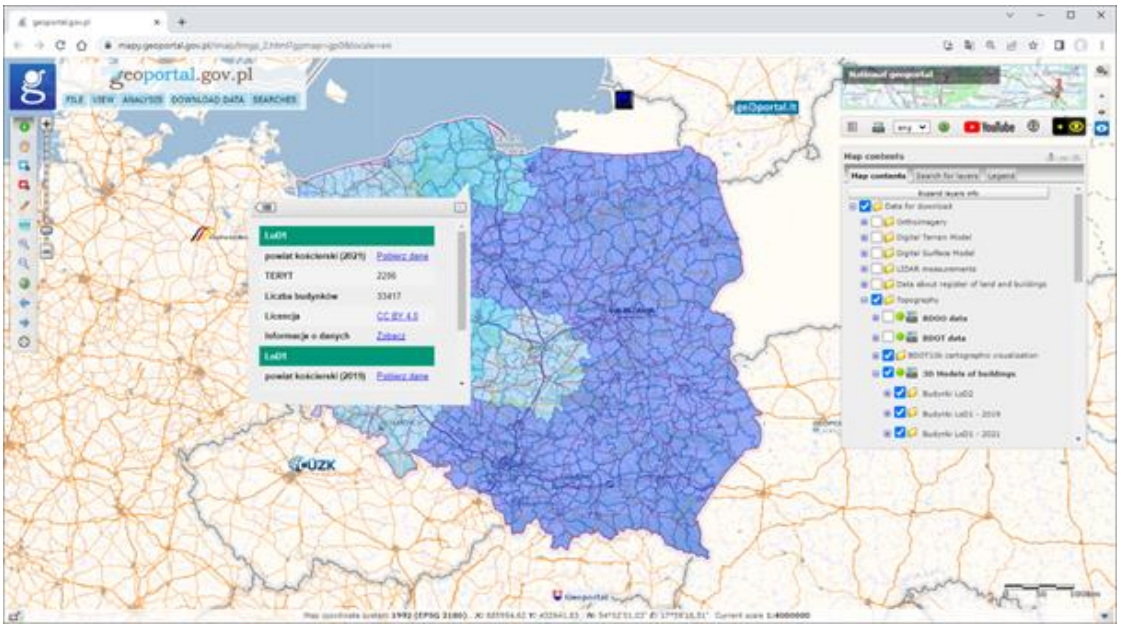

Fig. 21. Downloading 3D building models

5.1.3. Thematic and Special Maps

Administrative Map of Poland

The Head Office of Geodesy and Cartography, as part of its own work, has prepared the digital administrative map of Poland at a scale of 1: 500,000.

Fig. 22. Digital administrative map of Poland on a scale of 1:500,000

The previous edition of the administrative map of Poland was published by GUGiK in 2011. In the case of the latest version of the map, mostly the same editorial and technical assumptions and methods of graphic presentation were adopted. The changes primarily concern the toponymy. In the cases of localities in Poland, the informal names in minority languages were removed, leaving only the official names. For the fragments of neighboring countries on the map, the names of towns, cities, rivers and lakes in the original languages (for Germany, Czech Republic, Slovakia, Lithuania) or transcriptions in transliteration (for Russia – from Russian, for Belarus – from Belarusian, for Ukraine – from Ukrainian) were used.

The PL-1992 rectangular plane coordinate system was employed, based on the Gauss–Krüger projection, with a cartographic grid of meridians and parallels drawn every 30'. As in the earlier version of the map, additional side maps at a larger scale (1:300,000) were created for the areas of the Warsaw Agglomeration and the Silesian Conurbation, where the cartographic grid was condensed to 15'.

The topicality of the information presented on the map is January 1, 2022. The main data sources are: National Register of Boundaries (PRG), National Register of Geographical Names (PRNG), Topographic Objects Database (BDOT10k), General Geographic Objects Database

(BDOO), EuroGlobalMap, EuroRegionalMap and OpenStreetMap.

Fig. 23. Digital administrative map of Poland – Warsaw Agglomeration

Fig. 24. Digital administrative map of Poland – Silesian Conurbation

The level of detail in the source data required the determination and application of selection criteria and the appropriate generalization of objects. In the case of reservoirs, those with an area of more than 2 km^2 were presented, and of flowing waters - main rivers and their tributaries and others with a length of more than 5 km. A selection of cities and towns was also made based on the administrative function performed (seat of the voivodeship office, voivodeship assembly, powiat (county) office, commune office), number of inhabitants (division into groups):

- cities and towns: over 1,000,000, 500,000 to 1,000,000, 250,000 to 500,000, 100,000 to 250,000, 50,000 to 100,000, 25,000 to 50,000, 10,000 to 25,000 inhabitants;
- towns and villages with a population of 1,000 to 10,000;
- communal towns and villages with a population of less than 1,000;
- other localities, important due to the:
    - location (at road intersections, along longer transportation routes),
    - other criteria (important tourist destinations, health resorts, border crossings or former border crossings).

The areas of cities with a population of more than 25,000 were presented by area signatures.

The map was prepared in QGIS software (with the support of FME Desktop by Safe Software and ArcGIS by ESRI) in raster format (as .tiff and .geotiff) in a size corresponding to a wall map (with a map content window of 131 x 140 cm). The map was included in the state geodetic and cartographic repertory with a date of August 22, 2022, and is available upon request for a fee (standard tasks) or free of charge (public tasks and scientific or educational purposes)[2].

Updating the administrative map of Poland at a scale of 1: 500,000 is planned annually as part of GUGiK's own work.

Land Cover Map of Poland

As part of the statutory activities of the Surveyor General of Poland to create, maintain and provide thematic and special cartographic publications, in August 2022 the Head Office of Geodesy and Cartography announced a public procurement, for the elaboration of a digital version of the land cover map of Poland at a scale of 1: 500,000.

The map includes the following thematic layers:

- boundaries (state, voivodeships, territorial sea);
- the main categories of land cover related to the physical and biological use of the land surface, i.e. anthropogenic land, agricultural land, forests, wetlands, etc., hydrographic network, road and railroad route network, nature conservation (national parks, scenic parks);
- selected high points, passes, caves, rocks;
- the settlement network including nomenclature;
- relief based on a digital elevation model (shading method).

For the production of the map, the PL-LCC rectangular plane coordinate system on the GRS80 reference ellipsoid was employed, according to the theory of Lambert's conic equiangular mapping, with a modification of the parameter – the geodetic length of the origin of the coordinate system from 10^0 E to 19^0 E.

The main data sources for the elaboration of the land cover map of Poland were data from the National Register of Boundaries (PRG), the National Register of Geographical Names

[2] On the website of the Head Office of Geodesy and Cartography, for illustrative purposes, its thumbnail has been placed at:
https://opendata.geoportal.gov.pl/Mapy/Tematyczne/2022/administracyjna_2022_100m.tif

(PRNG), the Topographic Objects Database (BDOT10k), the General Geographic Objects Database (BDOO), the Register of Polish Geographical Names of the World, the General Directorate of National Roads and Highways, the Digital Elevation Model and EuroDEM.

The map was incorporated into the state geodetic and cartographic repertory on December 12, 2022. Like the administrative map, the land cover map is provided in raster form in .geotiff and .pdf formats, upon request, for a fee (standard tasks) or free of charge (public tasks and scientific or educational purposes). A thumbnail of it: https://opendata.geoportal.gov.pl/Mapy/Tematyczne/2022/Mapa_Pokrycia_PL_2022_miniatura.tif is available on the website of the Head Office of Geodesy and Cartography for reference purposes. An annual update of this study is planned as part of GUGiK's own work.

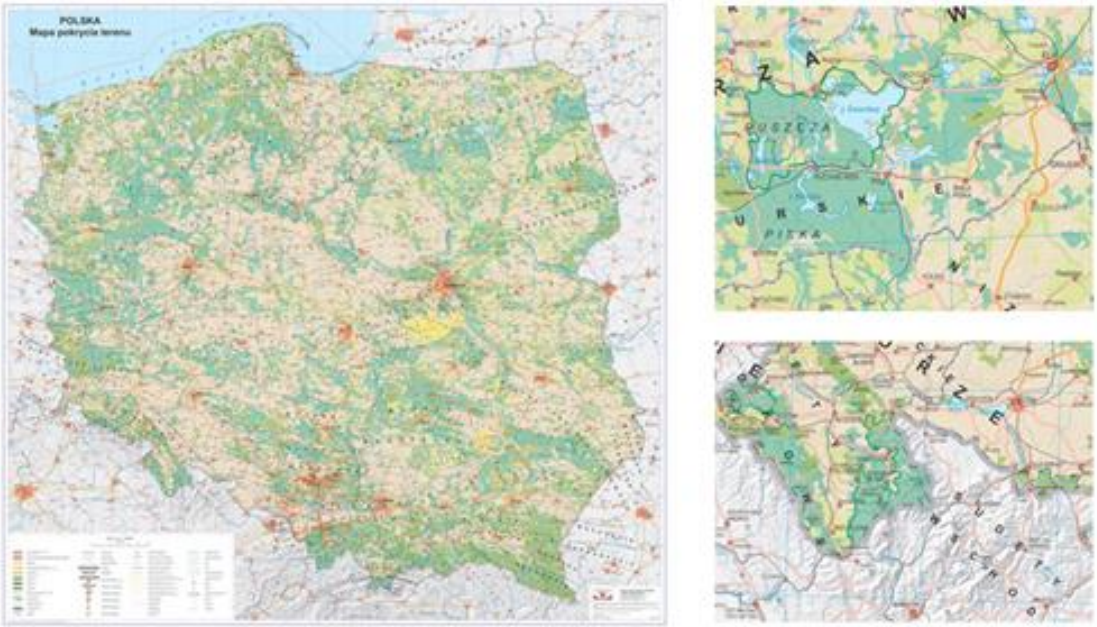

Fig. 25 Digital land cover map of Poland at a scale of 1:500,000

Maps for Blind and Visually Imaired Persons

According to the Regulation of the Council of Ministers of October 3, 2011 on the types of thematic and special cartographic studies (Journal of Laws 2011 No. 222 item 1328) producing and providing access to typhlological maps is one of the duties of the Surveyor General of the country. As a consequence of the decision taken in 1983 on the systemic production of typhlological maps, responding to the demands made, the great needs, recognizing the importance of the issue and its social significance, the Head Office of Geodesy and Cartography became the initiator, coordinator of work and publisher of many maps and atlases for the blind and visually impaired.

The cartographic works published and provided so far are:

- Geographic Atlas of Poland (2004) – swelling paper technology,
- Atlas of Warsaw (2005) – swelling paper technology,
- Geographical Atlas of Europe (2006) – swelling paper technology,
- Geographic Atlas of the World (2012) – relief technique with color subprint,
- Geographic Atlas of Poland (2020) – swelling paper technology, thermoforming technology.

The digital version of the typhlological maps can be downloaded using WMS and WMTS web services, which are connected as standard in www.geoportal.gov.pl. These services can also be connected in any software that can use such standards (e.g. QGIS). The list of services is available at https://www.geoportal.gov.pl/uslugi/usluga–przegladania–wms in the **'Indexes of maps**' group (fig. 26).

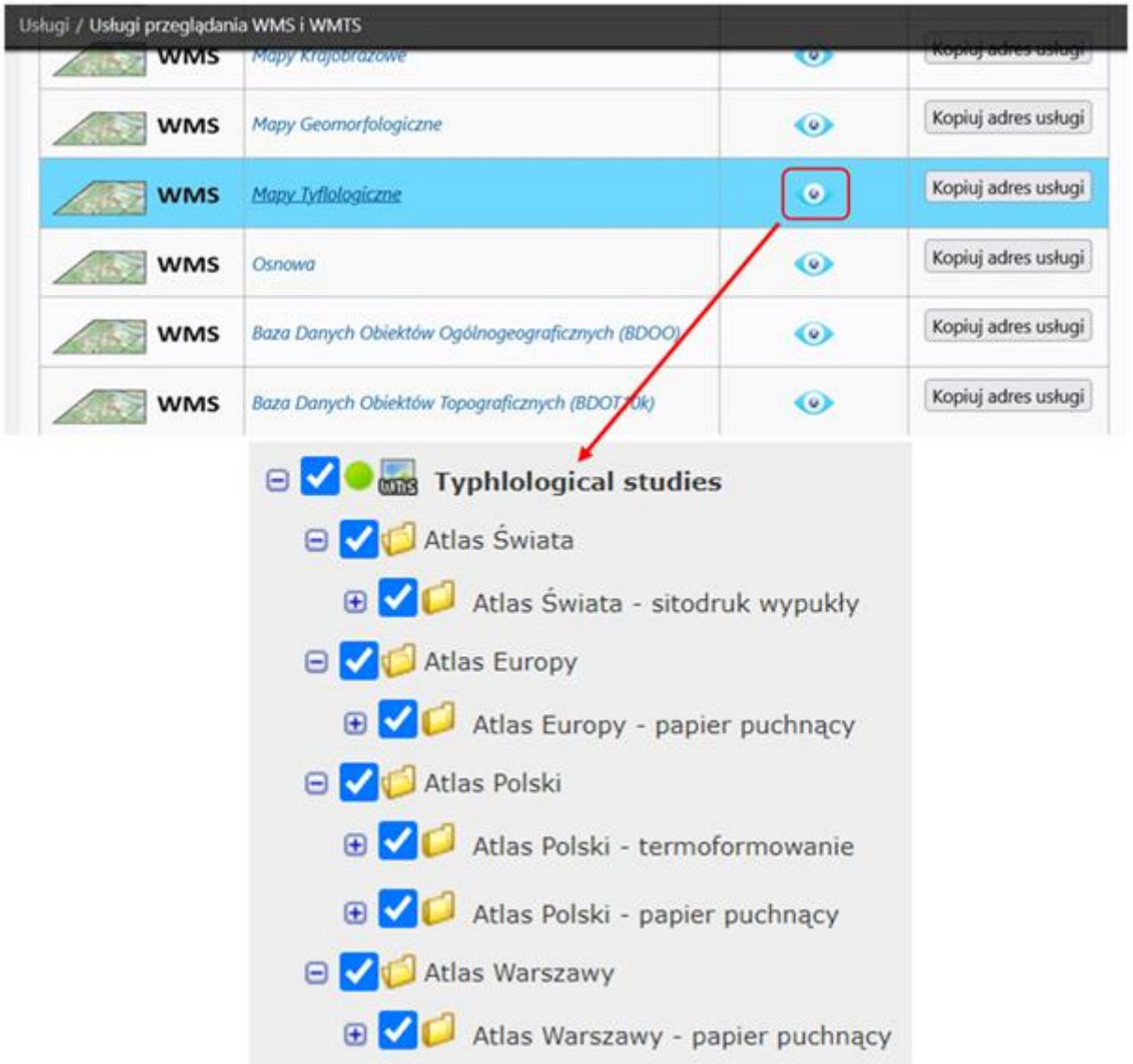

Fig. 26. Index of maps for blind and visually impaired persons

As of 2021, the cartographic maps for the blind and visually impaired published by the Head Office of Geodesy and Cartography in digital form are available free of charge and can be employed for any use. Downloading is available through www.geoportal.gov.pl. In the **'Data for download'** section, there is a group of **'Topography'** layers, and among them are **'Typhlological studies'[maps]**. Clicking on the layer it is possible to download the typhlological maps of the Atlas of the World, Europe, Poland (both the 2004 and 2020 editions) and Warsaw, in digital form:

- Geographic Atlas of Poland (2004) – .cdr, .jpg, .pdf files;
- Geographic Atlas of Poland (2020) – .cdr, .jpg, .pdf, .tiff files (separately for swelling

paper and for thermoforming);

- Geographic Atlas of Europe (2006) – .cdr, .jpg, .pdf files;
- Geographic Atlas of the World (2012) – .cdr, .jpg files;
- Atlas of Warsaw (2005) – .cdr, .jpg files.

Downloading of the typhlological studies in www.geoportal.gov.pl is carried out by the WMS service, specifically by its GetFeatureInfo function, which provides a link to download the corresponding map file at the point of clicking as an attribute. The maps in analog form can be provided on the basis of a request for access to materials of the state geodetic and cartographic repertory.

5.1.4. Topographic Maps

Based on the updated data collected in BDOT10k, in 2019–2022, the voivodeships marshals, in agreement with the Surveyor General of Poland, produced the 968 sheets of topographic map at a scale of 1: 10,000 in the form of digital files.

Cartographic Visualizations

Considering the fact that manual map creation by cartographers is too time–consuming and costly today, and taking into account the available budget as well as user expectations, in the first quarter of 2022 GUGiK started pilot projects to prepare tools to automatically generate topographic maps at scales of 1:10,000 and 1:25,000. At this stage, the cartographic visualizations are a pilot project and are not a topographic map, as referred to in Article 4, paragraph 1e, point 3 of the Act of May 17, 1989 Geodetic and Cartographic Law, but the goal is to refine these tools and include the final visualizations in the state geodetic and cartographic repertory as legitimate, full-fledged, legal topographic maps. This approach will make it possible to provide up-to-date (topicality correlated with the one of the source data) and homogeneous topographic maps for the entire country, and at the same time will allow to automate the production process and drastically reduce the its costs. Automatic map generation seems to be a necessity today and at the same time a ‘golden mean’ between rational spending of public money, user needs and manual map production.

The tools are being improved all the time, but there are already pilot products available in the form of BDOT10k cartographic visualizations, which can be downloaded independently and free of charge from www.geoportal.gov.pl. In the group of layers **‘Data for download’ – ‘Topography’** it is necessary to select the layer **‘BDOT10k cartographic visualization’** and the appropriate scale. Then, after searching for the sheet of interest and clicking on its area, a .pdf file download option appears in the map window.

BDOT10k cartographic visualizations are generated fully automatically, at 1: 10,000 scale – using free QGIS software (contour lines were generated in FME by Safe Software), and at 1:25,000 scale – using FME and ESRI software.

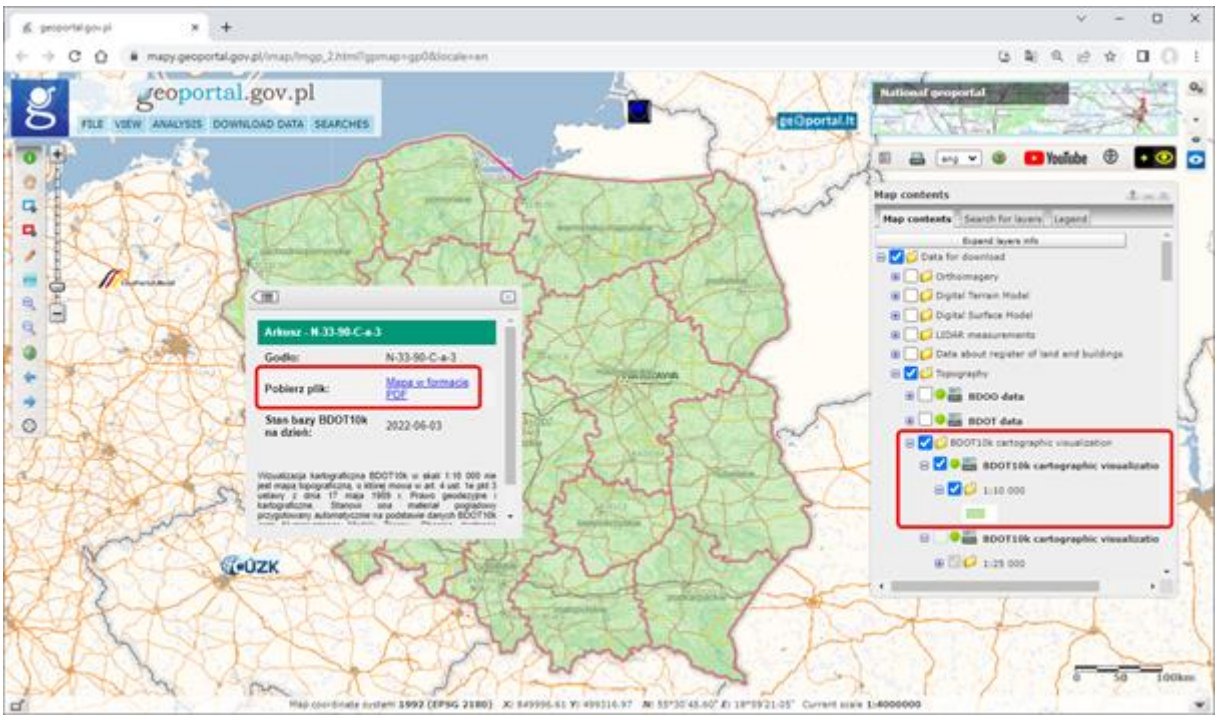

Fig. 27. Downloading BDOT10k cartographic visualizations

Methodology for the creation of BDOT10k cartographic visualizations at a scale of 1: 10,000

The first fully automatically generated cartographic visualizations of BDOT10k at a scale of 1: 10,000 for the country's territory, were made available in late March and April 2022. In mid - August, GUGiK completed the generation of the second iteration of BDOT10k cartographic visualizations at a scale of 1: 10,000 eliminating some of the errors that occurred, both in terms of cartographic presentation of objects, editing names and descriptions, as well as in terms of frame and off-frame content. In particular, the symbolization of administrative boundaries and some of the point and surface objects was improved, to some extent, the presentation of contour lines, street names, object names have been improved, cartographic abbreviations have been added, some of the names from PRNG have been added, names of neighboring countries have been added, the legend, off-frame descriptions and coordinate descriptions have been improved. Of course, one should also be aware that with automatic map generation, some of the errors that occur are due to errors in the source data.

The visualizations are created automatically in the QGIS software. To produce them, current BDOT10k data (which can be obtained from the software level using the GUGiK's Data Downloader plug–in), PRG, PRNG and DEM data is used. A modified Import BDOT10k GML/SHP plug–in was used to generate these data. Levels lines are generated using FME software based on the latest elevation data is PL–ETRF89 system.

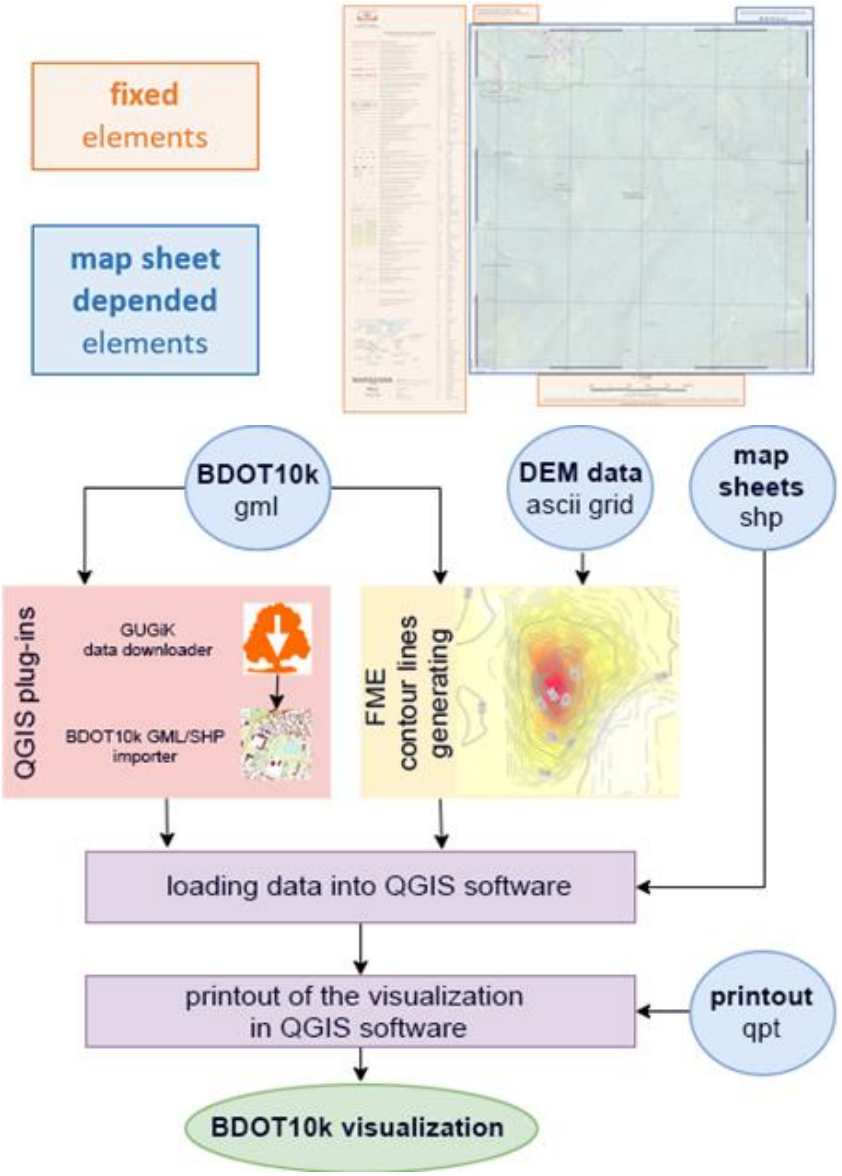

Fig. 28. Diagram for the process of creation BDOT10k cartographic visualizations at a scale of 1:10,000

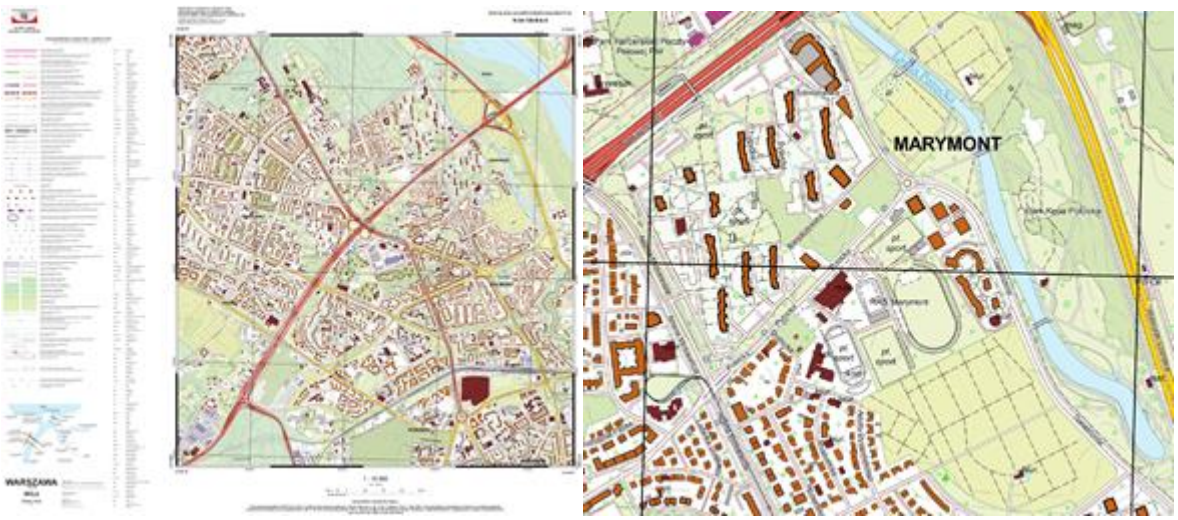

Fig. 29. Example of BDOT10k cartographic visualization at a scale of 1: 10,000
(whole sheet and enlarged section)

A template for printing is prepared in QGIS software. It contains fixed elements such as legend and scale, as well as sheet section–dependent elements: sheet name, content and scope of the map, map frame with grid in PL-1992 system, coordinates of corners in PL-ETRF89 system.

Methodology for the creation of BDOT10k cartographic visualizations at a scale of 1:25,000

Further BDOT10k cartographic visualizations, but at a scale of 1:25,000, have been created and provided by GUGiK already in April 2022. The studies are carried out fully automatically on the basis of up-to-date data available in the state geodetic and cartographic repertories, in particular the Topographic Objects Database BDOT10k, PRNG and PRG. The processes of automatic generalization and editing of BDOT10k data, in this case use FME transformers and integrate ESRI's arcpy library (for example, in terms of rectangulation of buildings or aggregation of surface objects including linear obstacles) were prepared. The results of the processes are saved in an Oracle database, from where they can be exported to .gml files, or saved automatically by ArcGIS Pro to .pdf format and published on www.geoportal.gov.pl. It takes two months to prepare the maps sheets for the entire country area. Currently, work is underway to update BDOT10k cartographic visualizations at a scale of 1:25,000. Missing objects, level lines, administrative divisions are being added, and off-frame content is being corrected. Missing descriptions will be added, as well as their distribution corrected. Here it should also be noted that production for the 1:25,000 scale is more difficult, as it requires generalization of many BDOT10k objects.

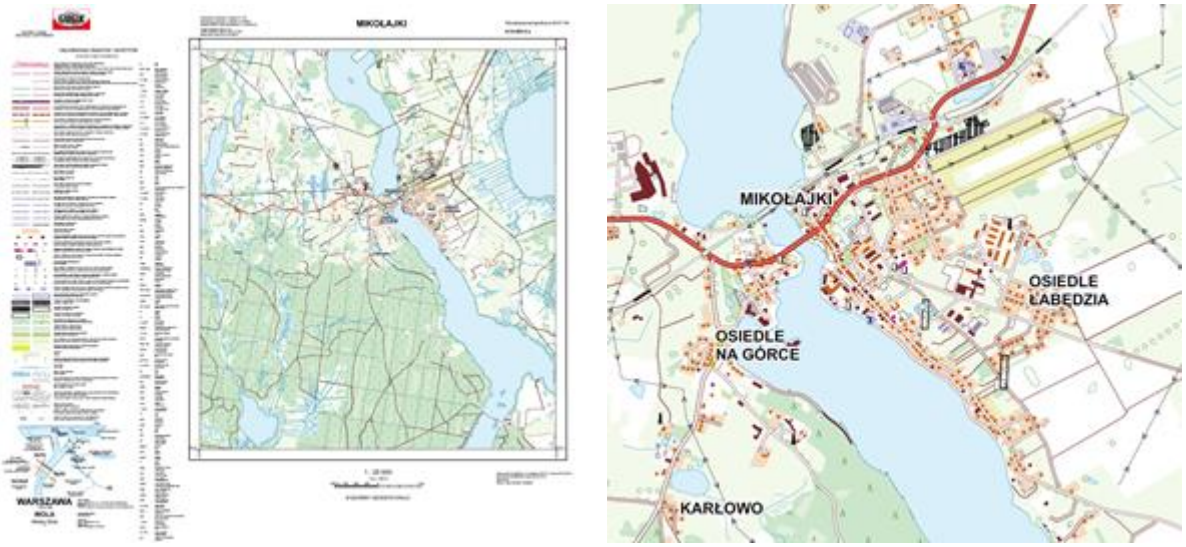

Fig. 30. Example of BDOT10k cartographic visualization at a scale of 1:25,000 (whole sheet and enlarged section)

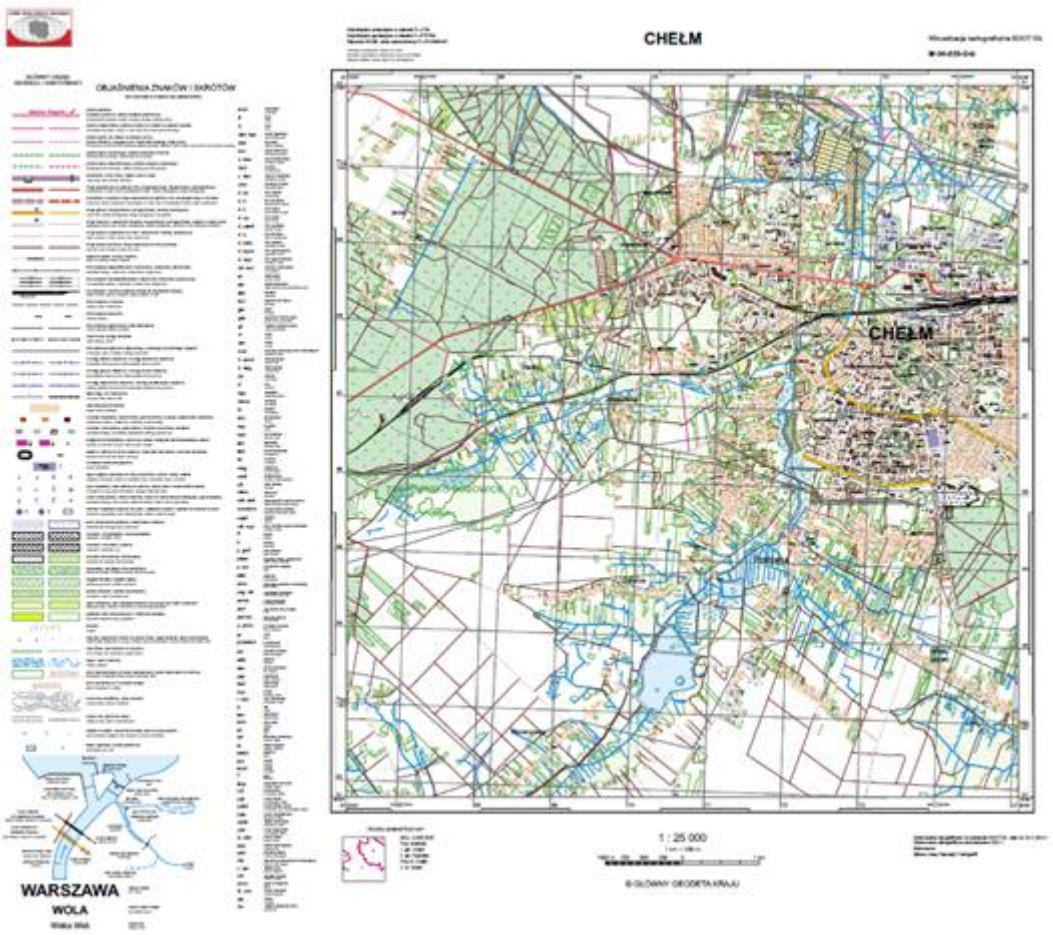

Fig. 31. BDOT10k cartographic visualization on a scale of 1:25,000

In the next (third) iteration, there will be level lines, missing descriptions, collision-free intersections of roads and railroads, and roundabouts added. Short dual carriageway sections will also be removed and placement of descriptions will be improved.

5.1.5. Development of www.geoportal.gov.pl Service

In 2019–2022 period, the Head Office of Geodesy and Cartography carried out a number of works aimed at increasing the availability of spatial data to citizens through digital tools (map portals and web services). These included the activities listed below.

- Development of a number of viewing and downloading WMS, WMTS, WCS, WFS, ATOM services useful for users, presenting data of the state geodetic and cartographic repertory and indexes of maps. The list and addresses of services is available at: https://www.geoportal.gov.pl/uslugi.
- In 2019, a web service (available at http://services.gugik.gov.pl/nmt) was created to enable:
    - determination of height based on DEM data, for any point in the country (for given XY coordinates);
    - determination of points of minimum and maximum height in the specified area;
    - calculation the volume of soil masses in the specified area relative to a plane with a given height.

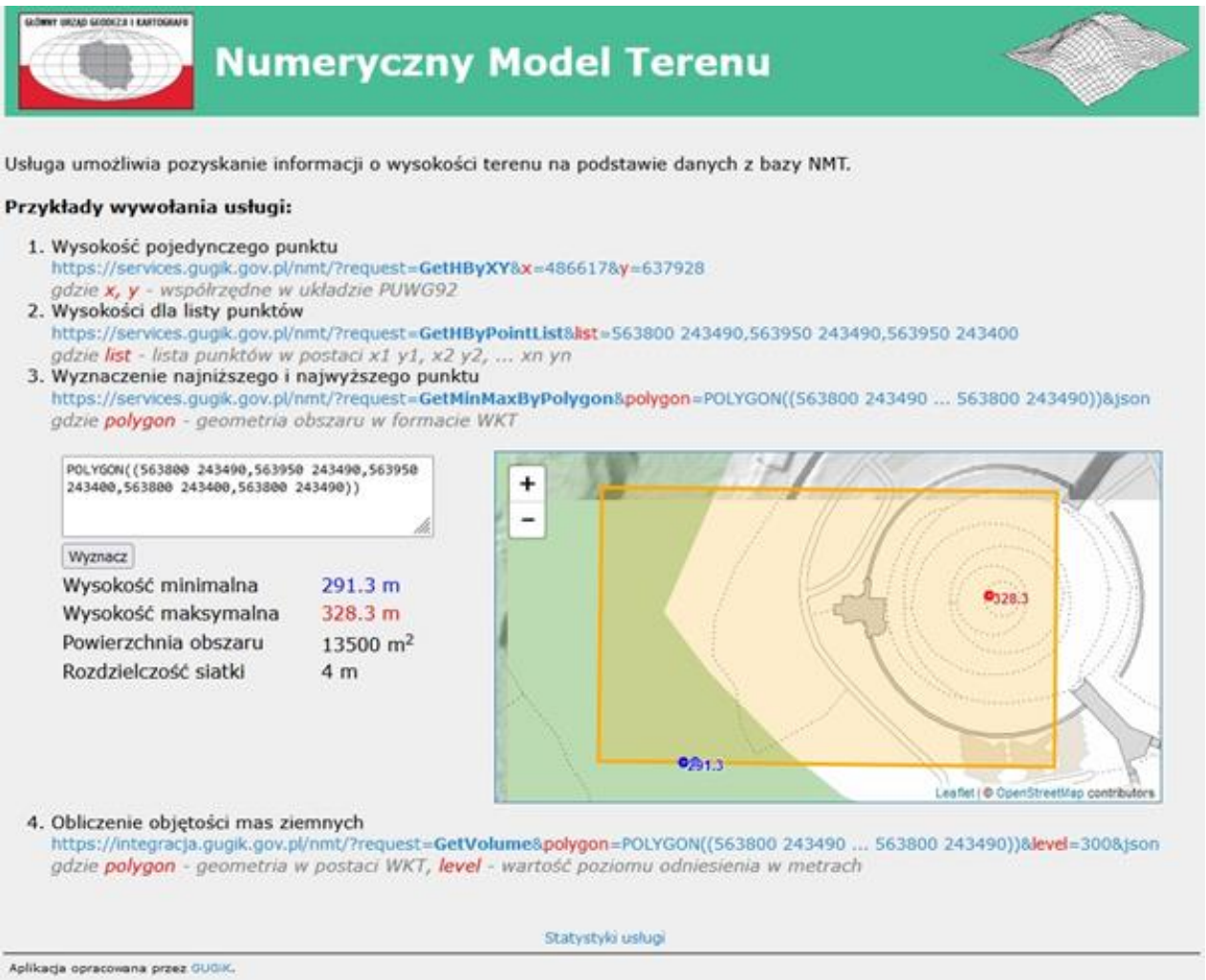

Fig. 32. DEM network service with call examples

- At the end of 2019 the functionality of generating a 'Longitudinal profile of terrain' in www.geoportal.gov.pl was added, which allows creating a profile along a broken line drawn by the user. The profile could be made on the basis of the Digital Elevation Model with a grid of 100 m, 5 m and 1 m available for the entire territory of Poland. In 2021, the tool was expanded to also use DSM source data with a 1 m grid and to display a reference line on independently selected source data.

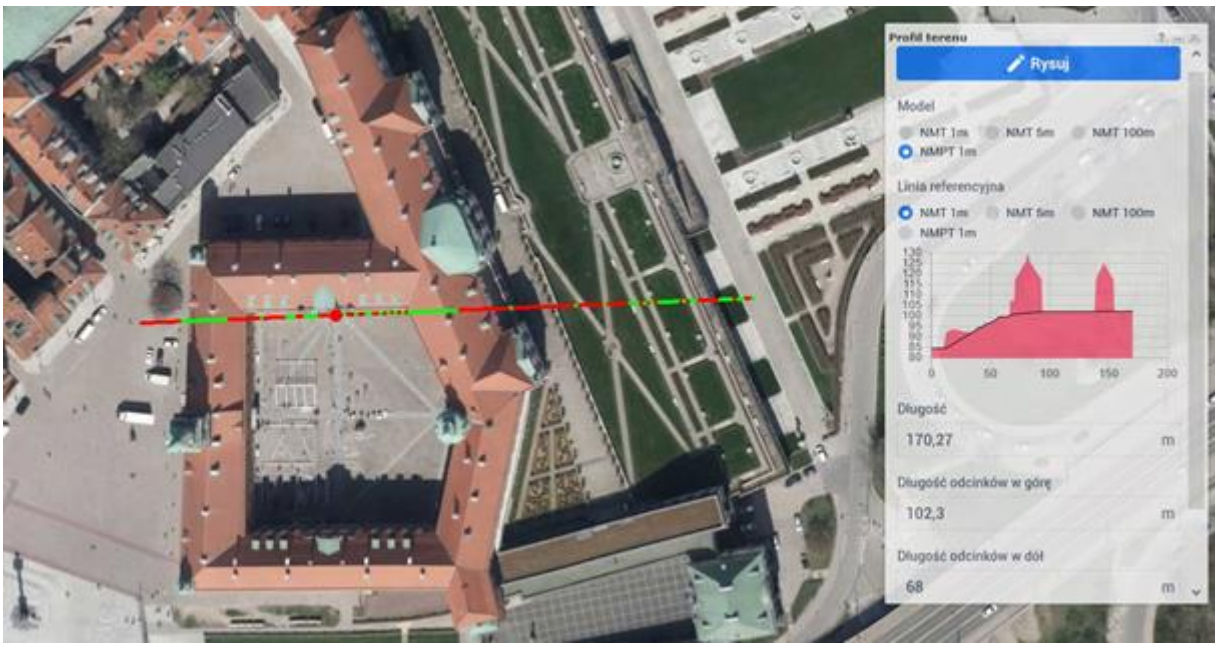

Fig. 33. Terrain profile on DSM data and reference line on DEM data

- At the end of 2019 an index service, enabling convenient downloading of data from the Database of General Geographic Objects (BDOO). It is available in packages corresponding to individual voivodeship, with a few clicks at www.geoportal.gov.pl. In 2021 it was expanded to include the ability to download selected archival data.

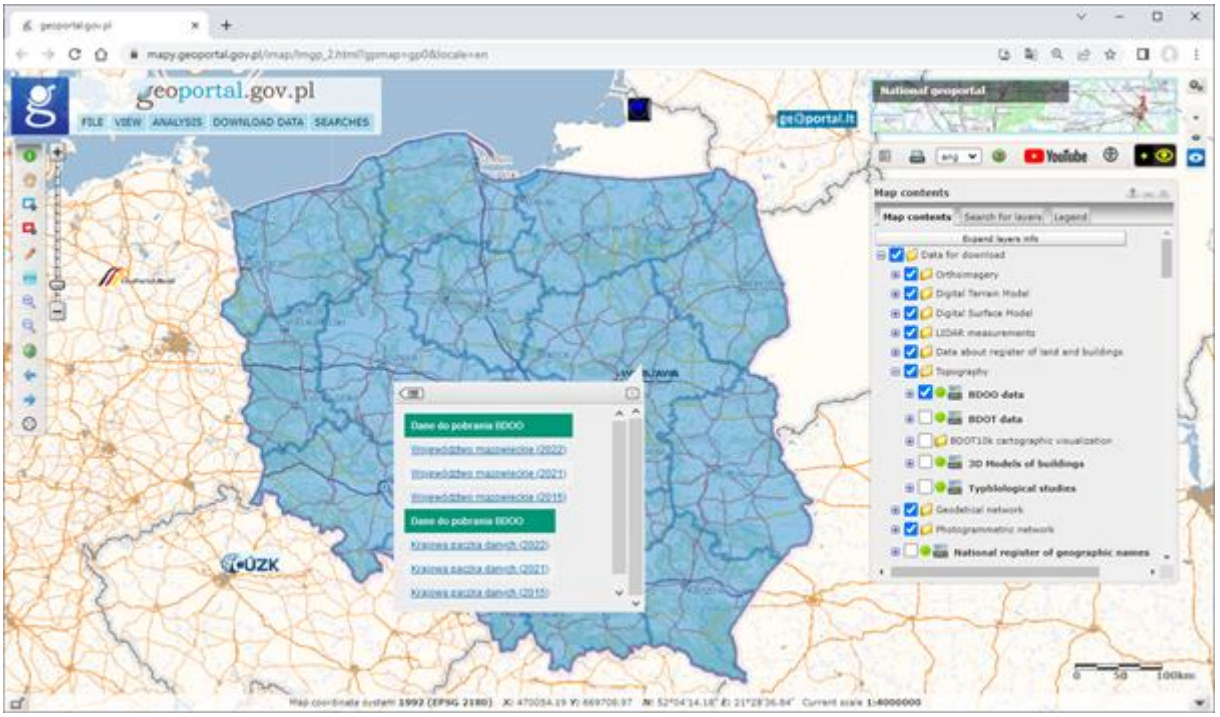

Fig. 34. Map window of www.geoportal.gov.pl with BDOO data download service visible

- In 2020, a mobile version of the Geoportal mapping portal (https://mapy.geoportal.gov.pl/mobile) was build. It significantly facilitates viewing spatial data provided through WMS and WMTS services on mobile devices, as it has a

simple interface that adapts to the user's screen size. There are several predefined layer compositions available, which the user can also customize by including or excluding data from the services available in the list. Other publicly available WMS or WMTS services can also be added by indicating their network address. The location search works both through address points and registered parcel numbers.

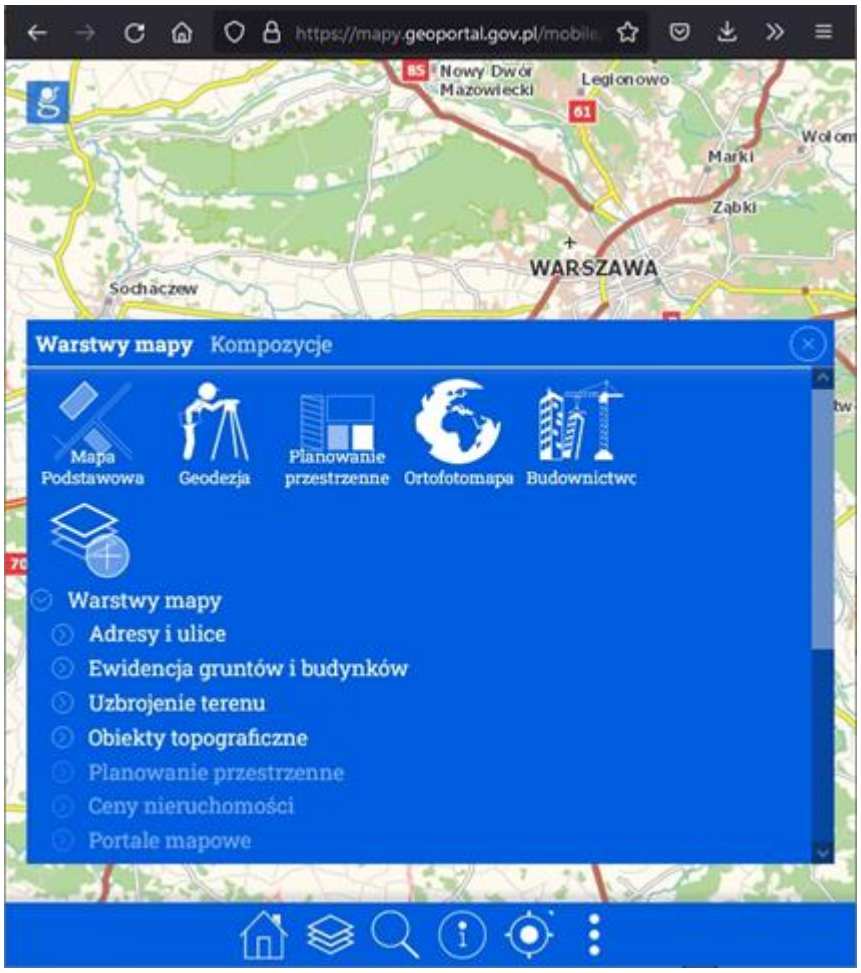

Fig. 35. Mobile version of the map service www.geoportal.gov.pl

- In 2020, new layers were added to www.geoportal.gov.pl to the **'Archival data'** layer group, presenting raster of archival thematic maps (administrative, landscape, hydrographic, sozological and general geographic maps), as well as scans of topographic maps organized by coordinate systems and scales of each study.

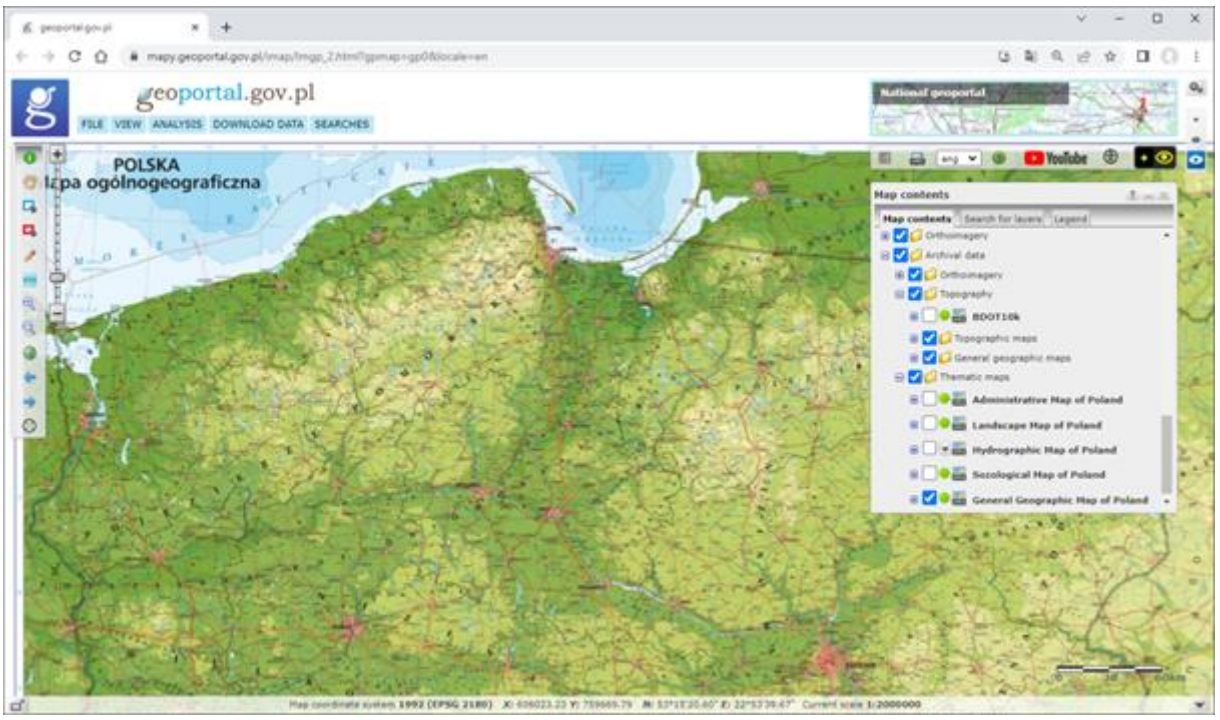

Fig. 36. Map window of www.geoportal.gov.pl with the general geographic map

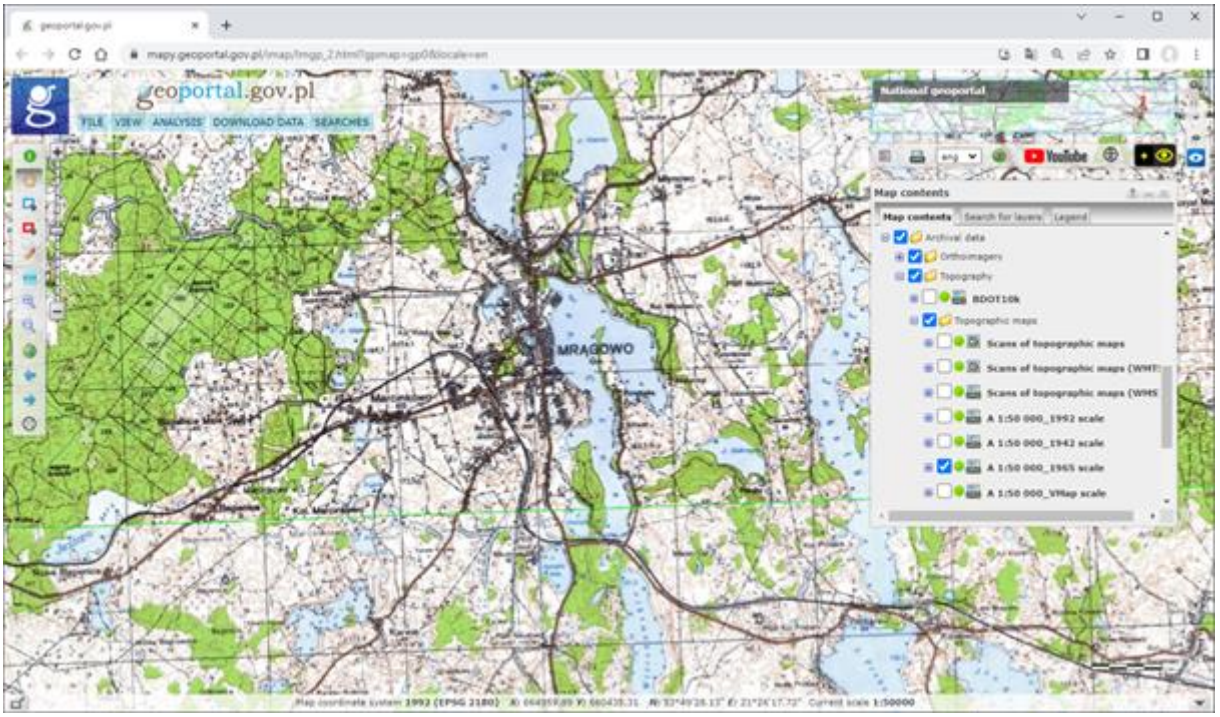

Fig. 37. Map window of www.geoportal.gov.pl with a 1:50,000 scale topographic map

- In 2020, the ‘packages’ of BDOT10k data were prepared for the areas of each powiat (county) and voivodeship, which were accessed through a directory service with links to allow users to conveniently download the data. At first, these were data in .gml format, and later ‘packages’ of data in .shp format were also added.

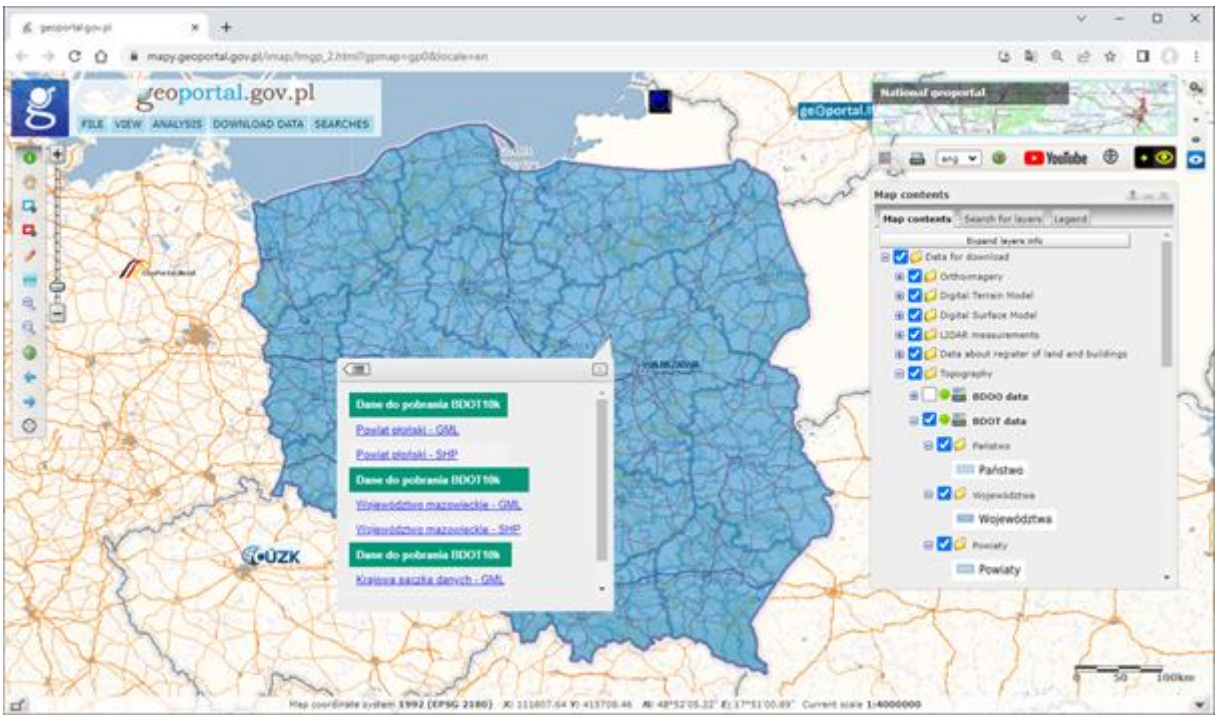

Fig. 38. Map window of www.geoportal.gov.pl with BDOT10k data download service

- At the end of 2020, as a part of the call of tender announced by GUGiK, a web application - BDOT10k Portal was created, enabling visualization, searching and performing analysis on data from the Topographic Objects Database (BDOT10k). It is available at https://bdot10k.geoportal.gov.pl, and can also be launched from www.geoportal.gov.pl (via the context menu).

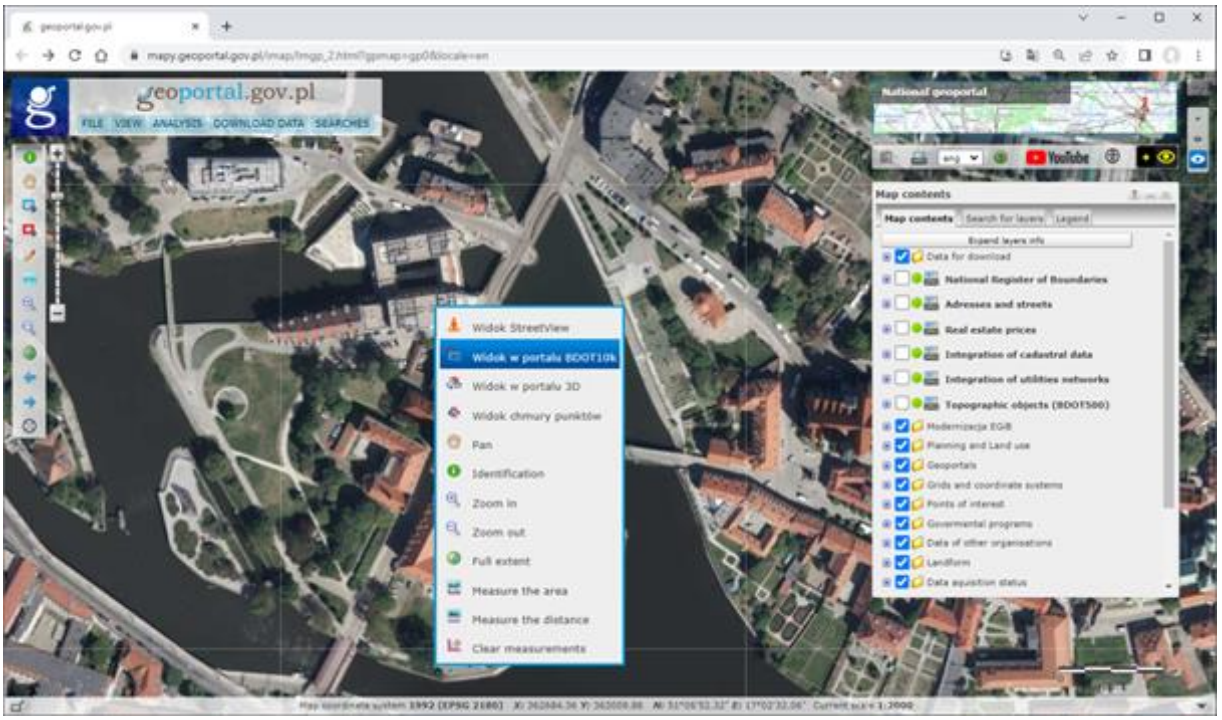

Fig. 39. Map window of www.geoportal.gov.pl with transition to BDOT10k Portal

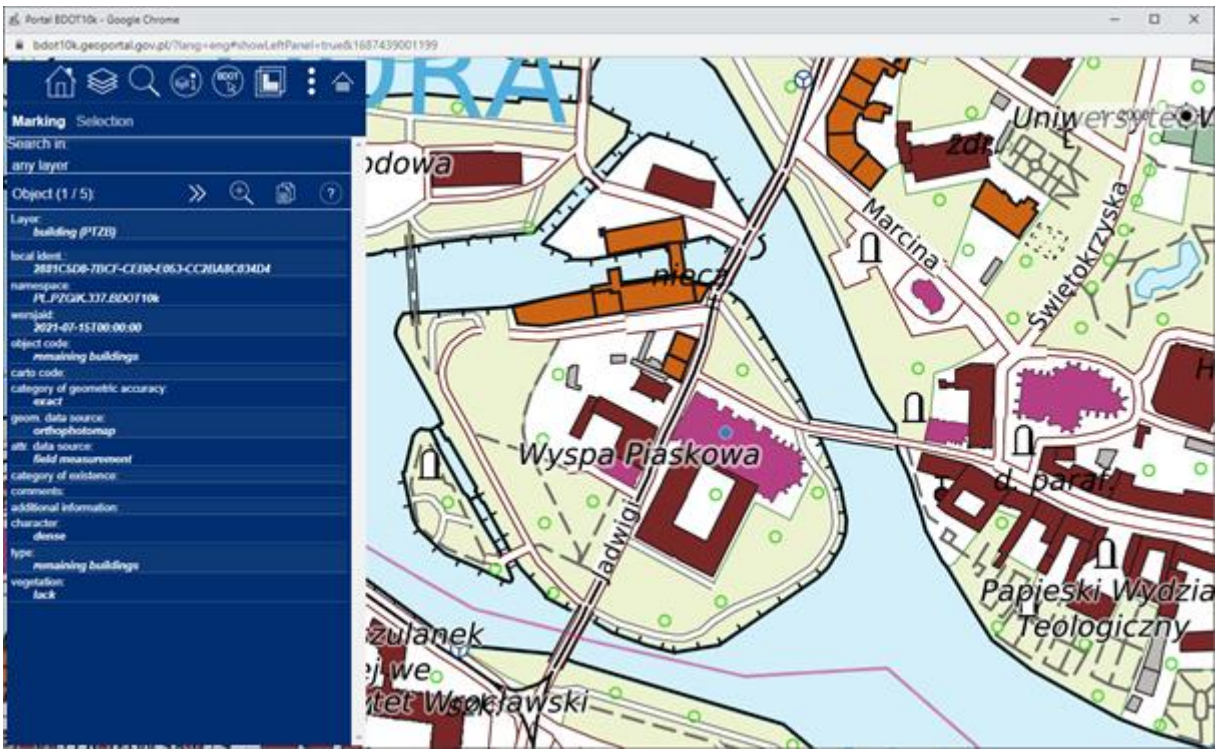

Fig. 40. BDOT10k portal

- At the turn of 2020 and 2021, a tool for viewing laser scanning - derived data (using Potree software) at www.geoportal.gov.pl was made available. It allows the user to customize the display of the point cloud based on, among other things, point classification and RGB values (if they have been assigned to the point cloud), performing basic measurements such as height difference, and displaying terrain profiles along a preset line.

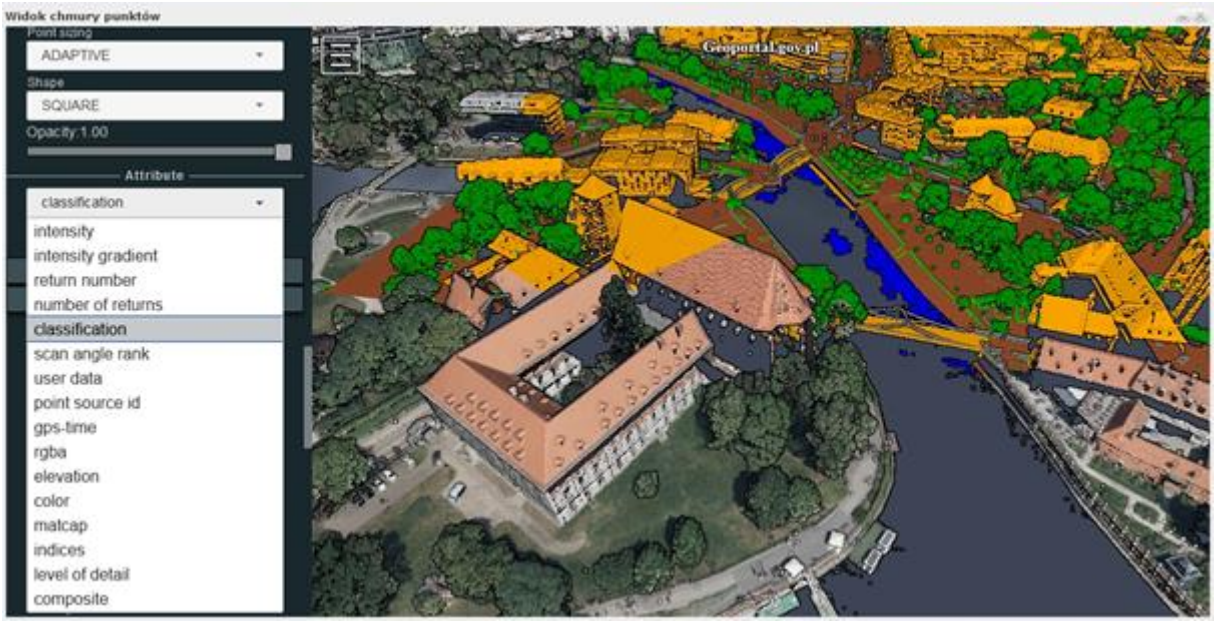

Fig. 41. View of the point cloud for a section of Wroclaw

with visualization of data by classification and RGB values

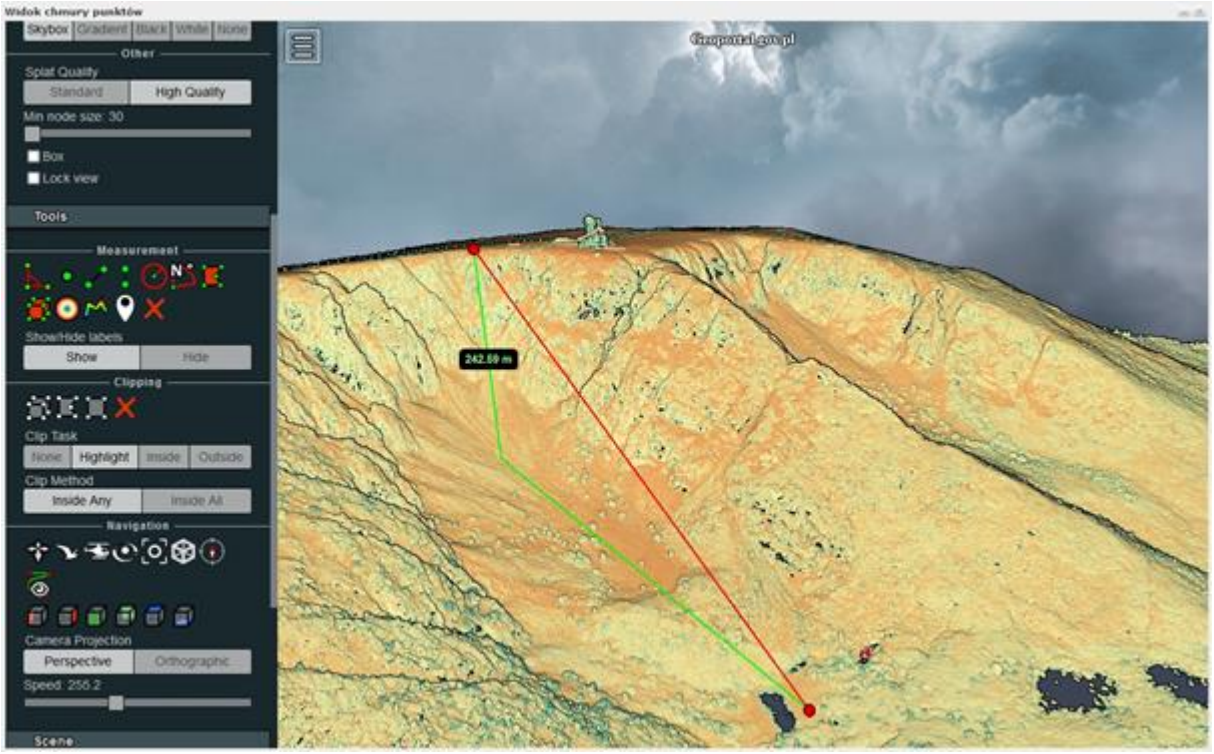

Fig. 42. View of the point cloud for a section of the Karkonosze Mountains with an example of measuring height differences

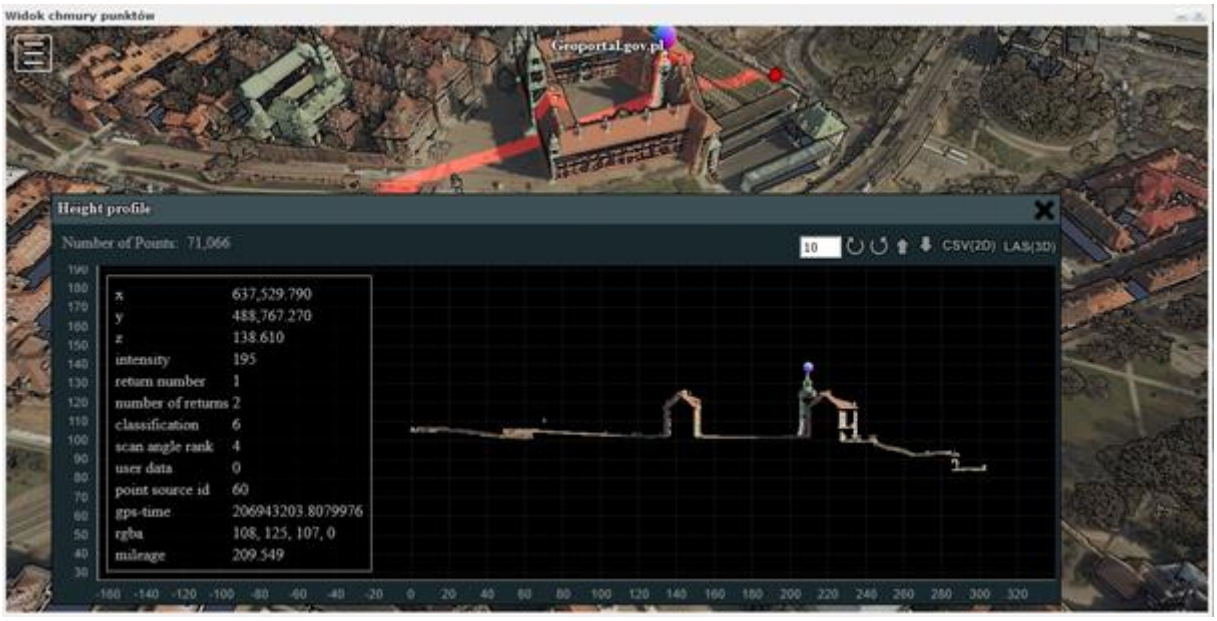

Fig. 43. Height profile through the point cloud

- In 2021, in the www.geoportal.gov.pl functionalities to search for objects from the Topographic Objects Database (BDOT10k), based on user–defined attribute and spatial conditions, were added.

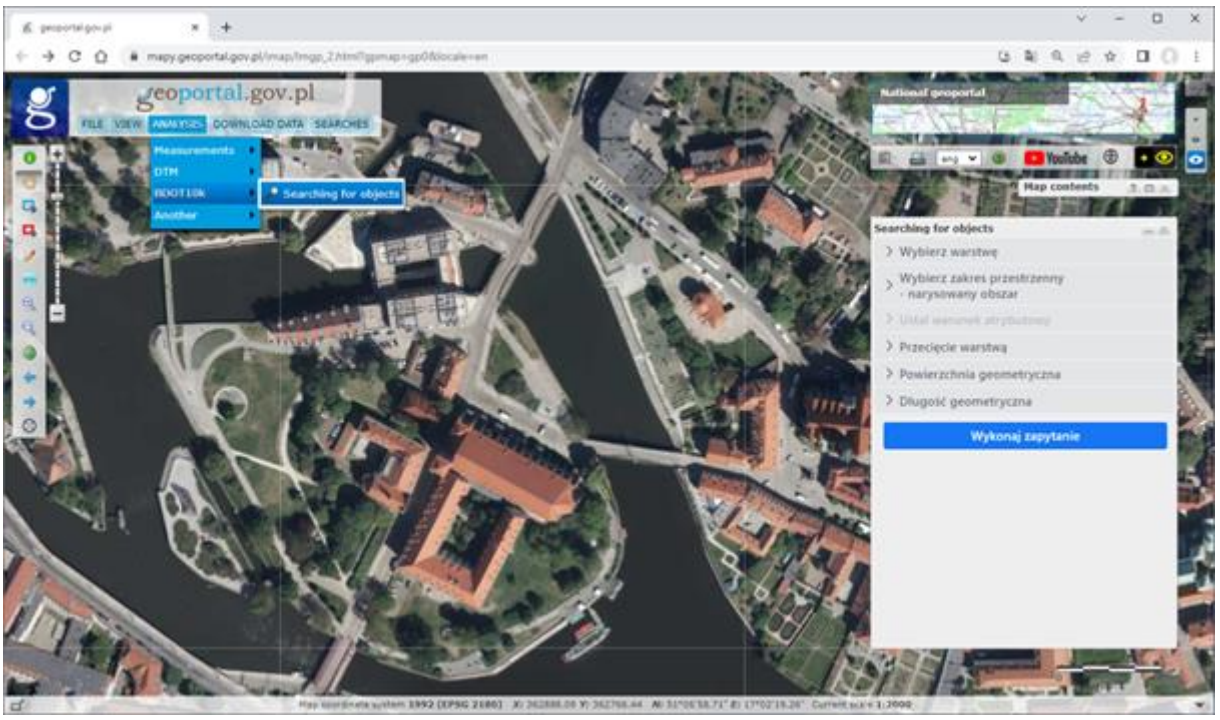

Fig. 44. Searching for BDOT10k objects on www.geoportal.gov.pl

- In 2021, the visibility analysis tools available at www.geoportal.gov.pl were modified to be based on data from the Digital Surface Model, so that they represent the actual visibility of the surroundings in the field. In addition to the point from which visibility is analyzed and the range, the user can specify the height of the observer above the terrain and the number of directions to be analyzed around the indicated point.

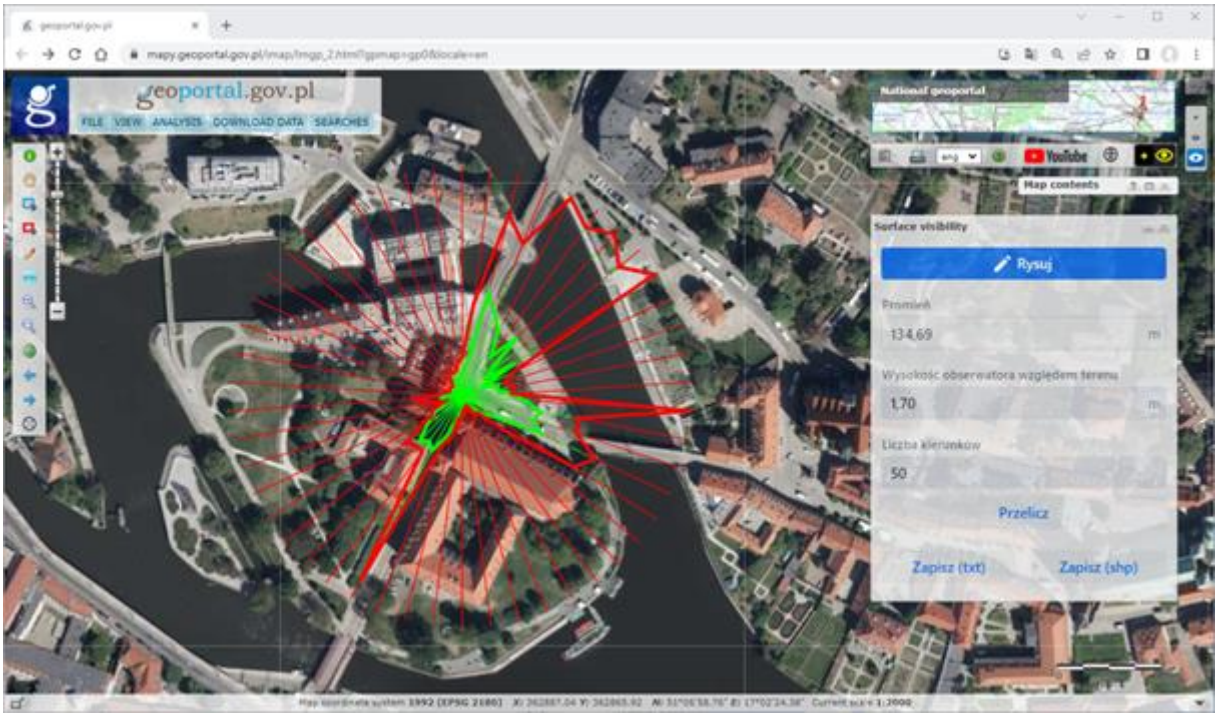

Fig. 45. Map window of www.geoportal.gov.pl with area visibility analysis visible

- At the beginning of 2022, the website www.geoportal.gov.pl new tool - ‘Route Search’ was launched. This tool allows to determine on the map the routes to a selected place. To search for a selected route it is necessary to:
    - specify its beginning and destination by searching among address points, or indicating points on the map;
    - specify the mode of transportation from the available options: car, on foot, bicycle;
    - select the type of route from the available options: recommended, fastest or shortest;
    - click the ‘RouteSearch’ button.

As a result, the course of the route is displayed on the map, while the tool panel presents its exact parameters, i.e. duration, length, and route stages containing navigation guidelines.

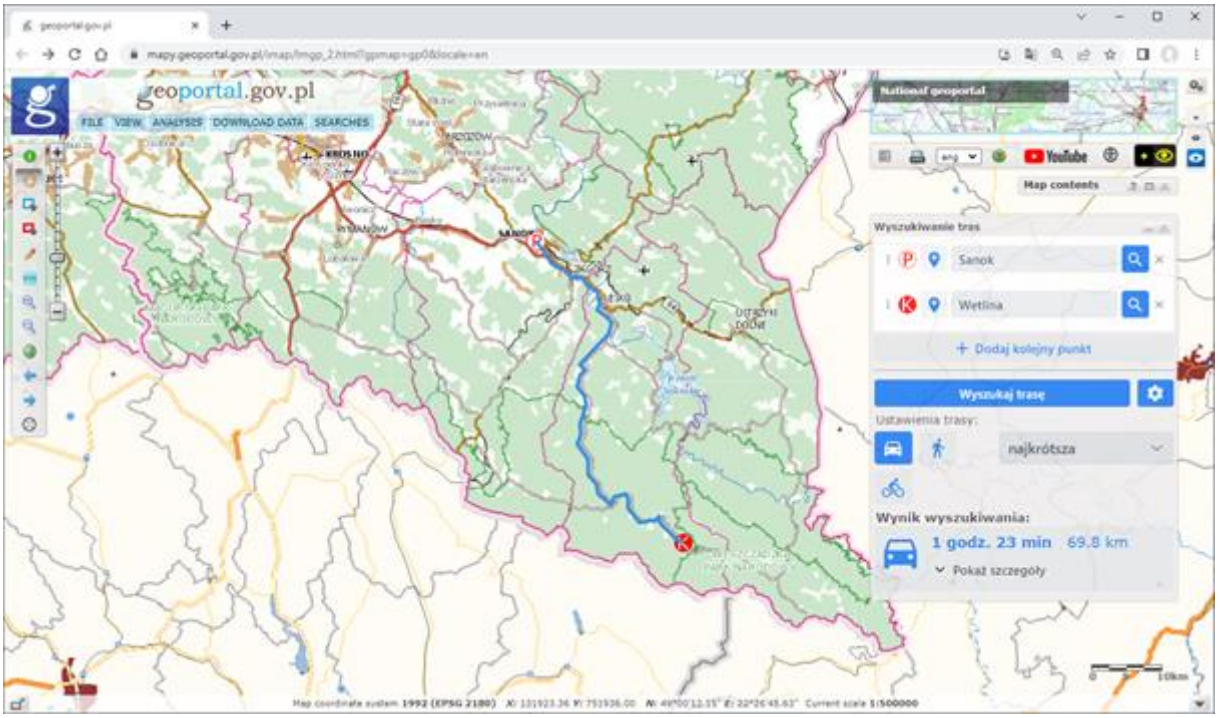

Fig. 46. Route Search at www.geoportal.gov.pl

- In 2022 the additional www.geoportal.gov.pl functionality was added, enabling the application to be launched in such a way, that the topographical object indicated in the call is displayed at the start, in accordance with the identifyObjectIIP parameter.

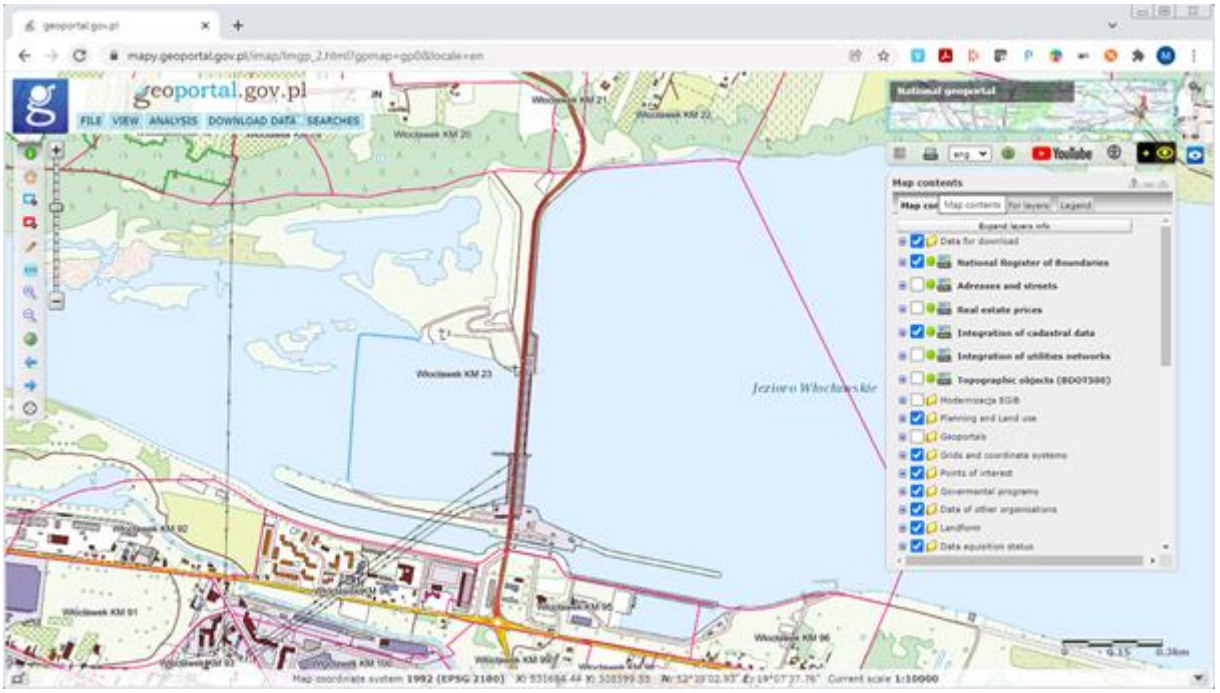

Fig. 47. Example call of www.geoportal.gov.pl with zoom on a specific object

The WMS and WMTS services presenting a raster image of data from the Topographic Objects Database (BDOT10k) and the General Geographic Objects Database (BDOO) were also successively updated and improved, as were the index services presenting the extent and topicality of topographic, thematic and special maps available in the central geodetic and cartographic repertory. All of these services are available both in the service maintained by the Head Office of Geodesy and Cartography – www.geoportal.gov.pl, and for use in any external software capable of presenting data from WMS or WMTS network services.

5.1.6. National Register of Geographical Names

Work on standardization of geographical names is carried out in Poland by two bodies:

a. the minister responsible for public administration, who, in accordance with the Act of August 29, 2003 on official names of localities and physiographic objects, conducts matters related to establishing, abolishing or changing the official names of towns, cities and physiographic objects **located on the territory of the Republic of Poland**;
b. Surveyor General of Poland, who, in accordance with the Act of May 17, 1989 Geodetic and Cartographic Law, conducts:
   - matters concerning the standardization of Polish - language naming of geographical objects **located outside the borders of the Republic of Poland**,
   - **database of the national register of geographical names**, containing up-to-date information on the names of localities and their parts and names of physiographic objects (referred to in the Law of August 29, 2003 on official names of localities and physiographic objects).

To carry out the above - mentioned tasks, were established, as advisory bodies, two commissions:

a. **Commission on Names of Localities and Physiographic Objects** operating under the minister of public administration;
b. **Commission for Standardization of Geographical Names outside the Borders of the Republic of Poland** operating under the Surveyor General of the country.

Commission on Names of Places and Physiographic Objects (KNMiOF).

The Commission is a consultative and advisory body in matters of establishing, making changes to and abolition of official names of towns, cities and their parts and physiographic objects from the territory of the Republic of Poland.

In the period 2019–2022, the Commission gave its opinion on a total of more than 450 applications from communes to establish, change or abolish official names of localities or their parts and physiographic objects, resulting in:

1) establishment of 15 new official localities names or parts thereof,
2) changing 288 official names and/or types of localities or parts thereof,
3) abolition of 610 official localities names or parts thereof,
4) establishment of 17 new official names of physiographic objects,
5) change of 23 names of physiographic objects,
6) abolishing 465 official names of physiographic objects.

Commission for Standardization of Geographical Names outside the Borders of the Republic of Poland (KSNG)

The Commission has been operating under the Surveyor General of the country since 2001 and its tasks include:

1) gathering opinions on applications to the Commission on the determination of the original wording and spelling of the names of countries, dependent territories, administrative units, localities, physiographic objects and other geographical objects located outside the borders of the Republic of Poland, and preparing lists of these names;
2) preparing official lists of Polish names (exonymes) of geographical objects located outside the borders of Republic of Poland;
3) establishing rules for the latinization of the names of geographical objects originally written in non - Latin writing systems;
4) cooperation with international organizations and relevant bodies of other countries dealing with the issue of standardization of geographical names;
5) proposing for international use foreign - language forms of the names of major geographical objects located on the territory of the Republic of Poland.

The results of the Commission's work include official lists of names of countries and dependent territories (issued every 2 years), lists of Polish names of geographical objects located outside Poland (issued every 5 years), toponymic guides and latinization rules. In the 2019–2022 period, two new editions of the ‘Official List of Names of Countries and Dependent Territories’ (in 2019 and 2021) were prepared by the Commission and the second edition of the ‘Official List of Polish Geographical Names of the World’ (in 2019). In 2019–2022 period the Commission for the Standardization of Geographical Names outside the Borders of the Republic of Poland made changes for a total of 1,317 Polish names of geographical objects of the world, adopting 779 new names, changing 199 names and removing 339 names.

Fig. 48. Publications of the Commission for the Standardization of Geographical Names

The Official List of Names of Countries and Dependent Territories (6th ed. 2021) contains 195 states recognized by the Republic of Poland (i.e. 193 UN member states plus Kosovo and the Vatican) and 69 non self-governing territories. An appendix to the list is a list of 9 territories with undetermined or disputed international status. The publication takes into account the Commission's resolutions up to October 6, 2021. The names of countries, territories and their capitals included in the list have been approved by the Ministry of Foreign Affairs. Information on the political affiliation of territories and footnotes explaining the status of states and territories or their names are from the Ministry of Foreign Affairs. Adjectives from the names of states and territories and names of inhabitants are given in accordance with the opinion issued by the Orthographic Team of the Council of the Polish Language. Linguists were also consulted on the conjugation of names given in the list. The following information is given for each country:

- abbreviated Polish name of the country in the nominative, the complement and the possessive;
- the official (expanded) Polish name of the country in the nominative, and in the case of names whose conjugation may cause problems, also in the complement and the possessive;
- the name of the country's official language or languages;
- the abbreviated name of the country in the official language(s);
- the full official name of the country in the official language(s);
- an adjective from the Polish name of a country (in the nominative singular of the masculine);
- polish names of citizens of the state in the masculine and feminine singular and in the plural masculine;
- the name of the capital (or capitals) of the country used in Polish;
- the name of the capital (or capitals) in the official language(s).

The similiar information is also given to non self–governing territories and territories with undetermined or disputed international status, only instead of the names of citizens, the names of residents of the territory are given. Additional information given next to territories is the political affiliation.

The Official List of Polish Geographical Names of the World (2nd ed. 2019), which is an update of the 1st edition of 2013, takes into account the resolutions of the Commission adopted until November 20, 2019. The list provides Polish names for 13,599 geographic objects. Compared to earlier studies, in this one the Commission has significantly expanded the number of recommended Polish names for geographic objects (mainly localities) lying within Poland's borders before World War II. In addition, pseudo - exonyms were included more extensively than in earlier lists (especially for objects whose names are originally written in non - Latin script systems), and the Polish nomenclature of protected areas and administrative units was significantly expanded.

For the geographical objects listed, names of two types are provided: Polish geographical names (exonyms and pseudo–exonyms) and the corresponding their original names (endonyms – names of geographic objects in the languages used in the area where the object is located). It should be emphasized that the Commission for the Standardization of Geographical Names outside the Borders of the Republic of Poland standardizes only Polish names, while it does not deal with the standardization of endonyms, and the exonyms and pseudo - exonyms included in the lists are the only Polish geographic names recommended by the Commission. Failure to mention an object is tantamount to saying that the Commission does not recommend a Polish name for it, even if such a name is encountered in some publications. The reason for the absence of a name in the list may also be that the object is insignificant or has ceased to exist. For names in languages using non - Latin script, a latinized notation is given according to the rules that the Commission recommends for use in Poland for geographic names from the language in question.

The list includes the names of objects from all continents, as well as the names of undersea objects; however, objects lying entirely within the territory of Poland are not included. The list is divided into eight parts (chapters): seven of them correspond to individual parts of the world, the eighth is devoted to undersea objects. The entries relating to individual geographic objects include:

- a polonized name: an exonym or pseudo–exonym;
- the original name (endonym) in the official language (or the original names, if more than one official language is in effect or the object has official names in several languages);
- latinized writing of the name (for non–Latin writing systems);
- geographic coordinates of the object.

The publications are available for free download on the Commission's website at: https://www.gov.pl/web/ksng.

The National Register of Geographical Names (PRNG) is an official reference database that forms the basis for other spatial information systems using geographic naming data. The information in the registry is the most complete set of data containing current and former names of localities and physiographic objects from the area of the Republic of Poland, along with extensive characteristics and location (geographical coordinates).

The legal basis for creating, updating and verifying, providing data and the scope of information collected in the PRNG database is the Regulation of the Minister of Development, Labor and Technology of January 29, 2021 on the National Register of Geographical Names (Journal of Laws of 2021, item 273).

The PRNG registry consists of two parts covering:

a. **register of geographical names of the Republic of Poland** containing the names of geographical objects located in whole or in part on the territory of the Republic of Poland, including the maritime areas of the Republic of Poland and maritime administration;
b. **register of Polish geographical names of the world** containing Polish - language names of geographical objects located outside the Republic of Poland.

The register of geographical names of the Republic of Poland contains data on official, standardized and non - standardized names of geographic objects (towns, cities names and physiographic objects) along with their attributes. Each geographic object name is described by 31 attributes, of which mandatory attributes include:

- main name,
- the complement ending of the main name,
- name status,
- object identifier,
- category and type of object,
- location of the object within the units of the basic three-level territorial division of the country,
- source of information about the name and object,
- geographic and XY coordinates.

As of January 2023, the National Register of Geographical Names of the Republic of Poland contains a total of 255,815 names of geographical objects located in the territory of the Republic of Poland, including: 124,578 localities names and 131,237 names of physiographic objects.

According to the Geodetic and Cartographic Law, PRNG data are made available free of charge at www.geoportal.gov.pl and for any use. The data of the National Register of Geographical Names of the Republic of Poland are provided in four ways:

1. by using the WMS service, which is connected as standard in the geoportal: https://mapy.geoportal.gov.pl/wss/service/PZGiK/PRNG/WMS/GeographicalNames;
2. by using the WFS service: https://mapy.geoportal.gov.pl/wss/service/PZGiK/PRNG/WFS/GeographicalNames;
3. by using the ATOM service: http://mapy.geoportal.gov.pl/wss/service/ATOM/httpauth/atom/GUGIK_PRNG;
4. through the service of providing downloadable file data at www.geoportal.gov.pl in .gml, .shp and .xlsx formats.

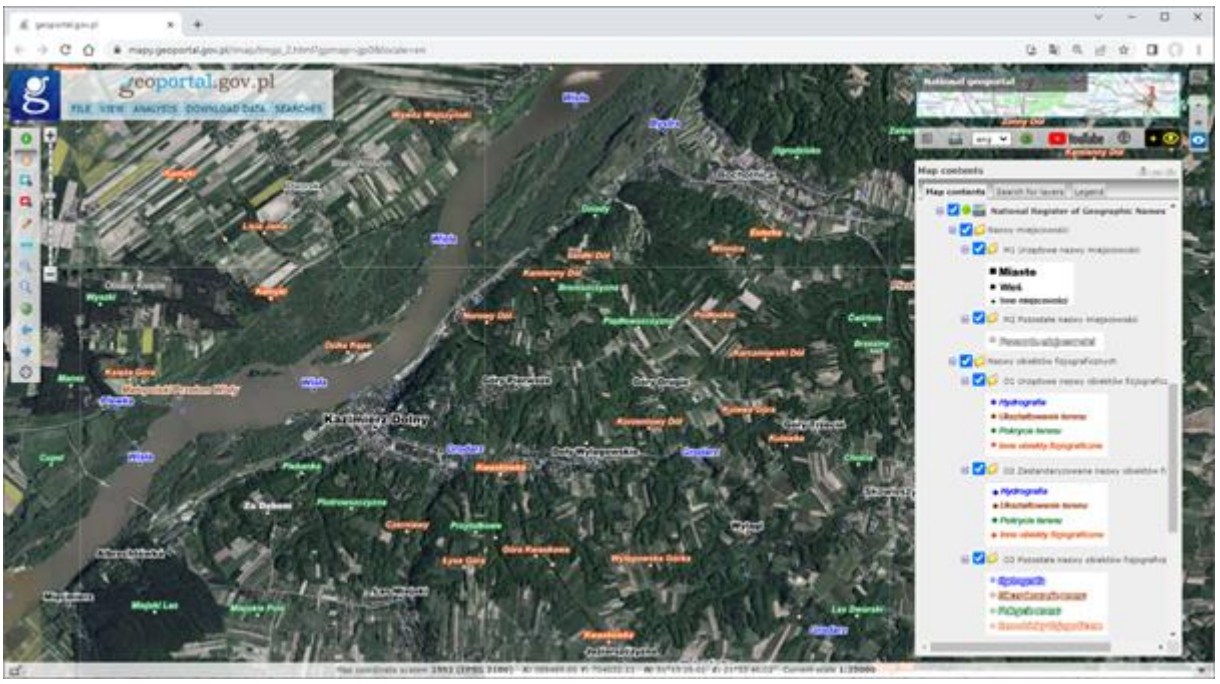

Fig. 49. Geographical Names of the Republic of Poland in www.geoportal.gov.pl

The register of Polish geographical names of the world was established at the end of 2021, and as of December 31, 2022, the register collected a total of 13,448 Polish geographical names of the world adopted by the Commission for the Standardization of Geographical Names outside the Polish Borders (KSNG), acting at the Surveyor General of Poland. The register is maintained in the form of a spatial database containing, in particular, Polish names of countries, non self–governing territories, administrative units, localities and major physiographic objects, together with their attributes containing detailed information on the name itself and the described object. All objects (names) collected in the PRNG database have a spatial reference (geographic coordinates). The register includes names of geographic objects for which Polish names are recommended. The register includes names of objects from all continents, as well as names of undersea objects. Updating of the database is carried out on an ongoing basis, based on KSNG resolutions.

The data of the register of geographical names of the world are provided in three ways:

1. search, browse, identify objects through dedicated map portal https://prng.geoportal.gov.pl,
2. WMS viewing service https://mapy.geoportal.gov.pl/wss/service/PZGiK/PRNG/WMS/WorldGeographicalNames,
3. downloadable file data at www.geoportal.gov.pl in .gml, .shp and .xlsx formats.

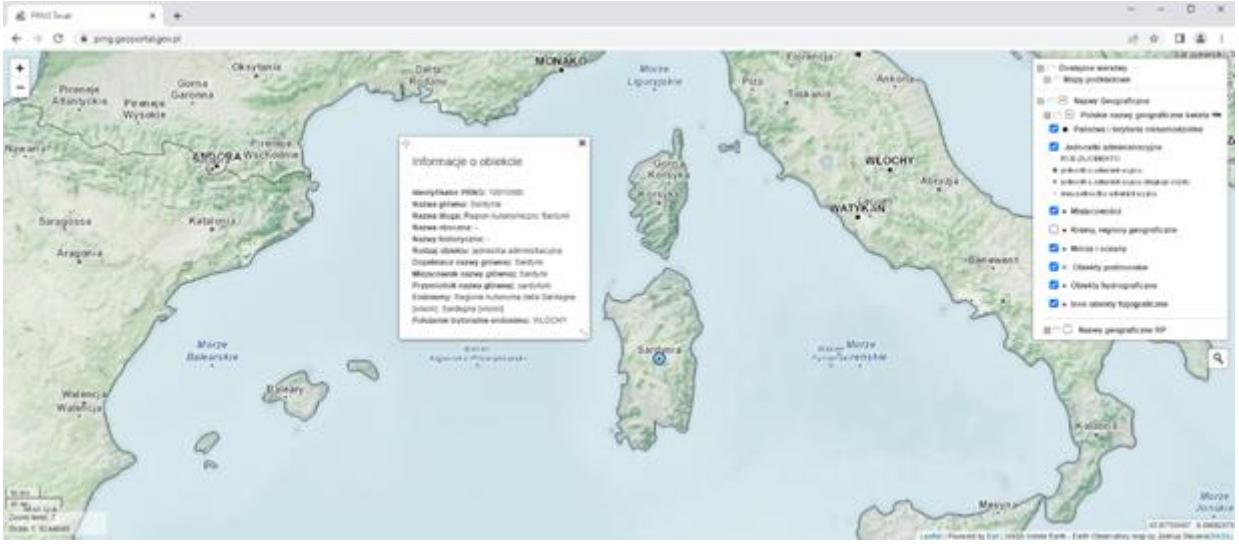

Fig. 50. Polish geographical names of the world at www.geoportal.gov.pl

5.2. The Polish Geological Institute – National Research Institute (PGI–NRI)

Geological mapping is one of the basic scientific tasks and statutory activities of **the Polish Geological Institute – National Research Institute (PGI–NRI)**. The Institute prepares thematic maps at various scales in the fields of geology, hydrogeology, engineering geology, economic and environmental geology, geophysics and environmental geochemistry. The maps cover the entire country or selected regions, depending on the subject matter and needs. Current needs also determine the scale at which geological and geology related maps are compiled at the PGI–NRI: from the scale of 1: 10,000 for geological and engineering maps and atlases of selected areas, through the scale of 1: 50,000 for serial thematic maps covering the whole country (such as: geological, lithogenetic, hydrogeological, geoenvironmental maps) to synthetic overview maps at the scales of 1: 200,000 – 1: 500,000. All currently developed maps are prepared in GIS format and are systematically made available on the Internet through dedicated web applications or/and as OGC web services.

The development of detailed thematic maps at the scale of 1: 50,000 is one of the most important tasks of the PGI–NRI carried out within the framework of geological mapping. These maps, a total of 1,069 map sheets for each map, will eventually cover the entire country. Subsequent sheets of individual maps are being systematically developed as part of multi-year programs. The current status of the work is as follows:

1. Detailed Geological Map of Poland – has been compiled for the entire country for the last 60 years. Some of the oldest map sheets were published only in the form of offset printing (they are available as raster files/scans now). To date, 850 map sheets have been developed digitally, the remaining sheets, published more than 25 years ago using traditional methods, are being updated with the latest geological data and prepared in GIS version as well. Between 2018 and 2022, another 132 map map sheets have been digitally developed and prepared for publication. In addition to the map itself, geological cross–sections and profiles, explanatory text and other appendices are prepared and made available for each map sheet.

2. Hydrogeological Map of Poland – all sheets of the map of the main usable aquifer were published for the whole country by 2005. This map is of fundamental importance for assessing the potential groundwater availability for population supply and economic use. Maps of the first aquifer that are of particular importance for environmental protection and ecosystem functioning are being developed currently. To date, 922 sheets of the map depicting the occurrence and hydrodynamics of the first aquifer have been developed, 55 sheets of the map were made in the last four years. Maps of the sensitivity of the first aquifer to pollution and water quality are also available. To date, 433 sheets of the map have been published, no new sheets have been made in recent years.
3. Geoenvironmental Map of Poland – the map is addressed primarily to institutions, local governments and state administration as entities involved in the rational management of natural resources. As a result of subsequent updates, the source map data has formed a comprehensive geoenvironmental database where information on Poland's existing and potential raw materials, environmental conditions and potential conflicts related to mining is stored. The update of 467 map sheets (from Southwestern Poland) was completed in 2013–2015 and the update of the remaining map sheets – in 2016–2019.
4. Lithogenetic Map of Poland – the map presents simplified information on the structure of the near–surface zone and is developed on the basis of the Detailed Geological Map of Poland – a total of 750 sheets of the map have been developed so far, no map sheet has been developed recently.

In recent years the Polish Geological Institute – National Research Institute (PGI–NRI) has also elaborated and published:

1. Geological Map of Poland at the scale of 1: 200,000 – 77 sheets, that covered teh whole country, were developed and published (in hard copy/paper version) by 1996. Currently, in the frame of the new edition of the map subsequent sheets are being updated. They are compiled in GIS format. 34 sheets has been developed by 2021, work is currently underway on another 15 sheets. Each map sheet consists of two plats: A – surface map (so called ‘covered’map) and B – sub–Quaternary map (so called ‘uncovered’ map) and is accompanied by geological cross–sections and profiles, explanatory text and other appendices.
2. Geological Map of Poland at the scale of 1:500,000 (2022) – in the frame of the project, three map sheets were developed: A – surface map (‘covered’), B – sub–Quaternary map, and C – map sub–Cenozoic map. Both the map data in GIS format as well as print–ready map sheets are available.
3. Tectonic Map of the Tatra Mountains at the scale of 1:50,000 (2023). It is currently being prepared for publication.
4. Overview Geological Map of the Carpathians (‘uncovered’ sub–Quaternary map) (2020).

The PGI–NRI’s maps are made widely available through the GeoLOG geoportal (as spatial data services or/and as raster files/scans of the original paper maps) as well as through other web applications in the pgi.gov.pl domain.

5.3. The Institute of Meteorology and Water Management – National Research Institute (IMWM NRI)

The Institute of Meteorology and Water Management – National Research Institute (IMWM NRI) is a representative of Poland in the World Meteorological Organization. Its main objectives are to conduct research and to perform the function of national institution in the fields of meteorology, hydrology, oceanography, water management and engineering, quality of water resources, waste management, treatment of waste sediments.

The Institute of Meteorology and Water Management – National Research Institute (IMWM NRI) is currently publishing:

1) maps showing the current meteorological (weather) conditions,
2) maps showing climatic conditions presented on the internet portal http://klimat.pogodynka.pl/ and in the periodically published 'Bulletin of Polish Climate Monitoring' and 'the Southern Baltic Monitoring Bulletin'.

5.4. The Hydrographic Office of the Polish Navy (HOPN)

The Hydrographic Office of the Polish Navy (HOPN) develops and publishes marine navigation maps as part of the national and international collections (INT). According to the current 'Catalogue of Nautical Charts and HOPN Nautical Publications', 60 maps are published and kept up to date. Of these, 30 maps cover Polish sea areas, 19 of which constitute INT collection. In addition, OPN is the publisher of 3 atlases with of maps for small vessels to cover the Polish coast with adjacent inland waters. These studies, depending on the scale and purpose, are prepared in accordance with the adopted division into general, littoral, approach and port maps. Polish navigational charts are based on the Mercator projection system using the ellipsoid and the WGS–84 reference system. They meet all the standards of the International Hydrographic Organization.

The Polish marine areas are also covered entirely with cells of the Electronic Navigation Chart (ENC). These maps are vector products. They are used in Electronic Chart Display and Information Systems (ECDIS). The Hydrographic Office of the Polish Navy is the sole author of ENC for the Polish territorial waters. 61 ENC cells are maintained as the permanent service in bands 2–5. The catalogues of HOPN maps are available at:

- https://bhmw.gov.pl/c/pages/atts/2023/6/Katalog_pogladowy.pdf
- https://bhmw.gov.pl/c/pages/atts/2023/7/Katalog_Map_552_2019_07.07.23.pdf.

It should be noted that both sea charts and cells of the Electronic Navigation Chart are updated on a weekly basis. For sea charts, the update source is issued by HOPN 'Wiadomości Żeglarskie' [Sailing News], and for ENC cells, the updates are distributed by an authorized distribution service (PRIMAR).

The nautical publications issued by HOPN, which include Baltic Pilotage, Lists of navigation lights and beacons and nautical radios, signs, abbreviations, terminology used on maps published by HOPN or the above–mentioned 'Wiadomości Żeglarskie' constitute a significant supplement to the content presented on the nautical charts. More information about the activities of HOPN is available at: http://www.HOPN.gov.pl.

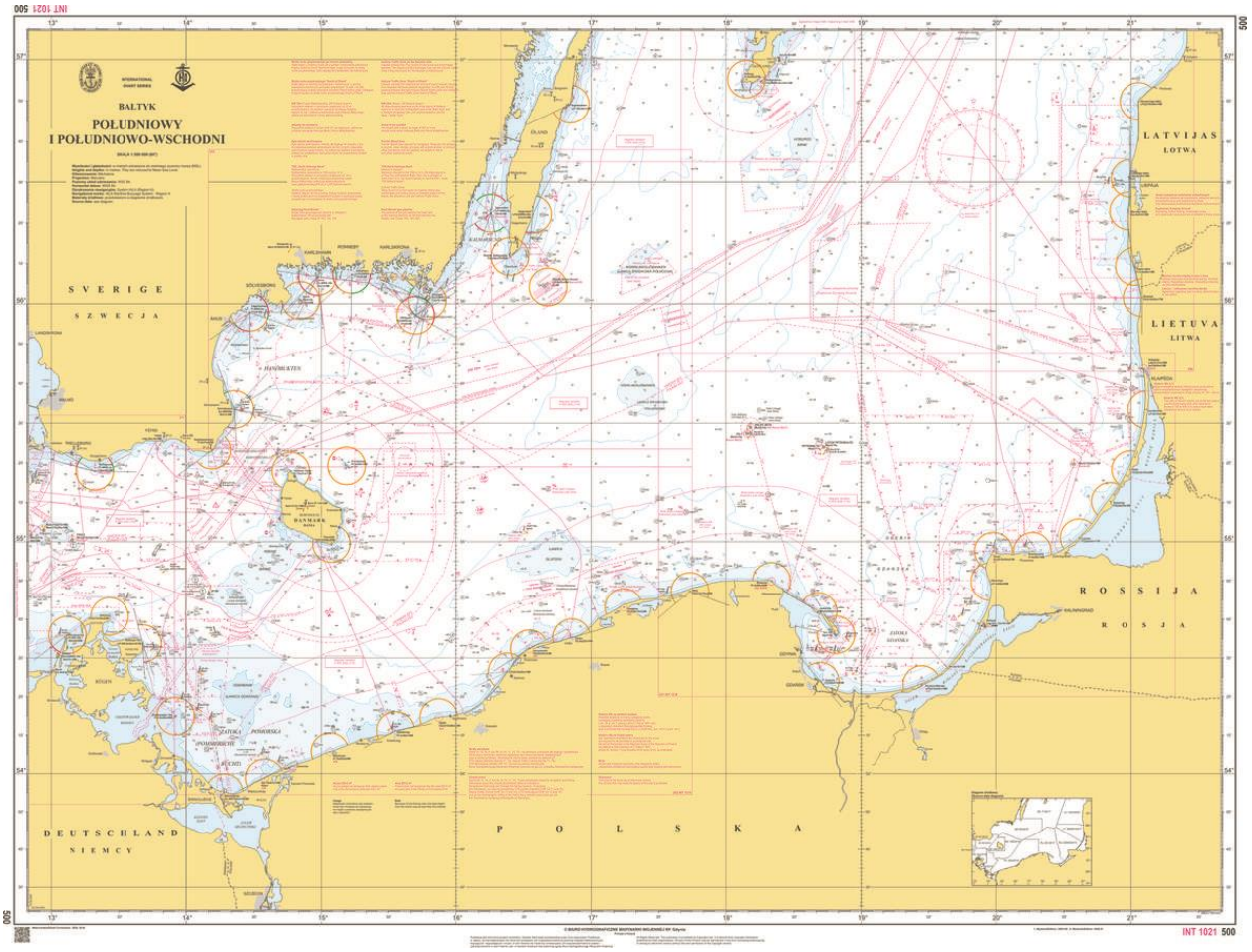

Fig. 51. Sea map of Sout and South–East Baltic on a scale of 1: 500,000

5.5. Statistics Poland (GUS)

Statistics Poland (GUS) is a central body of public administration that collects and provides access to statistical data concerning, in particular, the country's economy, population and society at the national, regional and local levels. Statistical cartography includes both numerous intertextual statistical maps published in traditional statistical publications (yearbooks, analyses, reports, information) and separate cartographic publications – traditional and digital (Geostatistics Portal, Atlas of Regions, statistical atlases). Data visualizations on maps are also available, among others, on the websites of the 'Strateg System', Knowledge Databases and international statistics.

The new **Geostatistics Portal** (https://portal.geo.stat.gov.pl/en/home/) was launched for public use in 2022. Within last years the functionalities of the previously provided services in the Geostatistics Portal were updated and expanded as the answer to user needs. As a result the new Portal has an intuitive graphical interface prepared in accordance with the principles of user-oriented design and is an innovative tool for visualizing statistical data on maps enabling presentations tailored to user needs in graphical form on maps and charts. It allows to create maps based on statistical data using various visualization methods, to prepare statistical analyses within any spatial division, e.g. defined by the user, downloaded from external spatial data services (WFS), based on 'dynamic' grid cells, the possibility of combining statistical data with the user's own data or geocoding users' data to use in geostatistical analysis. In addition, new services were developed, which facilitate the use of exploratory spatial data analyses using statistical information, performance of analyses in the field of geostatistical

modelling and the support of supplementing users' own data with geostatistical information and analyses. The system gives also possibility to export and/or print results of users work. Moreover there was developed a new possibility allowing to store and share data, results of analysis and created maps with other users or whole organizations within the system or for public use on the Internet.

The new functionalities are available to advanced users, but also to users without specialist knowledge in the field of statistical analyses. The implementation of automatic content analysis mechanisms (i.e. 'text mining') and usage of metadata describing geostatistical analyses available in the system, provide users with the possibility of supplementing their own text with graphic elements. Moreover new Geostatistics Portal is accessible also from mobile devices. Released application enabling the viewing of map applications and presentation of thematic data of the Statistics Poland using cartographic presentation methods and displays basic statistics for territorial units.

The new Geostatistics Portal makes it possible to conduct previously unavailable analyzes on spatial data sets and on public statistics resources, allowing to obtain previously unavailable results, and to optimize business processes, significantly enriching the state's information system. In addition, due to the innovative and unique nature of the project's products, they can be used in scientific research to analyze the relationship between phenomena from various research fields. That is why the Portal is an innovative and unique tool for all e.g. users from public administrations, scientific and research centers, entrepreneurs or students.

The Geostatistics Portal also enables access to spatial data sets as part of INSPIRE services for two spatial data themes for which the President of Statistics Poland is the leading body: statistical units and population distribution (demography). Discovery, view and download services are available. All services are publicly available and datasets can be downloaded for free. Data published in INSPIRE services comply with the technical guidelines of the Directive. For the theme statistical units the download service is available datasets for 2010–2022 and a dataset with a 1km x 1km statistical grid. For the theme population distribution (demography) are available data for 2011: population data in statistical regions, census enumeration areas and for 2021: resident population data in a kilometre grid.

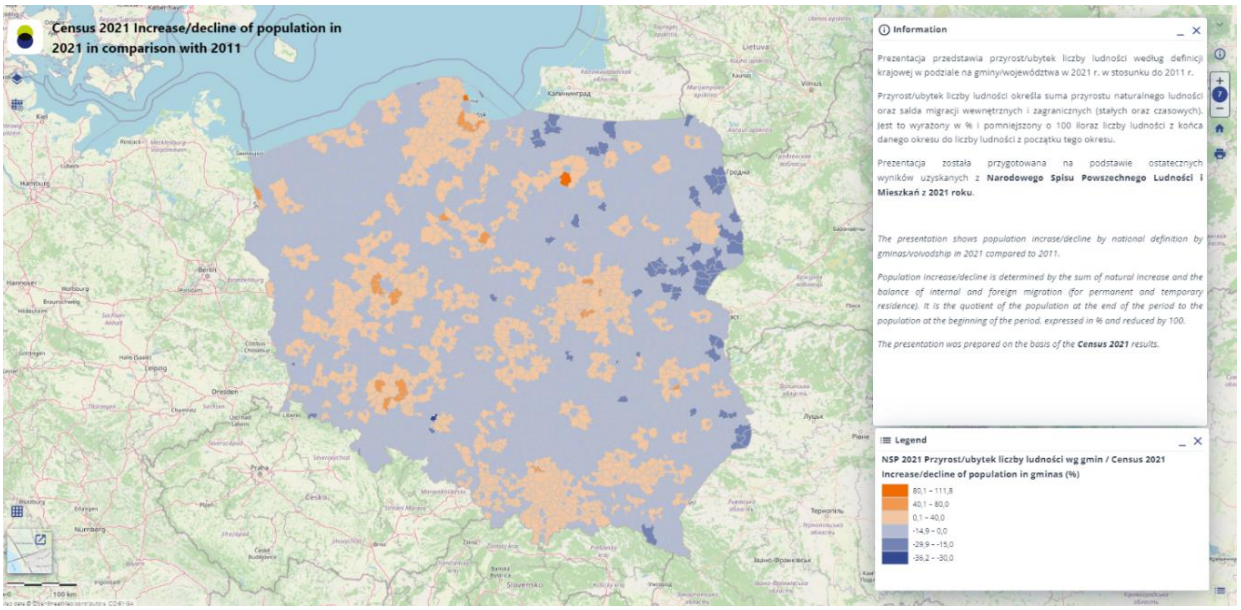

Fig. 52. A screenshot of the Geostatistics Portal site

Public Services Monitoring System (SMUP) (https://smup.gov.pl/advanced) provides local self-government units, entrepreneurs and the society with information necessary for comprehensive evaluation of public services provided at the local level. The system, first released in 2021, was developed by a project team representing the following partner institutions: Ministry of Internal Affairs and Administration, Statistics Poland, Association of Polish Cities, and Association of Polish Counties.

The system provides advanced functionalities for data visualization, including a map module. It enables the user to present statistical indicators on choropleth and diagram maps at territorial levels corresponding to successive levels of local self-government: gminas (district), powiats (county) and voivodships. Ultimately, maps will be able to be created for all levels of NTS classification starting from the gmina level. SMUP provides the user with the ability to change the default visualization parameters, e.g. independent selection of classes, as well as selection of colour scheme and graphic symbolization. Maps created in the system can be saved and exported, also in vector file formats.

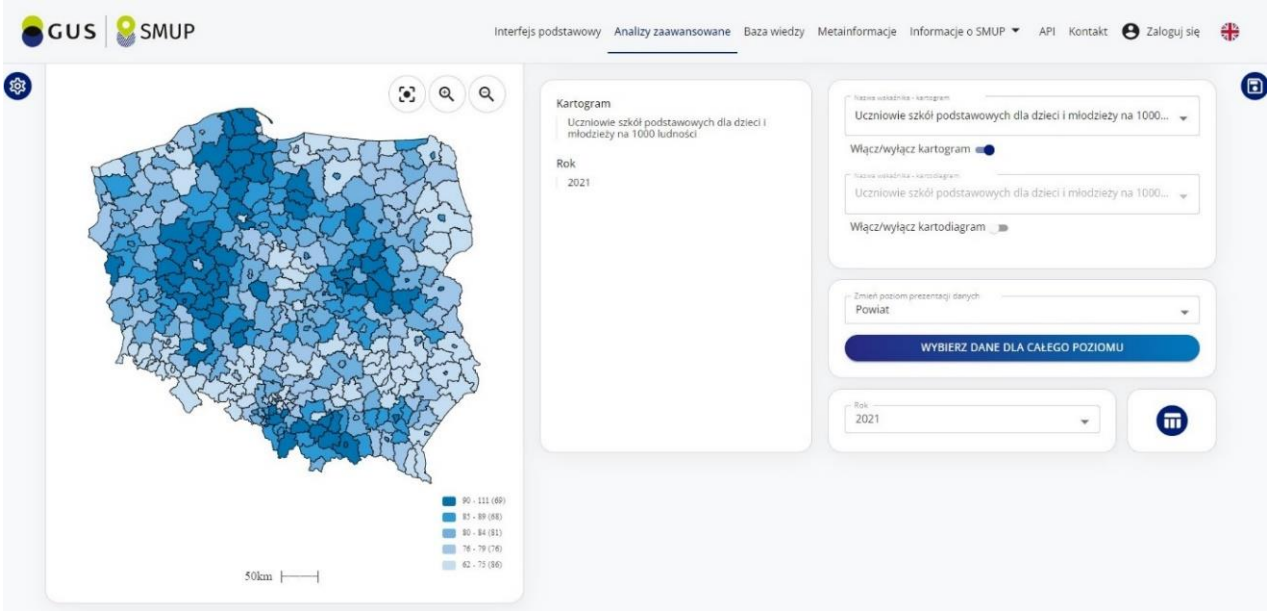

Fig. 53. View of *Public Services Monitoring System's* map module

Atlas of Enterprises (https://stat.gov.pl/en/topics/economic–activities–finances/activity–of–enterprises–activity–of–companies/atlas–of–enterprises,16,1.html) was published in 2019 by Statistics Poland and provides information characterizing non-financial enterprises in Poland in spatial terms. The Atlas has 118 pages with 120 maps (mainly choropleth and diagram maps) and 1114 charts. The maps represent data from 2017 mainly for Poland in division into voivodeships. In addition, 11 maps have been devoted to Europe and the world with data for countries.

Fig. 54. Cover of the *Atlas of Enterprises*

Atlas of Environment was published in 2021 (https://stat.gov.pl/en/topics/environment–energy/environment/atlas–of–environment,6,1.html). This is the first cartographic study illustrating the state and threats to the environment in Poland, in European countries, and in other countries of the world. The data contained in the atlas concern: the natural conditions of Poland and the use of land and soil, water management, pollution and protection of air, radiation, waste management, nature and biodiversity protection, forestry, economic aspects of environmental protection, monitoring of sustainable development goals in Poland compared to other EU countries. The publication consists of 120 pages with 123 maps and 117 charts. It presents data mainly for 2020 or 2019, mostly for Poland in division into voivodships (although there are also maps in other territorial divisions, including data by river basins), in addition, 31 maps concern Europe and 7 the world.

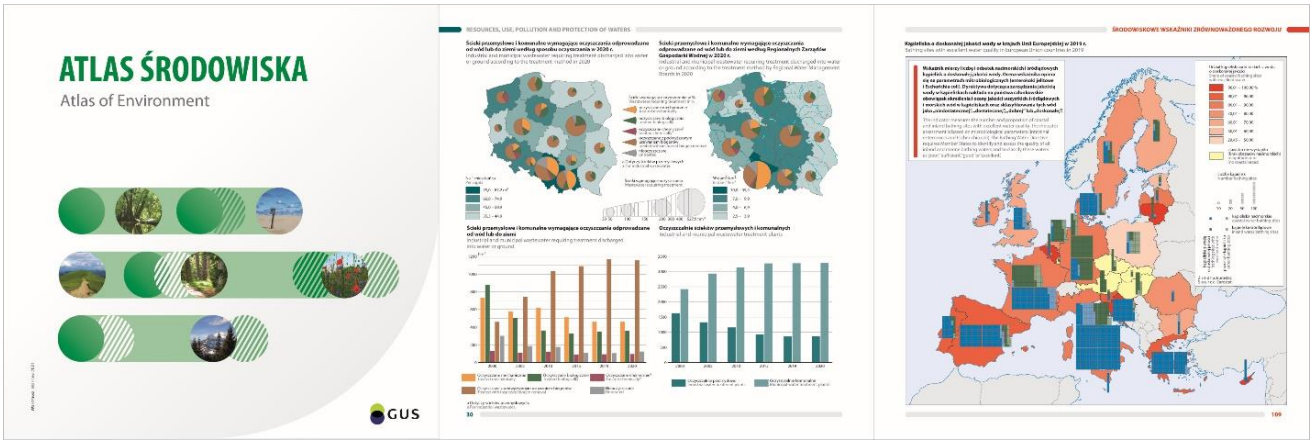

Fig. 54. Cover of the *Atlas of Environment* and sample maps

Statistics Poland has also published a manual on statistical cartography – **Statistical maps. Data visualisation methods** (https://srp.stat.gov.pl/Maps) was published in 2020 as a part of a series of scientific monographs Statistical Research Papers. This publication is an English adaptation of 'Mapy statystyczne. Opracowanie i prezentacja danych' [Statistical maps. Data preparation and presentation] published in Polish in 2017. Poland-specific matters have been

omitted, whereas certain topics absent in the Polish edition that may be useful for an English speaking reader have been added. This edition was also supplemented with a number of changes and additions resulting from reviews and user comments on the first Polish edition. The main purpose of the publication is to familiarize non-cartographers with the standards of cartographic presentation of statistical data, resulting from the tradition of cartography and statistics, as well as to show the opportunities and problems resulting from the use of GIS software to develop statistical maps. The handbook provides the theoretical basis for the proper preparation of maps for the needs of statistical publications. It is also being used to disseminate among statisticians the knowledge of what statistical maps are intended for, what may be presented by means of them and how to properly develop such maps. The handbook is richly illustrated with maps, mostly originally prepared for the Polish edition of the publication, or its English version. The maps which refer to Poland or its regions were based mostly on data provided by the Polish official statistics.

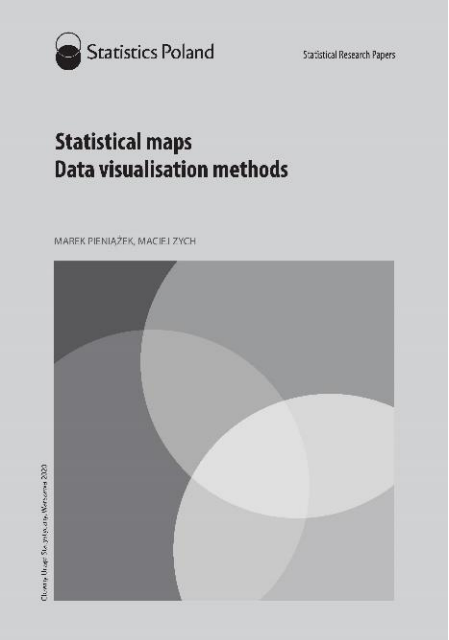

Fig. 55. The cover of the *Statistical maps. Data visualisation methods*

5.6. The Institute of Geography and Spatial Organization of the Polish Academy of Sciences (IGSO PAS)

The **Institute of Geography and Spatial Organization of the Polish Academy of Sciences (IGSO PAS),** is an important research centre in the field of socio-economic geography, physical geography and spatial development in Poland. It incorporates the Central Library of Geography and Environmental Protection, which is one of the largest institutions of this type in the world. The strong side of the IGSO PAS is the international scientific cooperation, including among others, its employees' participation in more than 50 scientific and practical programs and projects in recent years. In addition, about 200 other national research projects, practical studies, expert opinions, etc. have been implemented in the last decade. The employees of IGSO PAS annually publish about 300 bibliographic items, their own journals (e.g. GEOGRAPHIA POLONICA, Przegląd Geograficzny) and publishing series

included (Prace Geograficzne).

In 2019–2022, a few atlases have been published by the Institute of Geography and Spatial Organization of the Polish Academy of Sciences:

- Rural Atlas of Mazowieckie Voivodship which is a complete diagnosis of rural areas in various spatial approaches with the identification of processes and socio–economic phenomena in the last few decades. It covers the following issues: spatial organization of the countryside, rural population, land use, economic functions of rural areas, housing and the countryside equipment in terms of infrastructure, particular areas in the countryside as well as planning and management of rural areas (https://www.igipz.pan.pl/atlas–obszarow–wiejskich–mazowieckie.html).
- Rural Atlas of Kujawsko–Pomorskie Voivodship (https://www.igipz.pan.pl/atlas–obszarow–wiejskich–kujawsko–pomorskie.html).

Fig. 56. Rural Atlas of Mazowieckie Voivodship

Fig. 57. Rural Atlas of Kujawsko–Pomorskie Voivodship

5.7. Polish Air Navigation Services Agency (PANSA)

Polish Air Navigation Services Agency (PANSA) is the national provider of air navigation services for the Polish airspace. The PANSA Geographical Information Systems Section carried out cartographic studies for the needs of civil aviation. As part of the obligation to provide current aeronautical data by the Flight Information Service, the following items are published by PANSA in accordance with the AIRAC publishing cycle: AIP, AIP–VFR and AIP–MIL. Each publication contains a number of maps, including airport map, map of airport obstacles, SID, STAR, IAC, VAC, VOC, VFR.

For the needs of pilots performing flights in the uncontrolled space, FIS maps are issued (available at http://www.fis.pansa.pl) and the air map of Poland – ICAO.

6. Cartographic literature

The cartographic literature is very diverse in Poland. To sum up the number of all published textbooks, dissertations, articles, reports, reviews, manuals and catalogues, we get almost 300 items a year. Recently, the issues covered by them have been more and more dominated by problems of modern technologies and solutions (computer geo-visualization, numerical terrain models, spatial information infrastructure, various GIS applications), with less interest in theoretical issues and methods of cartographic presentation.

Scientific theses and articles are published primarily in:

- The journal **'Polish Cartographic Review'** (until 2015 'Polski Przegląd Kartograficzny') with a supplement in Polish (also PCR on–line:

https://content.sciendo.com/view/journals/pcr/pcr–overview.xml – starting with the volume 47, 2015 – articles in English) issued by the Cartographic Department of the Polish Geographical Society, the only magazine devoted exclusively to cartography;

- The semiannual journal **'Advances in Geodesy and Geoinformation'** (formerly 'Geodesy and Cartography') published under the umbrella of the Committee on Geodesy of the Polish Academy of Sciences (PAS); https://www.czasopisma.pan.pl/agg;
- The quarterly journal '**Roczniki Geomatyki' /'Annals of Geomatics'** http://rg.ptip.org.pl/ issued by the Polish Society for Spatial Information (PTIP) since 2003. The journal is devoted to geomatics, geospatial technology and geoinformation science, it illustrates progress in the acquisition, storage, delivery, management and use of geospatial information. To access articles online use the link http://rg.ptip.org.pl/index.php/rg/issue/archive.
- **'Geoinformatica Polonica'** http://www.ejournals.eu/GP/ – the series published by the Geoinformatics Commission at the Polish Academy of Arts and Sciences;
- **'Archives of Photogrammetry, Cartography and Remote Sensing'**, http://ptfit.sgp.geodezja.org.pl – a series published by four related scientific societies.

A new periodical which replaced long–published 'Prace Instytutu Geodezji i Kartografii' (Proceedings of the Institute of Geodesy and Cartography) is a half–yearly **'Geoinformation Issues'**, at http://www.igik.edu.pl/geoinformation–issuess, published in English by this Institute since 2009.

Practical issues of Polish geodesy and cartography, including legal and organizational problems, as well as technological issues dominate in two monthlies, i.e. **'Przegląd Geodezyjny'** [Geodetic Review] and '**Geodeta. Magazyn geoinformacyjny'** [The Surveyor. Geoinformation Magazine]. The half-yearly **'Biuletyn Stowarzyszenia Kartografów Polskich'** [Bulletin of the Association of Polish Cartographers] deals with similar issues.

In the English-language general geographic journal **'Geographica Polonica'**, published by the Institute of Geography and Spatial Organization of the Polish Academy of Sciences, there is a 'Poland on Maps' section.

The most substantial books published in the 2019–2022 period were:

- Dariusz Dukaczewski: *Encyjna metodyka projektowania czasowo–przestrzennych animacji kartograficznych. (Entities methodology of designing of spatiotemporal cartographic animations).* Seria Monograficzna, nr 21, Warszawa: Instytut Geodezji i Kartografii, 2019, 349 pp. + CD, ISBN 978–83–60024–24–9.
- Izabela Gołębiowska: *Użyteczność geowizualizacji wieloelementowych w kontekście semiotyki kartograficznej.* (*Usability of coordindated and multple views geovisualization tools in the context of cartographic semiotics).* Warszawa: Wydawnictwa Uniwersytetu Warszawskiego. 2021. DOI: 10.31338/uw.9788323553410.
- Mirosław Krukowski: *Nieostrość w modelowaniu kartograficznym*, (*Fuzziness in cartographic modeling*). Wydawnictwo Uniwersytetu Marii Curie–Skłodowskiej, Lublin, 2021, 171 pp.
- Beata Konopska, Marek Barwiński, *Kształtowanie granic Polski po pierwszej wojnie światowej. Metodyczne problemy badań źródeł kartograficznych i tekstowych*, (*The*

formation of Poland's borders after World War I. Methodical problems of research of cartographic and textual sources). Warszawa, 2021.

- Anna Markowska: *Badanie użyteczności kartograficznych anamorfoz powierzchniowych w szkołach, (Investigating the usefulness of cartographic surface anamorphoses in schools.)* Seria Monograficzna, nr 22, Warszawa: Instytut Geodezji i Kartografii, 2019, 184 pp. + CD, ISBN 978–83–60024–25–6.
- Beata Medyńska–Gulij: *Kartografia i Geomedia (Cartography and Geomedia)* Warszawa: Wydawnictwo Naukowe PWN, 2021, 286 pp., ISBN: 978–83–01–21554–5.
- Marek Pieniążek, Maciej Zych: *Statistical maps. Data visualisation methods*. Statistical Research Papers, Volume 1. Warszawa: Główny Urząd Statystyczny, 2020, 250 pp.
- Zenon Poławski, Małgorzata Brzezińska–Klusek.: *Kartograficzna prezentacja sieci osadniczej w Polsce (Cartographic presentation of the settlement network in Poland)*, Seria monograficzna nr 23, 2020, Warszawa: Instytut Geodezji i Kartografii, ISBN 978 – 83 – 60024 – 27 – 0.

Detailed information about these books are provided in the attached bibliography.

7. Education in cartography

The education of specialists in cartography at the academic level is conducted in Poland as a specialization within geographical studies at universities in Warsaw, Wrocław, Lublin, Poznań and Toruń, and also as part of engineering studies on surveying at the Warsaw University of Technology, the Military University of Technology in Warsaw and the Stanisław Staszic AGH University of Science and Technology in Kraków. Moreover, the essentials of cartography and geoinformatics are conveyed to all the students of geodesy and geography at universities, as well as to the students of engineering colleges.

7.1. The Department of Geoinformatics, Cartography and Remote Sensing at the Faculty of Geography and Regional Studies of the University of Warsaw

The **Department of Geoinformatics, Cartography and Remote Sensing** at the **Faculty of Geography and Regional Studies of the University of Warsaw** was established on September 1, 2014 as a result of merging the Department of Cartography with the Department of Geoinformatics and Remote Sensing. The Department of Geoinformatic, Cartography and Remote Sensing is a main part of the Chair of Geomatics and Information Systems. For more information please visit http://geoinformatics.uw.edu.pl/.

Out of the 24–person team of employees (including 3 habilitated Doctors, 13 PhDs, 4 Masters of Science and 4 post-graduate students), nine deal with cartography in a diverse thematic range. In recent years, the following research fields have been covered at the University of Warsaw: empirical research and assessment of methodical correctness, empirical evaluation of maps and geovizualitions including geodahboards, visualization of processes and phenomena occurring in the geographical space using GIS, formalization, automation and evaluation of the results of the generalization process, assessment and verification of calibration methods for old maps, research in the field of automatic generalization of topographic and general geographical maps, and research related to the elaboration of concepts regarding historical databases and updating thereof.

In the Department of Geoinformatics, Cartography and Remote Sensing at the Warsaw

University, in 2019–2022, six people have been awarded PhD titles, and two of the doctoral dissertations concerned cartography; moreover, two habilitation degrees have been awarded, including one in cartography. Currently, two PhD candidates in geoinformation and cartography are developing their PhD projects at the Faculty of Geography and Regional Studies.

Geography at universities is taught on the three following levels: Bachelor, MSc and PhD. In case of bachelor studies, students may choose a geoinformation module to expand their knowledge of geoinformatics, cartography and remote sensing during three terms. At the end of this stage, they prepare bachelor's theses in these fields. In the years 2019–2022, the BA diploma in the field of geoinformatics has been granted to 67 people.

Geoinformatics, cartographic and remote sensing are also part of the specialization during geographic studies at the master's level. Within a two–year Masters' degree programme, students are educated in cartography, remote sensing and GIS. Master's theses on cartography cover design of maps, methods of cartographic presentation, designing mobile applications and animated maps. 46 persons have completed the specialization courses in geoinformatics, cartography, remote sensing over the years 2019–2022. Graduates find their employment in cartographic publishing houses, GIS companies, telecommunications companies, public institutions, universities and other scientific centres.

7.2. The Department of Geoinformatics and Cartography (ZGK) at the University of Wrocław

In the **Department of Geoinformatics and Cartography (ZGK) at the University of Wrocław**, specialists in the field of modern geoinformatics, geostatistics, spatial data modelling and forecasting, cartographic visualization and geo-visualization methodologies, map and atlas design, cartography history and basic legislation in the field of surveying and cartographic activities are educated. 29 graduates have obtained their master's degrees in the field of geoinformatics and cartography over the years 2019–2022. The topics of their diploma theses covered applications of geographic information systems in environmental research, forecasting and modelling of phenomena in GIS, data mining and geoprocessing, cartographic visualization methodologies, map and atlases design, map perception, remote sensing and photogrammetry. One of the diploma theses took in 2021 the second place in the national master's thesis competition in the field of cartography and geoinformation.

The Department ZGK employees delivered numerous lectures, conducted workshops and organized exhibitions in the field of cartography and geoinformatics for various groups of recipients: from pre–schoolers, through primary and secondary school pupils, to clubs of history and culture enthusiasts.

The Department of Geoinformatics and Cartography at the University of Wrocław, in cooperation with the Cartographic Department of Polish Geographical Society, have organized successive 'Cartographic Schools' – the several–day international training conferences in English with lectures, exhibitions and discussions on up–to–date topics: 25rd Cartographic School 2019, 'Spatial Analysis of the Forest Environment'.

In 2020, the Department of Geoinformatics and Cartography at the University of Wrocław, in cooperation with the Department of Forest Resources Management, Faculty of Forestry, Hugo Kołłątaj Agricultural University in Cracow, organized the The scientific workshop SpAnFOSS 2020 – 'Spatial Analyses with Free OpenSource Software'. In 2022, as

part of the Global Night with Geography 2022 (Nuit de la Géographie / GeoNight 2022), an online meeting was held entitled. ‘Stereo in geography – geography in stereo’. The organizers of the event, aimed at geography students and enthusiasts, were the Department of Geoinformatics and Cartography, University of Wrocław and the OSGeo Polish Local Chapter.

7.3. The Department of Geomatics and Cartography at the Maria Curie–Skłodowska University in Lublin (UMCS)

The **Department of Geomatics and Cartography at the Maria Curie–Skłodowska University in Lublin (UMCS)** was established in 1964 as an independent Chair of Cartography by Prof. Franciszek Uhorczak. For almost 60 years the unit has been developing scientific, educational and organizational activities in line with new trends in science and technology. In 1970, the name changed to the Department of Cartography, and in 2011 – the Department of Cartography and Geomatics, in the year 2019 it was finally renamed to the present. Currently, the Department has eight employees, including five scientific–educational, two educational and one scientific–engineering. Dr hab. Beata Konopska, the Professor at UMCS is the head of the unit.

In the mentioned period the Department of Geomatics and Cartography participated in educational programmes in five fields of study: geography, geoinformatics, military geography and crisis management, spatial management, tourism and recreation at three levels: bachelor/engineer, master and doctoral. The employees of the Department held lectures, laboratories, conversatories and seminars on cartography and geographical information systems covering fields: cartographic methodology, cartographic methods of research, cartographic visualization and geo–visualization, history of cartography and geoinformation, geostatistics, law and organization of official cartography and geoinformation, management of geoinformation projects, mathematical foundations of GIS, programming in GIS, remote sensing, spatial analyses, spatial databases, spatial data infrastructure, WEB–GIS. The Department offered three thematic blocks: *Production of digital thematic maps* (bachelor level), *Geographical Information Systems* (bachelor level) and *Cartographic Visualization and Map Design* (master level). Department, with active doctoral students, participates in the third–level degree programme in Maria Curie–Skłodowska University’s Doctoral School of Social Sciences.

In the years 2019–2022 the employees of the Department have promoted 49 bachelors, 26 masters and one doctor in fields of geography, geoinformatics and tourism and recreation. Three of these works won prestigious, national–level, competitions for the best diploma theses:

- the winner of the first prize in 2019 – XI National Competition of Diploma Theses in the field of Cartography, Geomatics and Geoinformation,
- 2020, 2021 – The Stanislaw Alexandrowicz Prize for diploma theses in the field of history of cartography.

One employee is currently undergoing a habilitation procedure.

Within the last five years, the Department organized national and international conferences:

- 16–19 October 2018, in Lublin and Zwierzyniec, the 1st Cartographic Open Plenary Meeting – Lublin 2018, co–organized by University of Manizales (Colombia), Warsaw

University, Roztocze National Park, Polish Society of Latin American Studies, Polish Geographical Society – Cartographic Branch, Centro de Investigación de Geography Aplicada de la Pontificia Universidad Católica del Perú (Peru) and Sociedad Geografica de Lima (Peru).

- 13–15 October 2022, in Toruń, the 34th Polish National Conference for Cartography Historians ‘ Fortifications on old maps’. The co–organizers of the conference were: the Nicolaus Copernicus University in Toruń, Maria Curie–Sklodowska University in Lublin and Toruń Fortress Museum.

Furthermore, employees of the Department organized the 12th edition of the National Competition of Diploma Theses in Cartography, Geomatics and Geoinformation (13th October 2020, online).

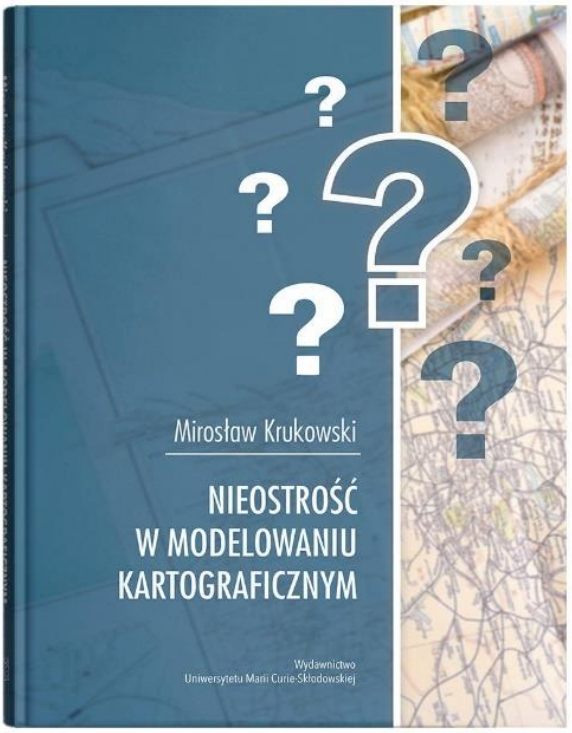

Fig.58. Mirosław Krukowski: ***Nieostrość w modelowaniu kartograficznym*****, (*****Fuzziness in cartographic modeling*****). Lublin 2021**

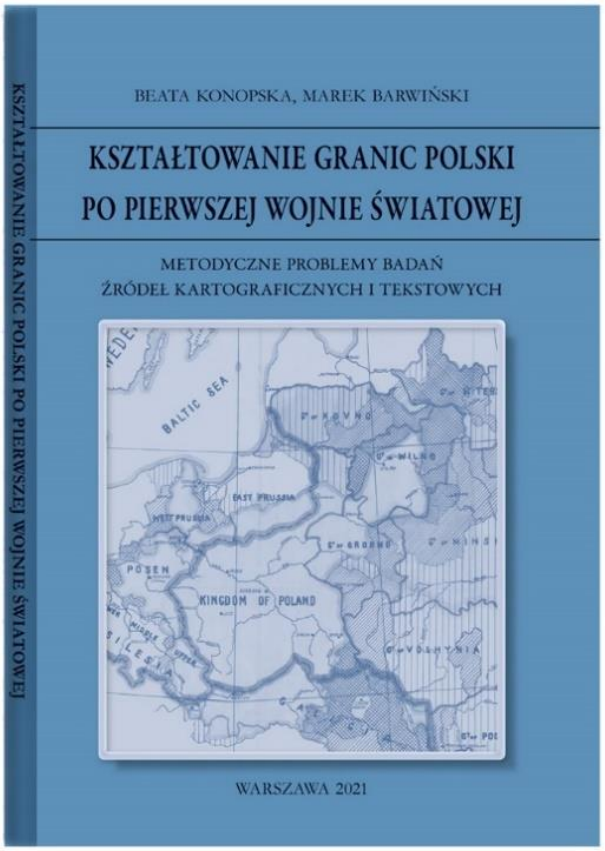

Fig. 59. Beata Konopska, Marek Barwiński, *Kształtowanie granic Polski po pierwszej wojnie światowej. Metodyczne problemy badań źródeł kartograficznych i tekstowych,* (*The formation of Poland's borders after World War I. Methodical problems of research of cartographic and textual sources*). Warszawa 2021.

7.4. The Department of Geomatics and Cartography at the Faculty of Earth Sciences of the Nicolaus Copernicus University in Toruń (NCU)

Department of Geomatics and Cartography at the Faculty of Earth Sciences of the Nicolaus Copernicus University in Toruń (NCU), employs six research and teaching staff and three PhD students. The Department includes the Laboratory of Cartographic Collections and Digital Reprographics. These collections are used on a daily basis by the scientific staff of the NCU Faculty of Earth Sciences, doctoral students and other students. They contain a collection of about 30,000 topographic and thematic maps (including about 1,500 tourist maps) and 500 atlases. Currently, about 2000 maps (dLibra) and over 5400 maps (GAIKK) have been included in the digital online resources. More information at: https://www.geo.umk.pl/kgik/. One of the most important achievements of the last four years is the development of the fourth volume of the Bibliotheca of Polish Cartographic Review (2021), i.e. POLISH CARTOGRAPHIC PUBLICATIONS 1968–2020, Bibliography based on the lists of new publications compiled by Jerzy Ostrowski and published in the quarterly ‘Polski Przegląd Kartograficzny’ (1969–2015) and in semiannual ‘Polish Cartographical Review. Suplement w języku polskim’ (2016–2020) including articles, notes and reviews published in these periodicals (develop and ed. Zenon Kozieł).

7.5. The Department of Cartography and Geomatics at the Faculty of Geographical and Geological Sciences of the Adam Mickiewicz University in Poznań

In 2019–2022 period, the team of Poznań cartographers has published 34 articles in international journals cited in SCOPUS and WEB of SCIENCE. The articles are available on the websites:

- http://kartografia.amu.edu.pl/index_en.html,
- http://kartografia.amu.edu.pl/index.html.

In 2021, a new academic textbook appeared: Medyńska–Gulij B., 2021, Cartography and Geomedia (in Polish), Wydawnictwo Naukowe PWN, Warsaw, 286, ISBN: 978–83–01–21554–5. In 2019–2022 there were 2 doctorates, 32 master's theses and 49 engineering theses successfully finalized. The employees from the Department of Cartography and Geomatics have presented 9 papers at 29th. ICC in Tokyo 2019, 4 papers at 30th. ICC in Florence 2021 and 3 papers at EURO–Carto 2022 in Vienna. In June 2022, the Poznan center organized an international symposium 'Cartography and Geomedia' with 27 participants from 9 countries, including 9 students. The symposium took the form of a discussion at one table with maps (fig. 60).

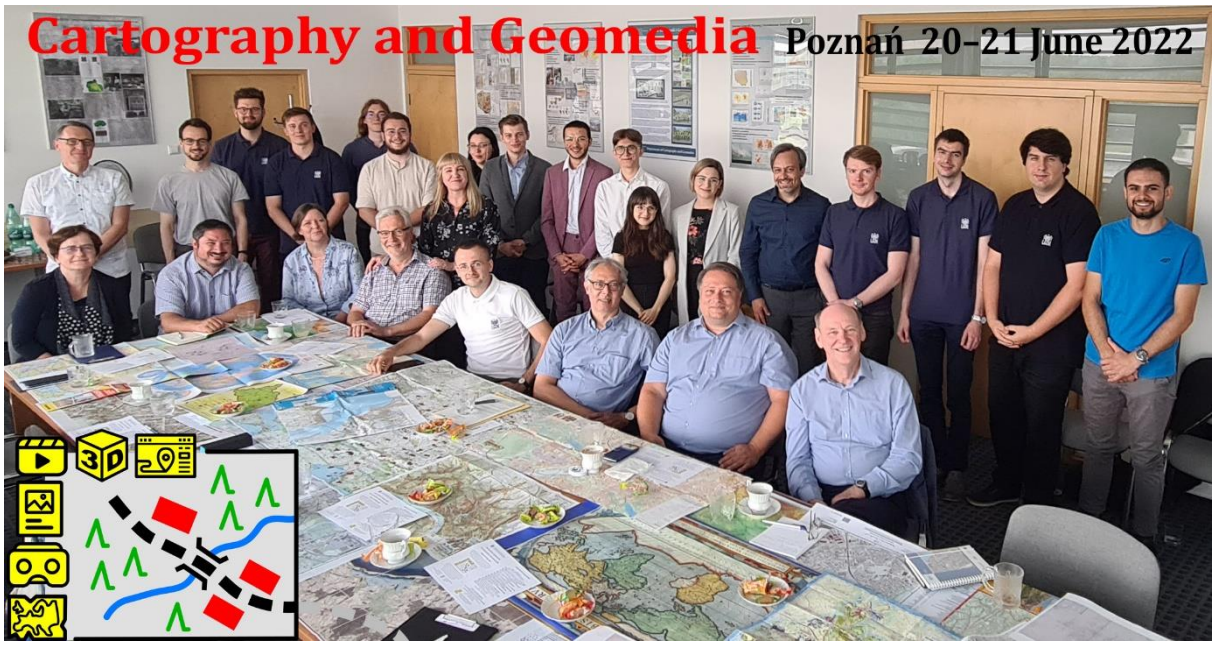

Fig. 60. 'Cartography and Geomedia' Symposium

7.6. The Division of Cartography at the Warsaw University of Technology (WUT)

One of the major achievements of employees of the Division of Cartography in the discussed period of time was the elaboration of a concept and a general program for the new subject called 'Geoinformatics' at the Faculty of Geodesy and Cartography of the Warsaw University of Technology.

Employees of the Division of Cartography were also co-authoring the concept and core curriculum for the new specialization called 'Mobile Mapping System and Navigation".

Listed below in Italics are subjects taught in the 2022/23 academic year by employees of the Division of Cartography:

1. The course of Geodesy and Cartography – the full-time bachelor studies:
   Introduction to databases (term 3), *Spatial databases* – elective subject (term 3), *Basics of cartographic mapping* (term 4), *Introduction to navigational cartography* – elective course (term 5), *Topographic cartography* (term 5), *Field exercises in photogrammetry and cartography* – elective course (term 6), *Basics of cartographic visualization* (term 6), *The spatial data infrastructure* – elective course (term 7, block B), *The cartographic multimedia and three-dimensional visualizations* – elective course (term 7);
2. The course of Geodesy and Cartography – the full-time master's degree studies – profile B (term 1): *Geostatistics, Spatial Data Infrastructure, Cartographic Modelling*;
3. The course of Geodesy and Cartography – the full-time master's degree studies – Cartography and GIS specialization:
   Digital map production systems (term 2), *Field exercises* (term 2), *Generalization of geographic information* (term 2), *Computer graphics in cartography* (term 2), *Mathematical cartography* (term 2), *Thematic cartography* (term 2), *Cartographic 3D models* (term 2), *Designing spatial databases* (term 2), *Mobile cartography* (term 3), *Selected topics of geoinformatics* (term 3), *Advanced geographic analyses* (term 3), *C&GIS diploma seminar* (term 3);
4. The course of Geoinformatics (the full-time bachelor studies):
   Introduction to geomatics (term 1), *Design Thinking* – elective subject (term 2), *Information systems architecture* – elective subject (term 2), *Databases and spatial data models* (term 3), *Developing geoinformation computer applications* (term 4, 5), *Basics of cartographic mapping* (term 4), *Basics of cartographic visualization* (term 4), *Smart cities* – elective subject (term 5), *Social cartography – neo-cartography* – elective subject (term 5), *The spatial data Internet sharing* (term 5), *Mobile location and navigation applications* – elective subject (term 6), *Building information modelling* (BIM) – elective subject (term 6), *Multimedia and DTP* – elective subject (term 6), *Programming mobile geoinformation applications* – elective subject (term 6), *Overview of navigational cartography* – elective subject (term 6), *Topographic databases* (term 6), *Geoinformation systems design* (engineering project) (term 6), *Diploma seminar* (term 6).

79 MSc and engineering theses have been defended in the Division of Cartography over the years 2019-2022, and at the beginning of 2023, the first graduates of Geoinformatics completed bachelor studies. Furthermore, two PhD dissertations of employees and post-graduate students in the Division of Cartography have been defended.

7.7. The Faculty of Geoengineering, Mining and Geology of the Wrocław University of Science and Technology

The Faculty of Geoengineering, Mining and Geology of the Wrocław University of Science and Technology offers a master's degree in ‘Geomatics’ within the field of study ‘Geodesy and Cartography’. As part of this specialization, classes in cartography are offered: digital cartographic models, topographic cartography, thematic cartography with geovisualization and selected sections of cartography. The Faculty is a co–organizer (together with the Association of Polish Cartographers) of the ‘Academy of Cartography and Geoinformatics’ conferences. As of 2019, 96 students have completed master's studies in this specialty, writing 30 theses on cartography. These master's theses cover a variety of topics, from environmental and heritage engineering to digital maps for the visually impaired. In the years 2017–2022, another master's degree course ‘Geoinformatics’ was offered in the field of mining and geology. During the two editions of the Master's studies, 36 Master's theses were defended, of which 12 concerned digital map designs in cartography We are currently developing models and visualizing space-time data. We are currently developing models and visualizing space–time data. For 20 years, based on GIS, we have been constructing maps from topographic databases and thematic environmental databases.

7.8. The Faculty of Civil Engineering and Geodesy of the Military University of Technology

At the **Faculty of Civil Engineering and Geodesy of the Military University of Technology** in Warsaw, education in cartography is carried out on engineering and master studies, both civilian and military studies at the Institute of Geospatial Engineering. Since 2020, in civil studies, education in cartography is carried out on engineering studies (7 semesters) and it is realized within two fields of study: geospatial engineering and geodesy and cadastre. Cartography course lasts 60 hours on each of them. In addition, students of these fields have a course of spatial information systems in the number of 60 hours also. The subjects closely related to cartography are: Spatial Analysis, Spatial Databases, and GIS Applications etc. in the field of geospatial engineering, as well as databases for economic/thematic studies in the field of geodesy and cadastre. At the level of master's studies (3 semesters), related subjects are additionally taught, such as: organization of spatial databases (geodesy and cadastre) and geodata processing algorithms, advanced spatial analysis, designing geoinformation systems, sharing geospatial data, management of geoinformation projects etc. (geospatial engineering). In 2019–2022 313 engineering theses and 181 master's theses were defended at the Institute of Geospatial Engineering, both civil and military students, of which 100 and 60, respectively, concerned cartography and GIS. Figures 61–62 presents results of engineering (fig. 61) and master (fig. 62) thesis of these students.

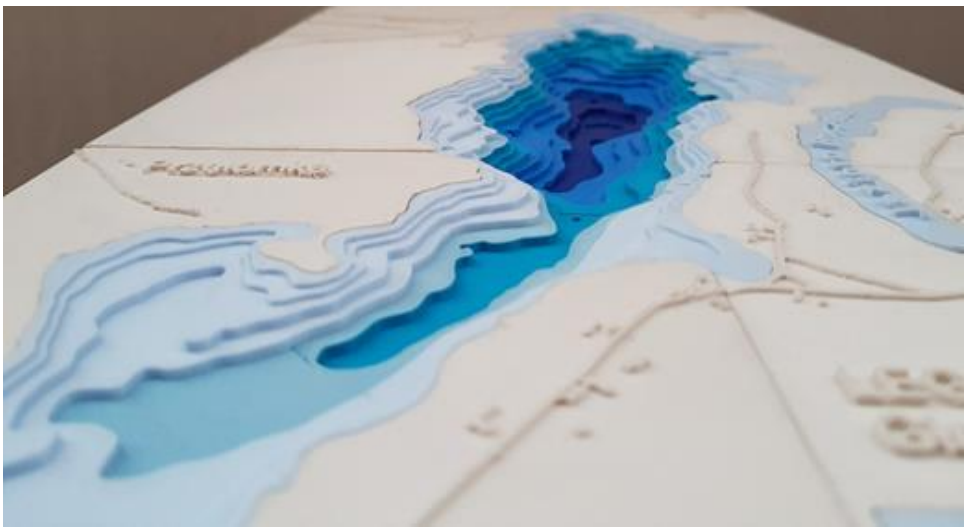

Fig. 61. 3D printed Bathymetric Map of Hańcza Lake done as part of engineering thesis (Source: Milewska A., *Development of a bathymetric map using 3D printing*. Engineering thesis, WAT 2019, Warsaw)

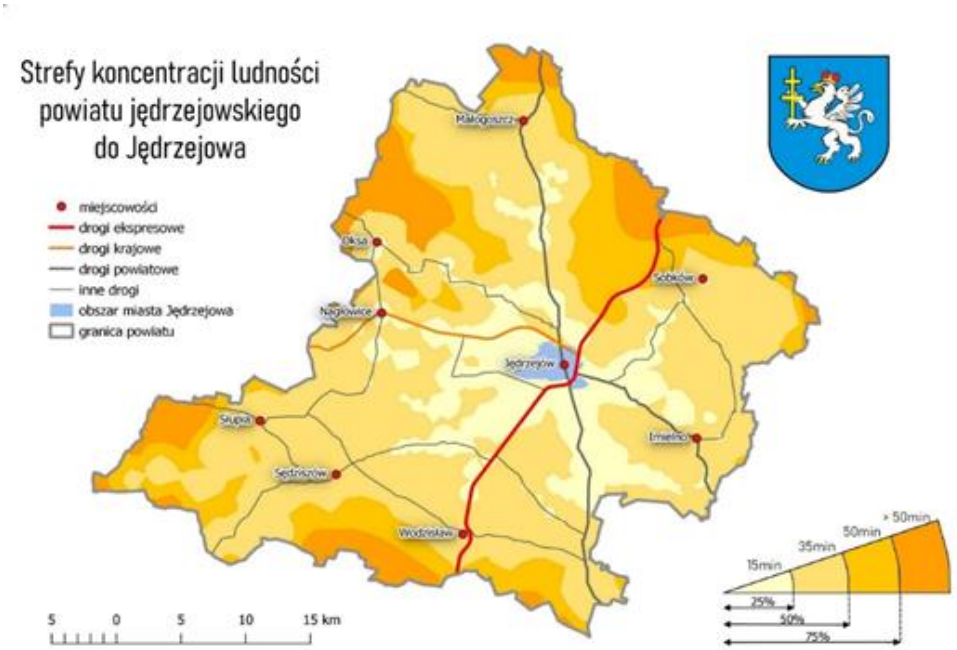

Fig. 62. Concentration zones of people living in regions with poor public transport – designated as part of the master thesis (Source: Krzepkowski S., *Use of spatial analysis to determine communication white spots*. Master thesis, WAT 2019, Warsaw

In military studies, education in cartography is realized within one field of study – geodesy and cartography, mainly specialization: geoinformatics. Cartography course last 108 hours. In addition, all students in this field of geodesy and cartography have a mandatory Topography subject with a week–long field practice. The cartography program in military studies is extended with special cartographic studies for the needs of the army (e.g. VMap, passability maps, synoptic charts, meteorological contour charts, navigation maps).

Cartographic interest is deepened individually owing to the activity of the student scientific club Geopixel. As part of it, students carry out additional projects, as well as take part in study trips and scientific conferences. Every year, a competition for the best extracurricular work is organized.

8. Research and implementation works in cartography

The scientific research in cartography is carried out in Poland in higher education institutions and units thereof (institutes, departments, divisions) dealing with cartography and geoinformatics, as well as in some institutes of the Polish Academy of Sciences and in the Institute of Geodesy and Cartography.

8.1. The Institute of Geodesy and Cartography (IGiK)

Institute of Geodesy and Cartography (IGiK) in Warsaw is the largest, leading research unit in Poland to deal with issues of geoinformation and cartography. The issues related to the analysis and modelling of spatial information and its visualization have been the main area of research conducted at the Institute in 2019–2022.

The IGiK elaborated in 2019 the Satellite Crop Identification and Monitoring System for Agricultural Statistics – SATMIROL. The same year the work on the Satellite data based Crop Monitoring System for Republic of South Africa, providing information on the condition of plants during the growing season, yield forecast and early warning information against threats to agriculture (SAPOL4CROP) has begun. In 2022 the Institute carried out the EOStat project of support of Ukraine in collection of agricultural statistics, elaborating a satellite system for forecasting the yield of winter wheat, rapeseed and maize for Ukraine, according to the State Statistics Service of Ukraine (SSSU) needs (fig. 63).

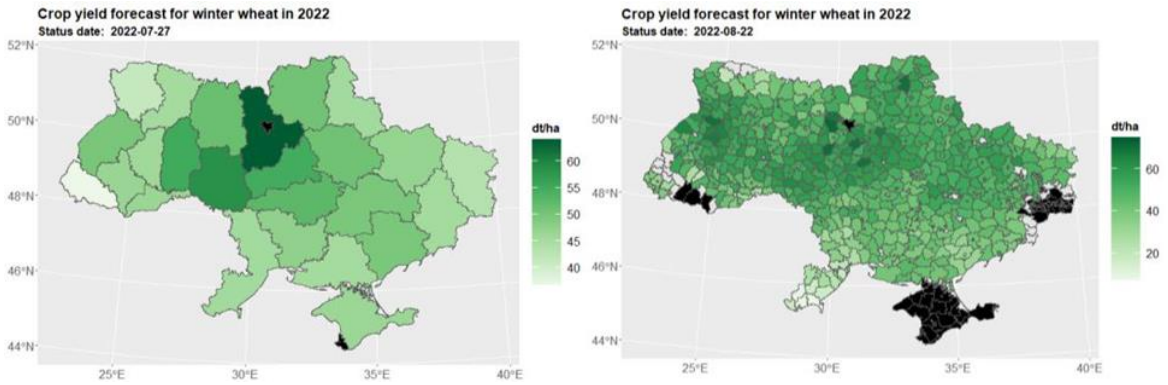

Fig. 63. Crop yield forecast of winter wheat in 2022 in Ukraine by oblast' (left) and regions (right)

As part of the GrasSAT program the IGiK builts the information system on grassland yields in various conditions in Poland. The Institute has elaborated the maps of drought in Poland in 1997 – 2019 period, published at Service4Drought www.e.susza.pl WIND–HYDRO geoportal. Since 2022 IGiK provides also maps for the agricultural drought monitoring geoportal www.suszarolnicza.polsa.gov.pl of the Polish Space Agency – POLSA (fig. 64).

The original methodology of analysis and processing of satellite radar data (Sentinel–1), elaborated in Geo4IRBM project, allowed to identify and to determine the magnitude of terrain deformation in Semarang and Bandung area, as well as in Jratunseluna river basin (Indonesia).

The work carried out in IGiK enabled the elaboration of methodology for the design of space-time cartographic animations for teaching of history and geography in primary and secondary schools in Poland.

Research on the quantitative and qualitative assessment of the correctness of the elaboration of surface cartograms was also conducted. The Polish and English classification

and terminology in this field were updated, then the methodology for assessing the correctness of the development of surface cartograms (taking into the consideration the qualitative and quantitative analysis) were developed.

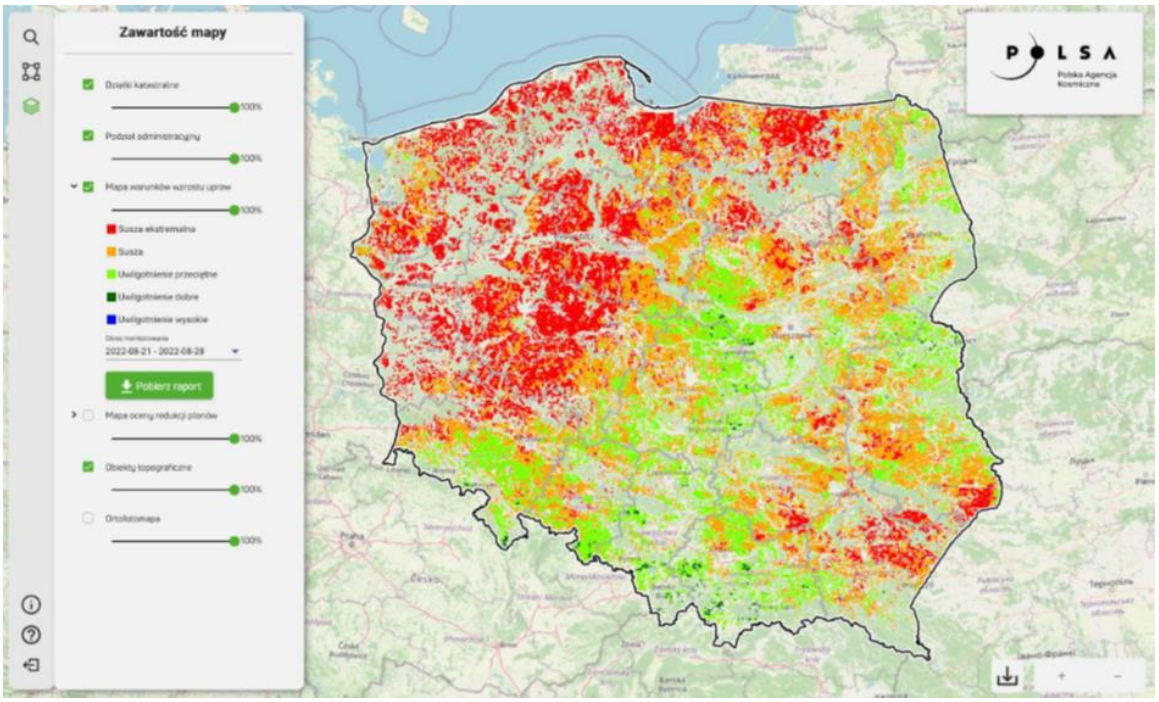

Fig. 64. Agricultural drought monitoring geoportal

In 2019 IGiK participated in ADAPTCITY project, aiming the reduction of negative effects of climate changes for the ecosystem of Warsaw. The results of carried analyses were published in the atlas 'Warsaw from the space'. The next year the NO_2 content monitoring, based on Sentinel–5P satellite data was started for the area of Agglomeration of Warsaw and Upper Silesia, resulting in production of monthly maps. In 2020 the Institute started the Urban Policy Observatory Project as a part of GEO and UN–Habitat Earth Observation Toolkit for Sustainable Cities and Communities Programme. The goal of this project was to design and to test the methodology of production of dasymetric SDG indicators concerning the quality of live in the cities (related to the 11.3, 11.6 and 11.7 SDG Targets), based on satellite data, databases and other *in–situ* data.

In 2021 IGiK started the ESA Project GAUSS – Generating Advanced Usage of EO for Smart Statistics, aiming the production of statistical data on the quality of natural environment, by elaboration of indicators of: air quality, water resources, snow cover and the extent and condition of green areas (fig. 65).

Fig. 65. The Google Earth Engine application on vegetation condition dedicated to the team of the Statistics Poland – GUS

The work on Smart Villages project (2020–2023) for Mazowieckie voivodeship resulted in elaboration of map of surface temperature 'hot spots' in 2001 – 2021 period, based on TerraMODIS satellite data (fig. 66), as well as of map of the proposed plantation of trees reducing the impact of high temperatures in rural areas and map of tropospheric vertical column of NO_2 in Mazowieckie voivodeship in 2019 – 2022 period.

In 2022 IGiK elaborated the river basin management plans for the State Water Holding – Polish Waters.

The Institute participated in the implementation of the project CORINE Land Cover for the fifth time (CORINE Land Cover 2018), as well as in Framework Service Contract for the Copernicus Land Monitoring Services – NRCs LC Copernicus supporting activities for the period 2017–2021 project. In 2020, IGiK published the Map of Forest Range Changes (between time states: 1960–1980–1990–2000–2018), and a map of forests formed on post–agricultural or other non–forest land after 1960. In 2020 IGiK elaborated the Earth Observation Based Service Supporting Local Administration in non–state Forest Management System – SAT4EST.

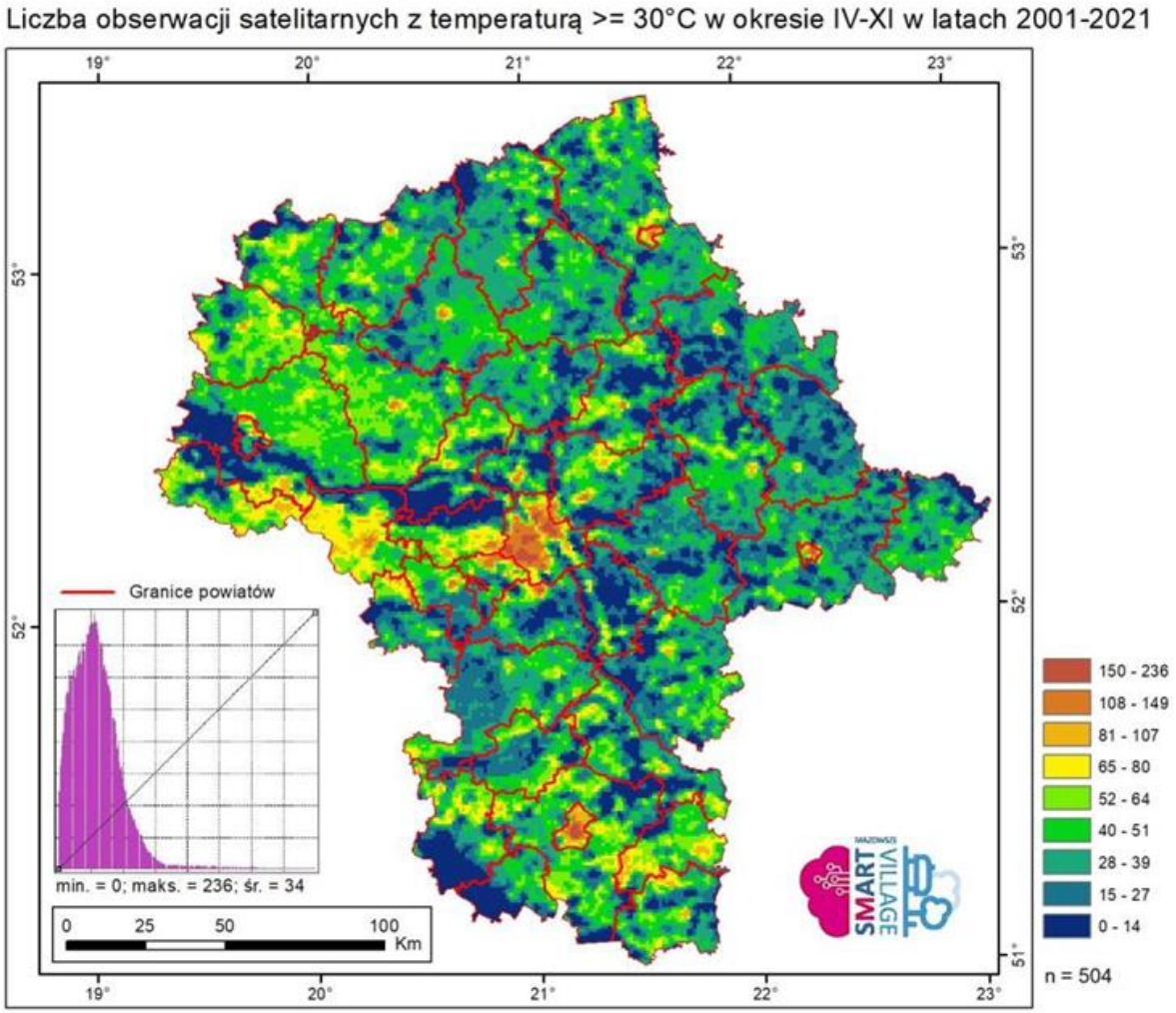

Fig. 66. Number of satellite observations with temperature <= 30° C in April – November 2001–2021 period in Mazowieckie voivodeship

In 2020 – 2022 period the IGiK in cooperation with Ordnance Survey Ireland (OSi) and North Ireland Land and Property Services (LPS) established the modern gravimetric network in Ireland (AGN Ireland).

In 2019 –2022 the IGiK team has published 63 articles in international journals cited in Scopus and Web of Science, as well as 3 monographs (plus 5 chapters in international monographs). The team has prepared and presented 112 papers at international conferences.

More information about the Institute is available at: www.igik.edu.pl.

8.2. The Institute of Geography and Spatial Organization of the Polish Academy of Sciences (IGSO PAS)

In the **Team for Geographic Information Systems and Cartography at the Institute of Geography and Spatial Organization of the Polish Academy of Sciences (IGSO PAS)**, the work has been focused on the terrestrial laser scanning (TLS) and on its use in mapping and natural environment research. The measurements were performed, among others, in the Polish Carpathians (among others in the Tatras Mountains and in the Beskids for landslides mapping) and in Podkarpacie region, in the caves of the Nida Basin and in the area of Polish Lowlands (mainly in the Lower Vistula Valley) (for more info see: https://www.igipz.pan.pl/zsigik–projekty–tls–realizacja.html). The efforts made in previous years to develop and issue a new National Atlas of Poland, former edition of which had been developed mainly at IGSO PAS, were continued as well. Unfortunately, the idea of creating this prestigious work has encountered numerous difficulties.

IGSO PAS has also participated actively in expert work and consultations, including work on the project: 'Developing digital competence of e–administration – training programs and publications for users of the spatial information infrastructure' implemented under the Operational Program Knowledge Education Development (POWER) and on the subject: 'Spatial development' (implementation of the INSPIRE Directive). A number of thematic synthetic maps have also been elaborated, including those for annual reports on the situation in municipalities with regard to planning, for evaluation projects concerning transport development and investments, or for the Responsible Development Strategy.

As part of the conceptual and implementation work at IGSO PAS, a new GraphScape tool has also been created to analyse the spatial structure and level of communication within the landscape. The main goal of creating the GraphScape program is to fill the gap between classic spatial configuration methods based on patch–metrics and the approach aimed at determining functional connectivity within the landscape using graph analysis methods. (for more info see: https://www.igipz.pan.pl/GraphScape.html).

In addition, IGSO PAS was the initiator and co-organizer of many cartographic exhibitions, special educational activities mainly in Warsaw's schools etc.

8.3. The Department of Geoinformatics, Cartography and Remote Sensing at the Faculty of Geography and Regional Studies of the University of Warsaw

For many years research interests of cartographers in the **Department of Geoinformatics, Cartography and Remote Sensing at the Faculty of Geography and Regional Studies of the University of Warsaw** have been related to the methods of cartographic presentation, both in theoretical aspect (classification and methodical basis for cartographic presentation) and in practical aspects (examination of usability and perception of maps).

In the period 2019–2023, three research projects financed by the National Science Centre were implemented. The first project titled 'The Evaluation of Cartographic Presentation Methods in the Context of Map Perception and the Effect of Visual Transmission' was conducted between 2017 and 2020. The project had two main goals. The

first goal was to develop a coherent methodology for the evaluation of map types and cartographic presentation methods. The second goal was to verify whether newly developed methods, that are outside the classic cartographic canon, should be included into the classification of cartographic presentation methods. The project was related to map perception examination carried out in representative secondary schools across Poland.

The second project entitled 'Optimization of the legend design of a map as a component of a geovisualization tool in the context of effectiveness and information acquisition strategies' is being conducted in the period 2019–2023. The objective of the project is to determine the role of a legend design which explains a map applied in an interactive geovisualization tool. The scope of the research includes analysis of small-scale thematic maps perception in the context of legend design. In order to achieve the stated goals, a controlled eye tracking experiment was conducted. The study evaluated two approaches in interface design in map–based dashboards. The investigation is a response to the new context in which maps appear. This growing complexity of geovizualization tools increases the need of deeper understanding how legends are used in the process of solving problems with the help of maps integrated with other visualization types applied in dashbaords.

The third and ongoing project titled 'Improving Settlement and Road Network Design for Maps of Small Scales Using Artificial Intelligence and Graph Theory' is being conducted between 2021–2025. The project aims to contribute to the development of effective and consistent methodology for generalizing small scale maps. Within the project scope the innovative methods of settlement, road and river network selection for small scale maps are being proposed and implemented. The designed methods and algorithms are specifically based on artificial intelligence elements (AI), including machine learning (ML) and graph theory (GT). Optimal and automatic generalization methods can improve and accelerate the map design process. It can be a response to the growing demand of the information society for current and available data and maps at various scales as it can significantly reduce map design costs.

The remote sensing research carried out at present have been focused on issues related to the use of aerial and satellite images for studies concerning natural environment and the social and economic issues in Poland, Europe, as well as in the area of operation of the Polish Research Station in Antarctica. Ground-based remote sensing methods are being developed to acquire reference data for calibration and verification of aerial and satellite images, as well environmental monitoring.

8.4. The Department of Geoinformatics and Cartography (ZGK) at the University of Wrocław (ZGK UWr)

In the **Department of Geoinformatics and Cartography (ZGK) at the University of Wrocław (ZGK UWr)**, research has been carried out both in traditional cartography and widely understood geoinformatics. The cartographical research has been focused on the history of cartography and the design of maps and atlases. The most important cartographic achievement, including many new methodological solutions, is developed by Marcin Wodziński and Waldemar Spallek Polish edition of 'Historical Atlas of Hasidism' published by Wydawnictwo Austeria in 2019 (fig. 67) Waldemar Spallek is also co–author of Polish and Czech version of Atlas of Karkonosze / Krkonoše (fig. 68, fig. 69).

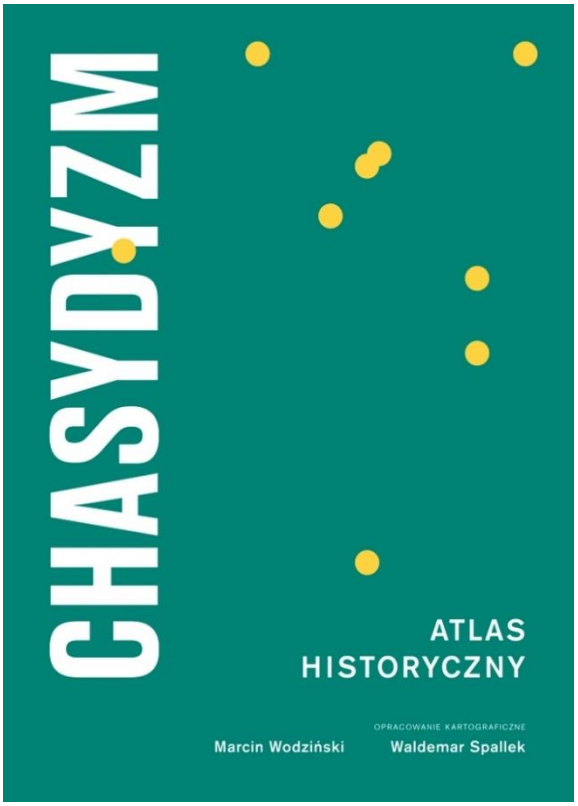

Fig. 67. Historical Atlas of Hasidism published by Wydawnictwo Austeria (Wodziński, Spallek, 2019)

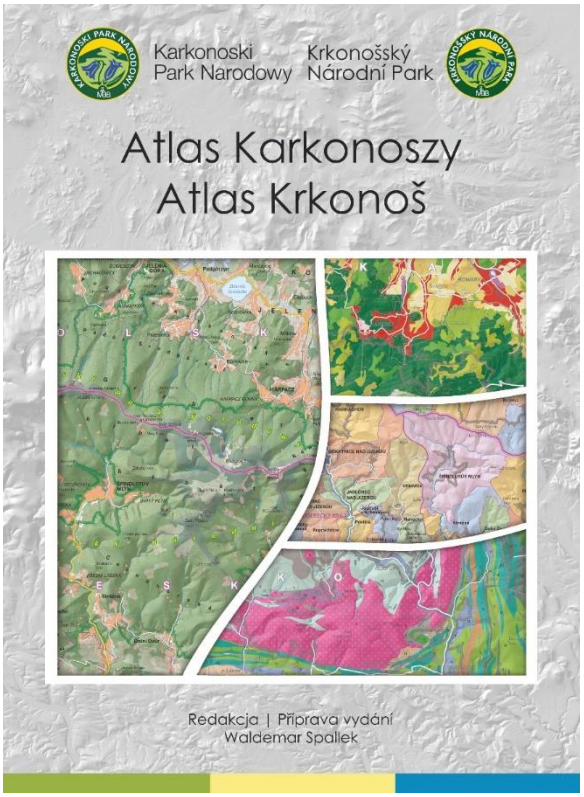

Fig. 68. Atlas Krkonoš published by Správa Krkonošského národního parku (Spallek, 2021a)

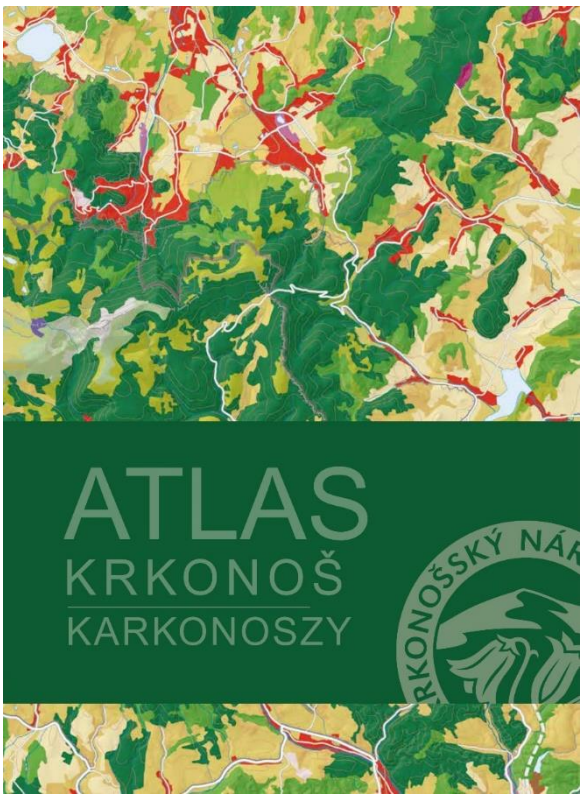

Fig. 69. Atlas Karkonoszy published by Karkonoski Park Narodowy (Spallek, 2021b)

8.5. The Department of Geomatics and Cartography at the Maria Curie–Skłodowska University in Lublin (UMCS)

The scientific activity of the employees of the **Department of Geomatics and Cartography at the Maria Curie-Sklodowska University in Lublin (UMCS)** have been focused on several research fields to follow tradition of the Department and those that result from contemporary trends. The interests include presentation methodology and cartographic editing as well as the history of cartography. The directions that have appeared in the research relatively recently and been developed in the Department are primarily historical geography (Historical GIS). The items to unite all the research directions mentioned above are the modern tools used to carry out the analyses and data visualization based on GIS software.

Among the achievements resulting from the research mentioned above, four scientific monographs should be mentioned: ‘Fuzziness in cartographic modeling’, ‘*The formation of Poland's borders after World War I. Methodical problems of research of cartographic and textual sources*’, as well as several articles published in reputable scientific journals. The results of research work based on 3 long–term scientific grants should also be mentioned.

8.6. The Department of Geomatics and Cartography at the Faculty of Earth Sciences of the Nicolaus Copernicus University in Toruń (NCU)

In the **Department of Geomatics and Cartography at the Faculty of Earth Sciences of the Nicolaus Copernicus University in Toruń (NCU)**, all scientific and research work has been derived from the application of modern geoinformation methods that are associated with cartographic and in particular the geomatic method of research support. The European project on the 'Historical Atlas of Polish Cities' is under implementation as part of the continuation of the financial grant, in cooperation with the Faculty of Historical Sciences of the Nicolaus Copernicus University in Toruń, as well as research centres in Kraków and Wrocław. In the aftermath of the work, 41 atlases for Polish cities. Five atlases have been developed in the past four years (Biecz – 2021, Fordon – 2021, Kalisz – 2021, Nowy Sącz – 2021, Racibórz – 2021). More info on the Website: http://atlasmiast.umk.pl/atlasy/.

8.7. The Department of Cartography and Geomatics at the Faculty of Geographical and Geological Sciences of the Adam Mickiewicz University in Poznań

In **the Department of Cartography and Geomatics at the Faculty of Geographical and Geological Sciences of the Adam Mickiewicz University in Poznań**, we pursue several research directions. Our mainstream is the geomatic basis for acquiring and managing spatial data as part of the geomatic process. Another research direction is cartographic visualization and geovisualization of spatial accessibility and spatial behavior. This includes conducting user research to assess the effectiveness, efficiency, and usability of various graphic and technological solutions. We also deal with animated cartography and the presentation of dynamic spatial-temporal data. In developing the principles of cartographic design, we make use of empirical research in the field of map perception. For this purpose, we use eye tracking devices and online surveys.

Another research trend is related to augmented (AR) and virtual reality (VR) and their application to the presentation of geographical space. As part of this trend, we research the possibility of implementing multi–resolution spatial databases to HMD immersive systems. The result is the creation of models of spatial behavior in virtual reality integrated with topographic mapping.

Regarding web cartography, our research concerns the effectiveness of interactive mapping services and responsive map design (RMD) in the HTML5 standard. We are also extending the usability of the Graphical User Interface (GUI) by examining the user experience with web maps. This translates into developing the principles of map design and human–map interaction, especially for mobile devices. We are also interested in cartography in computer games, in the context of symbols on maps in games, and designing a mini-map.

We also deal with the history of cartography, in particular with the issue of the development and evolution of cartographic principles. Interdisciplinary research is carried out in many of our projects: preattentive attributes of dynamic point symbols in the quantitative mapping (psychology); visualization of the European topographic space on multi–sheet handwritten maps from the 18th century (art history); a multimedia web service for the development of industrial centers since 1820 (cultural landscape) and geomedia (social communication and media studies).

8.8. The Division of Cartography at the Warsaw University of Technology (WUT)

The scientific activity of the employees of the **Division of Cartography at the Warsaw University of Technology (WUT)** in recent years has focused on several interrelated trends:

- creation of CENAGIS IT platform and spatial analysis scientific network to enable research in spatial big data analysis;
- review of map concepts and cartographic modelling that are fundamental to cartography;
- use of cartographic modeling methods for temporal and spatial analysis of the COVID-19 pandemic in Poland;
- the use of multi-agent systems and spatial data mining methods to model the terraformation process of Mars (collaboration with NASA Ames Research Center);
- development of a mobile cartography school;
- development of cartography for interior of buildings;
- using geographic information modelling methods to create smart cities;
- development of social geo-engagement methods using methods of gamification, game engines and elements of augmented reality;
- integration of cartographic modelling methods and artificial intelligence algorithms as well as multi-agent systems;
- development of the cartographic mapping theory with particular emphasis on the triaxial ellipsoid mappings and application thereof to maps of extra-terrestrial objects;
- the interdisciplinary cooperation in the field of integration of cartographic modelling methods and humanistic research – applied social sciences and historical sciences;
- searching for and promoting new geoinformatic technologies and applications of geoinformation.

As part of the development of individual directions, both projects and European grants have been implemented. As a result of the scientific work in the Division of Cartography of WUT, several dozen articles and conference speeches (both Polish and international) have been provided, three monographs and seven doctoral dissertations carried out under the supervision of independent employees of the Division of Cartography have been published.

CENAGIS IT platform: at the core of the 'The Centre for Scientific Geospatial Analyses and Satellite Computations' (CENAGIS) is a advanced IT infrastructure (cyber-infrastructure) allowing for implementation of geospatial analyses (such as spatial big data with data mining functionality) and satellite computations.

The infrastructure allows for performing analyses covering the entire country. Spatial analyses of large areas, such as the entire country opens quite new opportunities to perform new types of research works.

The basic idea of performed, scientific geospatial analyses is the development of new models and data analysis algorithms to be used by different industries, services and operations performed by public institutions.

CENAGIS consits of the scientific repository of geospatial data of Poland, computational centre, and virtual machines with access to open, vector and raster spatial data, for the entire Poland. As a result of cooperation with partners, access to satellite imageries of the European Space Agency (ESA) is ensured.

A unique solution includes the possibility to configure virtual machines, according to users' demands, ensuring the required computational power, GIS software, disk space and, first of all, the configured access to relevant files of spatial data. An open analytical platform plays key role. It will be developed within the project implementation and developed in successive years of utilisation of the CENAGIS infrastructure within various scientific projects, performed by scientists cooperating with the Centre.

CENAGIS provides the convenient access to big sets of spatial data (with the structures developed especially for scientific purposes), as well as an analytical platform dedicated for scientific analyses will be ensured. The Centre is by default open for cooperation in the field of many kind of geospatial resources, which are being developed in Poland (such as geodetic, road, railway, forest, geological, agricultural, meteorological, planning, architectural, environmental protection, defence data) in order to their common processing, analyzing and harmonisation.

Defining the concept of the map and features of cartographic modelling: This area of research is related to defining the theoretical foundations of cartography. The studies completed by Dr hab. Eng. Dariusz Gotlib and Dr hab. Eng. Robert Olszewski and implemented together with Prof. Georg Gartner allowed for a modern definition of the essence and role of cartography and a universal approach to the concept of the map. In the face of strikingly intense technological development, there have been significant discrep-ancies in the understanding of the concept of the map; an understanding that is fundamental to cartography and, more broadly, GIScience. The development of electronic products based on geoinformation has caused a growing need for the systematization of basic concepts, including defining what a map is. In particular, the modification of the idea of the map may profoundly influence the future development of cartography. The comprehensive and innovative use of maps, for example, in location-based service (LBS) applications, may contribute to more in-depth analyses in this area. In the article ‘The Extended Concept of the Map in View of Modern Geoinformation Products’ (2021) the authors examine how the concept of how the map is used in techno-logical or scientific literature about the latest geoinformation applications, as well as analyzing the survey results that confirm the change in social perception of the concept of the map in cartog-raphy. The article also refers to the role of the map in the process of indirect cognition and un-derstanding of geographical space-cognition realized through maps. A social understanding of mapping concepts is evolving and covers the entire spectrum of geoinformation products. It seems that the latest geoinformation solutions, such as navigation applications and, in particular, applications supporting the movement of autonomous vehicles (e.g., self-driving cars), have had a particular impact on the concept of the map. This is confirmed by the results of a survey conducted by the authors on a group of nearly 900 respondents from a variety of countries. The vast majority of users are convinced that the contemporary understanding of the concept of the map is a long way from the classic definition of this concept. Therefore, in the opinion of the authors of this article, it is worth undertaking research that will become a starting point for a discussion about the

broader definition of the map in GIScience.

Social geo-engagement: The research project carried out by the employees of the Division of Cartography has allowed to develop innovative methods of social geo-engagement using the methods of cartographic modelling, geoinformation technologies, methods of social gamification and AR technology (the so-called augmented reality). Developing innovative tools to support the process of shaping urban space in cooperation with residents had been part of the research carried out. The employees of the Department had designed the application to create and interpret the so-called geo-questionaries, using both spatial data and computational intelligence methods.

The use of multi-agent systems and spatial data mining methods to model the terraformation process of Mars: in the article 'Using spatial data science in energy-related modeling of terraforming the Martian atmosphere' the authors propose a methodology for numerical modeling of terraforming Mars' atmosphere using high-energy asteroid impact and greenhouse gas production processes. The developed simulation model uses a spatial data science approach to analyze the Global Climate Model of Mars and cellular automata to model the changes in Mars' atmospheric parameters.

The developed model allows estimating the energy required to raise the planet's temperature by sixty degrees using different variations of the terraforming process. Using a data science approach for spatial big data analysis has enabled successful numerical simulations of global and local atmospheric changes on Mars.

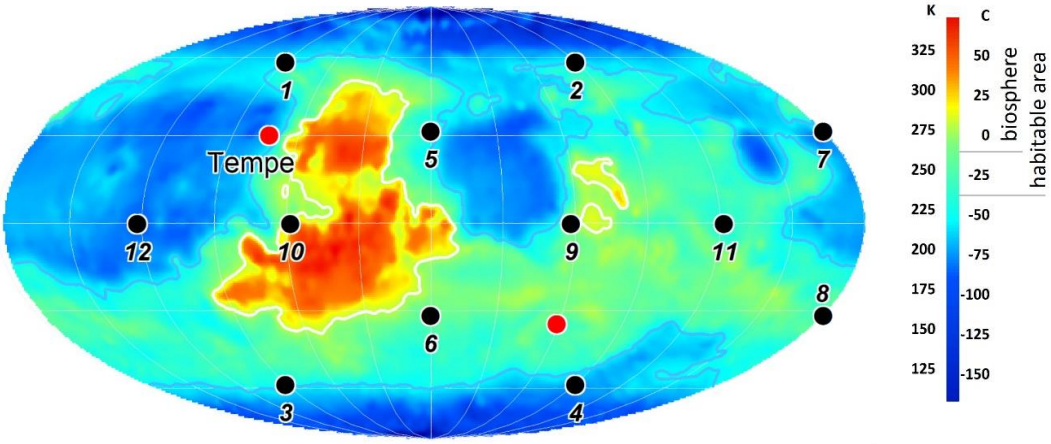

Fig. 70. Potential temperature on the surface of Mars after the planet has been warmed by greenhouse gas production (100 Martian years) at the Tempe location.

Cartography of building interiors and mobile cartography: The research related to the acquisition and cartographic presentation of data regarding the interiors of buildings for the needs of navigational applications and other information and decision systems (e.g. property management, support for police and rescue services) has been carried out in the Division of Cartography. The interest in modelling the interior of the buildings resulted initially from the need to develop a school of mobile cartography. However, the generalization of the research enabled us to initiate a new research direction. These activities have resulted in a measurable effect.

The use of cartographic modeling methods fortemporal and spatial analysis of the COVID-19 pandemic in Poland - integration of cartographic modelling methods and artificial intelligence algorithms as well as multiagent systems:

Research conducted in this field has been related to the use of the so-called computational intelligence for advanced processing of geographic information, to support the cartographic modelling process. In recent years, particular emphasis has been put on the use of multi-agent systems for processing geographic information and cartographic visualization of the results of data mining. The results of scientific works have been published in scientific magazine ‘Scientific Reports’. In the article ‘Using multiagent modeling to forecast the spatiotemporal development of the COVID-19 pandemic in Poland’, the authors present a multi-agent model that simulates the development of the COVID-19 pandemic at the regional level. The developed what-if system is a multi-agent generalization of the SEIR epidemiological model, which enables predicting the pandemic's course in various regions of Poland, taking into account Poland's spatial and demographic diversity, the residents' level of mobility, and, primarily, the level of restrictions imposed and the associated compliance. The developed simulation system considers detailed topographic data and the residents' professional and private lifestyles specific to the community. A numerical agent represents each resident in the system, thus providing a highly detailed model of social interactions and the pandemic's development.

The developed model, made publicly available as free software, was tested in three representative regions of Poland. As the obtained results indicate, implementing social distancing and limiting mobility is crucial for impeding a pandemic before the development of an effective vaccine. It is also essential to consider a given community's social, demographic, and topographic specificity and apply measures appropriate for a given region.

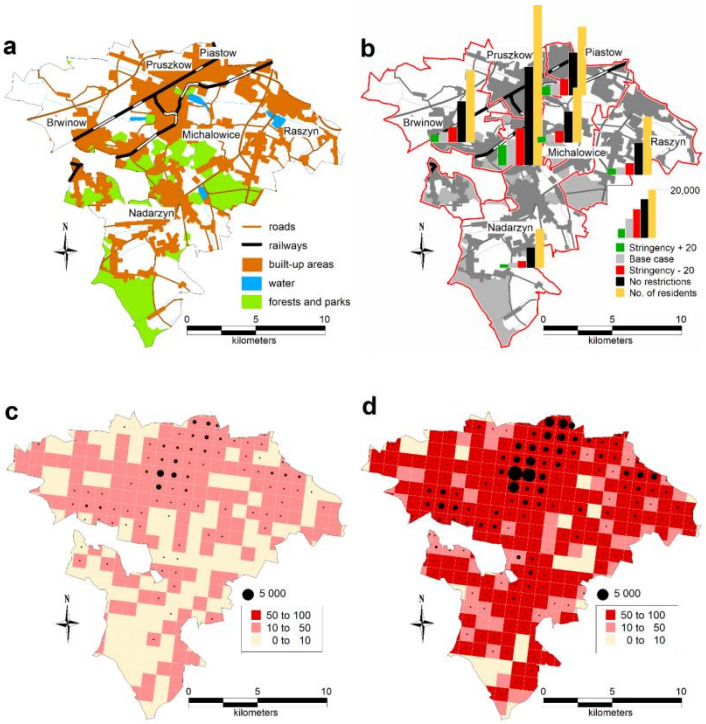

Fig. 71. Spatial distributions of the number of COVID-19 cases, their locations, and differences between the individual models in the Pruszków powiat. (a) Pruszków powiat: land cover. (b) The number of cases in the 4 models in the gminas in relation to the number of inhabitants of these gminas. (c) The number of cases in a 1×1 km grid and the percentage of cases (intensity of red color): Stringency Index +20 model. (d) The number of cases in a 1×1 km grid (pie chart) and the percentage of cases (intensity of red color): No restrictions model.

Deep learning methods in cartographic classification: Joint research between Warsaw University of Technology and Jagiellonian University has developed a methodology for using deep neural networks to classify landforms on Mars. The result of this research was the publication of an article 'Multi-source Classification of Meridiani Planum's Aeolian Landscape Using HiRISE and Opportunity Images Analysis based on Deep Learning'. The aim of the research was to analyze the possibilities of using deep learning methods for classifying multi-source image data for Mars. It should be emphasized that the main goal of the research was to develop a methodology for integrating image data acquired from orbiters (MRO mission's HIRISE camera) and in situ (Opportunity rover's NAVCAM camera) and to use their combined analytical potential. We used a VGG-16-based network for this study, which is well-characterized in the literature and has been successfully applied in a wide range of applications.

The article proposes a methodology for the supervised classification of landforms on Mars. The proposed solution was evaluated using the Meridiani Planum area, utilizing neural network deep learning and was based on multi-source image data. We found that our approach classified aeolian reliefs correctly for more than 94% of the test dataset. The classification accuracy increased to almost 96% when using panoramas developed from Opportunity's images and the derivatives of the digital terrain models used during the classification process. It is possible to broaden the proposed concept of multi-source classification and the customized deep learning system to the analysis of other regions of Mars and to multispectral imaging without losing the generalizability of the solution.

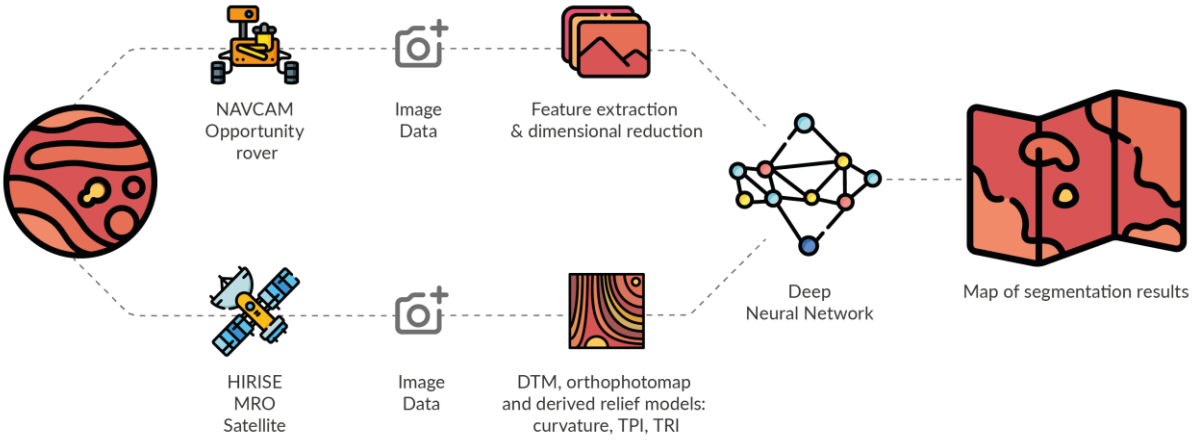

Fig. 72. Proposed research methodology.

Theory of cartographic mapping: In mathematical cartography, research has primarily been conducted on the determination of cartographic projections of the triaxial ellipsoid and application thereof in maps of extra-terrestrial objects. Among others, a method of constructing cylindrical equidistant projections in the direction of meridians and cylindrical equiareal projections have been developed, as well as pseudo-cylindrical equidistant projections towards parallels, azimuthal equidistant projections towards meridians and azimuthal equiareal projections. These methods are characterized by the use of elliptical integrals and Jacobi's elliptical functions. A method for constructing conformal projections of the triaxial ellipsoid which are characteristic of small distortions of projections has also been developed.

8.9. The Institute of Geospatial Engineering and Geodesy of the Faculty of Civil Engineering and Geodesy of the Military University of Technology

Research conducted at the **Institute of Geospatial Engineering and Geodesy of the Faculty of Civil Engineering and Geodesy of the Military University of Technology** focused on four main scientific issues. The first was to analyze the terrain and develop usability and accessibility maps for the Polish Army and emergency management officers. Passability rely in classifying the terrain into three classes (GO, SLOW–GO, NO–GO) based on the passability index (IOP), which is calculated using advanced data processing, (e.g. artificial neural network), topographic and remotely sensed data.

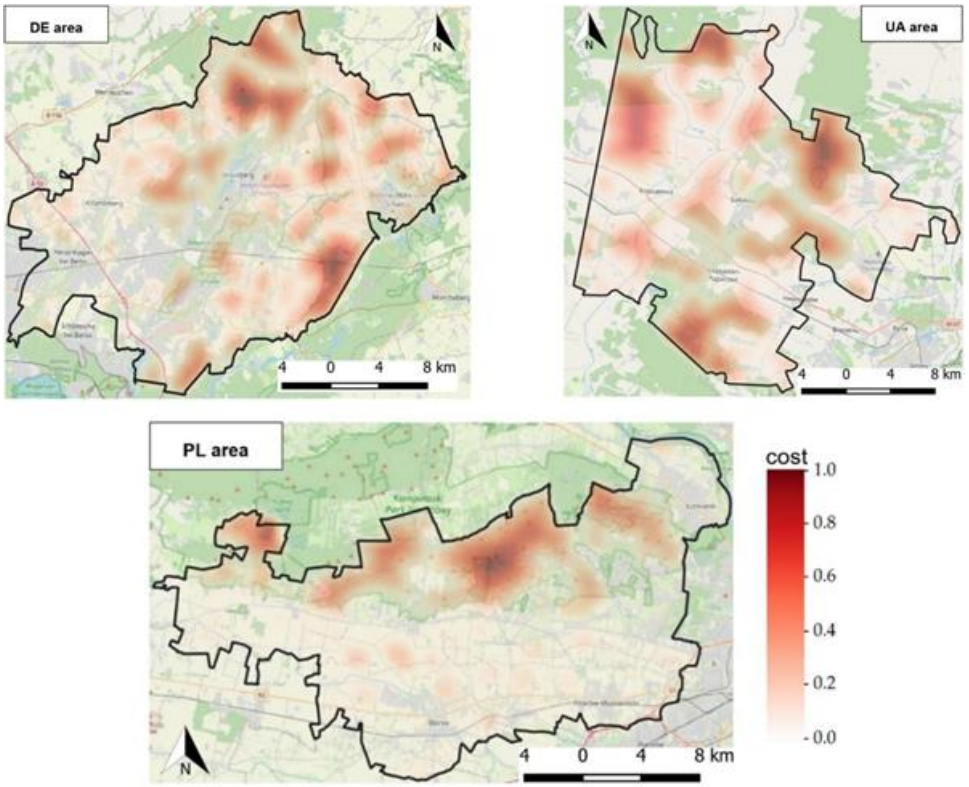

Fig. 73. Terrain accessibility maps (source: Dawid W., Pokonieczny K., Wyszyński M.: *The methodology of determining optimum access routes to remote areas for the purposes of crisis management,* International Journal of Digital Earth *2022, vol. 15, no. 1, pp. 1905–1928, DOI: 10.1080/17538947.2022.2134936*

The next research problem concerned the study on the haptic variables modification and the automation of tactile thematic map production using 3D printing techniques (fig. 74), as well as standardization of the tactile mapping proces. Currently, a research project 'Rzeczy są dla ludzi/0005/2020–00', titled 'Technology for the development of tactile maps of historic parks', financed by the National Centre for Research and Development in Poland is being conducted at the Institute. It concerns the development of tactile maps of gardens in the Baroque, Renaissance, English, Romantic and Japanese styles. This is a new type of map, departing from the development of navigation/orientation maps in favor of maps of gardens, as a compositions containing a system of specific elements of nature and architecture, juxtaposed in such a way that they form a harmonious whole (fig. 75).

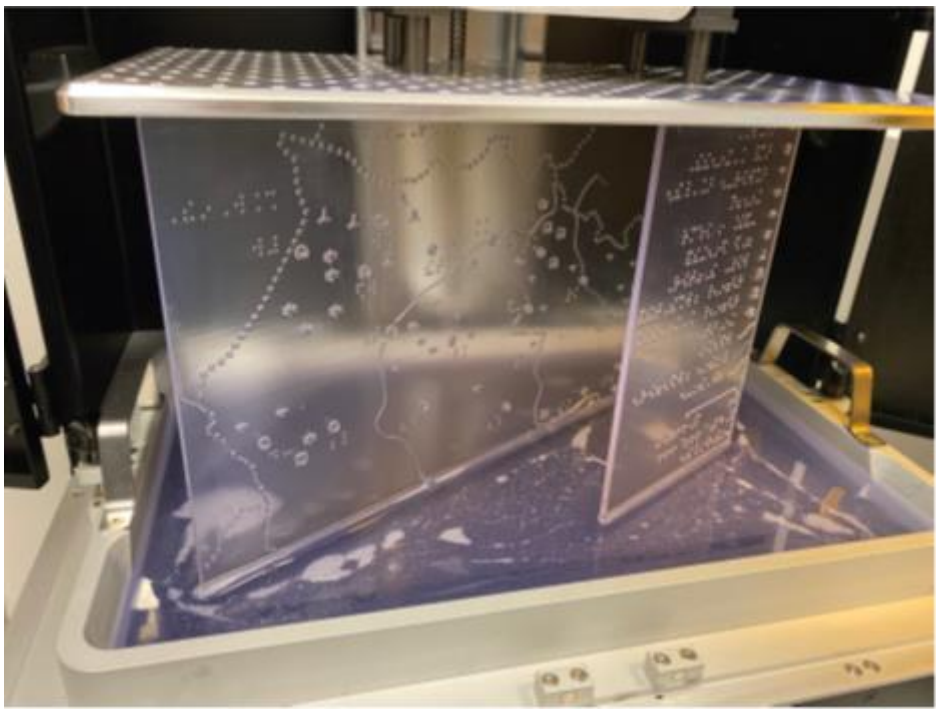

Fig. 74. The stereolitography printing process using transparent resin (Source: Wabiński J., Touya G., Mościcka A. (2022): *Semi–automatic development of thematic tactile maps*. Cartography and Geographic Information Science 2022, vol. 49:6, 545–565, DOI: 10.1080/15230406.2022.2105747)

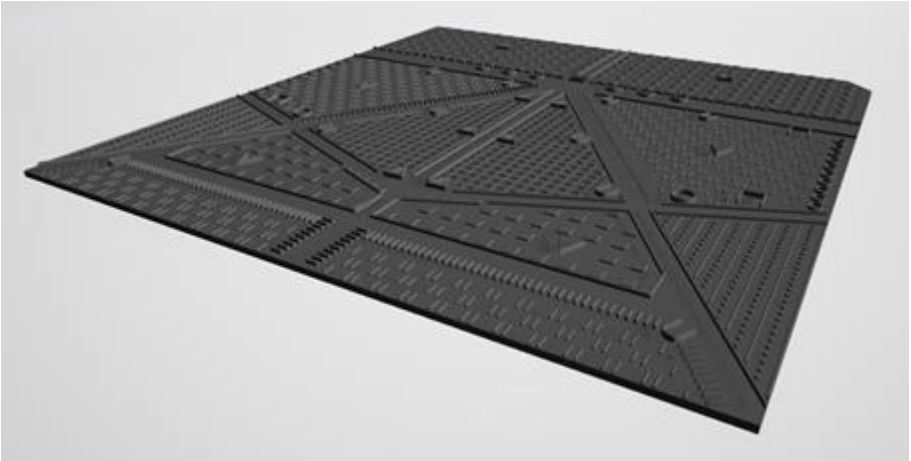

Fig. 75. 3D tactile map model prepared for testing features of baroque and renaissance gardens (Source: Mościcka A. working materials)

Another important research area is thematic maps and geovisualisation as a tool facilitating decision–making in early warning and crisis management, with particular emphasis on flood risk and monitoring (fig. 76) of sustainable development goals in accordance with the UN 2030 Agenda.

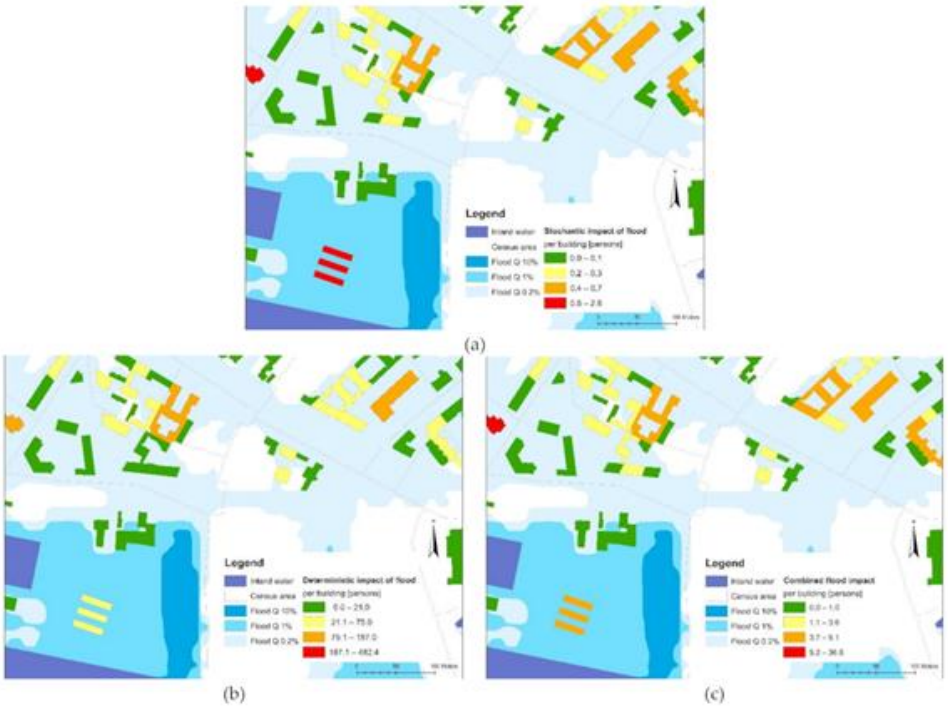

Fig. 76. Residents whose lives and health would be affected by a flood in a pre–modelled scenario, in the stochastic (a), deterministic (b) or both aspects (c), attributed to building. (Source: Nowak Da Costa J., Calka B., Bielecka E. *Urban Population Flood Impact Applied to a Warsaw Scenario. Resources* 2021, vol. 10, 62. https://doi.org/10.3390/resources1006006)

Finally, the Institute's research staff design and implement thematic geoportals. A good practice is a web portal providing access to Polish Global Navigation Satellite Systems (GNSS) data (fig. 77), namely the GNSS Data Repository and GNSS Data Analysis Centre.

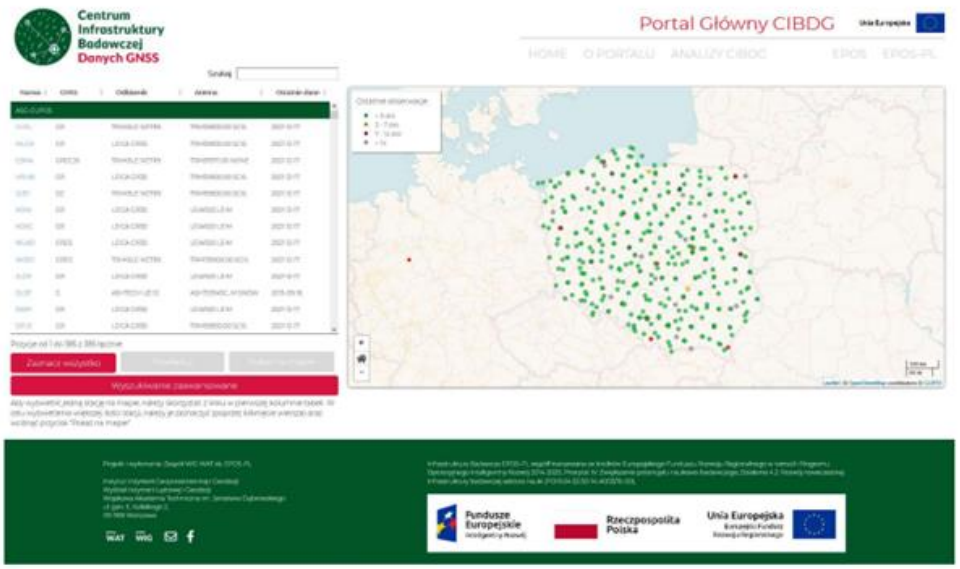

Fig. 77. Stating page of Geoportal (source: Araszkiewicz A., et al. Geoportal of the GNSS Data Research Infrastructure Center. Roczniki Geomatyki 2022 vol. XX no.1(96), pp. 7–16)

9. Cartographic collections

The Central Library of Geography and Environmental Protection operating at the Institute of Geography and Spatial Organization PAS in Warsaw (http://www.cbgios.pan.pl) has one of the largest collections of cartographic documents from around the world in Poland. This collection includes over 98,000 maps sheets and 5,700 atlases. It contains both new cartographic documents, also issued in electronic version, as well as old ones, including over 100 atlases issued before the year 1800. Information on a significant part of this collection is made available online as part of the nationwide Polish central catalogue of scientific and academic libraries NUKAT (http://katalog.nukat.edu.pl) and through the on–line local catalogue.

The library also keeps digitalizing its collection, which afterwards is successively made available at http://rcin.org.pl. Currently, there are over 2,300 cartographic objects in the Digital Repository of Scientific Institutes (RCIN), most of which are in the Public Domain. Until 2021, as part of the implementation of a three–year project 'Open Resources in the Digital Repository of Scientific Institutes (OZwRCIN)', financed from the resources of the Operational Program Digital Poland of the European Union, this platform will be modernized and enriched, among others with another 2,100 maps or more and atlases from the collections of the Central Library of Geography and Environmental Protection, which will represent European military cartography (mainly from the period of World War I and II).

The University of Wrocław has one of the largest cartographic collections in Poland, which are stored at the University Library (15,000 sheets of maps and volumes of atlases, 10,000 sheets of section maps) and in the Section for History of Cartography (PHK), which is a part of the Department of Geoinformatics and Cartography (2,500 atlases, 36,000 sheets of maps). The collection of PHK is intensively used for teaching and research. Few thousend pieces of valuable and unique old maps and atlases were digitised and now they are available online at the website of Digital Library of the University of Wrocław (Cartographic Materials of the Wrocław University Library:

- https://www.bibliotekacyfrowa.pl/dlibra/collectiondescription/24

and the Cartographical Digital Library of PHK:

- https://bibliotekacyfrowa.pl/dlibra/collectiondescription/213.

The Cartographic Collections Department of the National Library of Poland holds 145,200 cartographic documents (as of December 31, 2021), including over 300 atlases published before 1800. New acquisitions include 1,698 library units, collected mainly as Legal Deposit Copies. In 2021, 2,667 copies of maps and atlases were cataloged. Since 1997 the main online catalog has been using INNOPAC software. Overall, more than 94% of cartographic documents have been cataloged, and their descriptions are available in the database https://katalogi.bn.org.pl/ and in the digital library https://polona.pl/ scans of over 17,000 maps and atlases are stored.

APPENDIX

SELECTIVE BIBLIOGRAPHY OF POLISH CARTOGRAPHIC PUBLICATIONS 2019–2022

A. ATLASES

Historical atlases

Atlas historyczny Polski. Mapy szczegółowe XVI wieku, 6. Kujawy i ziemia dobrzyńska w drugiej połowie XVI wieku. Editor Wiesława Duży in cooperation with Arkadiusz Borek and Michał Słomski. Elab. Arkadiusz Borek et al. (15 persons), Warszawa: Polska Akademia Nauk, Instytut Historii, 2021, Część I Mapy, plany, folded maps and town plans in paper jacket; Część II Komentarz, Indeksy, 274 pp., 13 maps in text, summ.: *The Historical Atlas of Poland. Cuyavia and Dobrzyń Land in the Second Half of the 16th Century*.

Atlas historyczny Polski. Mapy szczegółowe XVI wieku, 8. Województwo podlaskie w drugiej połowie XVI wieku. Editors Michał Gochna, Bogumił Szady. Elab. Krzystof Boroda et al. (11 persons), Warszawa: Polska Akademia Nauk, Instytut Historii, 2021, Część I Mapy, plany, 4 folded maps and 4 town plans in paper jacket; Część II Komentarz, Indeksy, 333 pp., 18 maps in text, summ.: *The Historical Atlas of Poland. Podlasie Voivodship in Second Half of the 16th Century*.

Atlas historyczny Polski. Mapy szczegółowe XVI wieku, Suplement. Prusy Królewskie w drugiej połowie XVI wieku. Editors Tomasz Panecki, Marek Słoń. Elab. Roman Czaja et al. (13 persons), Warszawa: Polska Akademia Nauk, Instytut Historii, 2021, Część I Mapy, plany, 8 folded maps and town plans in paper jacket; Część II Komentarz, Indeksy, 169 pp., summ.: *The Historical Atlas of Poland, Royal Prussia in Second Half of the 16th Century*. Suplement to the volume published in 1961.

Atlas historyczny miast polskich, Tom. I. Prusy Królewskie i Warmia. Zeszyt 8. Toruń. Historical Atlas of Polish Towns. Vol. I, Royal Prussia and Ermland. Fasc. 8. Toruń. Historical editing Roman Czaja. Cartographic editing Radosław Golba. Authors: Radosław Golba et al. (8 persons). Toruń: Towarzystwo Naukowe w Toruniu, 2019, 23 tabl. Text in Polish and English, 98 pp., (continuation of the atlas fascicle published in 1995).

Atlas historyczny miast polskich, Tom. V. Małopolska. Zeszyt 7. Biecz. Historical Atlas of Polish Towns. Vol. V, Lesser Poland. Fasc. 7. Biecz. Editor Zdzisław Noga. Authors: Zbigniew Beiersdorf, Paweł Kocańda, Bogusław Krasnowolski, Zdzisław Noga. Cartographic elaboration Tomasz Sztyma, Toruń–Kraków: Towarzystwo Naukowe w Toruniu, 2021, 28 tabl., text in Polish and English, 87 pp.

Atlas historyczny miast polskich, Tom. VI. Wielkopolska. Zeszyt 1. Kalisz. Historical Atlas of Polish Towns. Vol. VI, Greater Poland. Fasc. 1. Kalisz. Historical editing Urszula Sowina, Cartographic editing Tomasz Panecki. Authors: Urszula Sowina et al. (6 persons). Toruń–Warszawa: Towarzystwo Naukowe w Toruniu, Instytut Historii Polskiej Akademiii Nauk, 2021, 25 tabl., text in Polish and English, 204 pp.

Atlas historyczny miasta Łodzi. Editors: Maria Dankowska, Marek Koter. Authors: Adam Bartnik et al. (24 persons). Technical and cartofgraphic editor Mariusz Stępniewski. Łódź: Łódzkie Towarzystwo Naukowe, 2022, 464 pp., (*Historical atlas of the City of Łódź*).

Atlas historyczny Galicji. Mariusz Paździora. Chrzanów: Miejska Biblioteka Publiczna w Chrzanowie, 2021, 128 pp., 54 maps, 16 plans of towns (*Historical atlas of Galicia – Kingdom of Galicia and Lodomeria 1772–1918*).

Atlas historyczny Pomorza Nadwiślańskiego 1814 – 2020. Authors of maps and texts Łukasz Richert, Adrian Watkowski. Gdańsk: Zrzeszenie Kaszubsko–Pomorskie, 2020, 40 pp. (*Historical atlas of Vistulaside Pomerania 1914–2020*).

Atlas Górnego Śląska 1919 – 1922. Wybór źródeł kartograficznych. Elab. Grzegorz Bębnik, Michał Mączka, Sebastian Rosenbaum, Mirosław Węcki. Warszawa–Katowice: Instytut Pamięci Narodowej, 2022. Collection of 179 copies of maps at different scales with explanatory text (*Atlas of Upper Silesia 1919–1922. Selection of cartographic sources*).

Atlas polskiego podziemia niepodległościowego. The atlas of the independence underground in Poland 1944 – 1956. Editorial team: Sławomir Poleszak (editor–in–chef), Rafał Wnuk, Agnieszka Jaczyńska, Magdalena Śladecka. Cartographic editing Krzysztof Kałamucki. Warszawa–Lublin: Instytut Pamięci Narodowej, 2020, 578 pp. (The second enlarged edition of the atlas published in 2007).

Atlas Biblijny. Conception and editing Adam Linsenbarth. Warszawa–Pelplin: Instytut Geodezji i Kartografii, Wydawnictwo Bernardinum, 2020, 328 pp. *(The Bible Atlas*. Second edition of the atlas from 2018).

Lechia, Sarmatia, Scytia. Atlas historyczny. Janusz Bieszk, Wojciech Zieliński. Warszawa: Wydawnictwo Bellona, 2021, 240 pp., (*Lechia, Sarmatia, Scytia. Historical atlas*. Reprints of 128 ancient and unique maps with introduction in Polish and English).

Atlas najnowszej historii XX i XXI wieku. Editors: Marzena Wieczorek, Piotr Wójcicki. Authors of maps Konrad Banach and al. (9 persons). Historical contents Witold Sienkiewicz, Marzena Wieczorek, Warszawa: Demart S A. 2021, 248 pp. *(Atlas of the newest history of the 20th and 21st century with historical comments).*

Wielki atlas historii Polski. Editorial elab.: Witold Sienkiewicz, Elżbieta Olczak, Marzena Wieczorek. Elab. And editing of maps Konrad Banach, Jan Goleń et al. (9 persons). Warszawa: Demart SA, 2021, 480 pp. (*Great atlas of history of Poland*).

Statistical atlases of Poland

Atlas przedsiębiorstw. Atlas of Enterprises Editorial team Danuta Cybula et al (18 persons) supervised by Joanna Ślepowrońska. Warszawa: Główny Urząd Statystyczny, 2019, 118 pp. (All titles and explanations in Polish and English).

Atlas środowiska. Atlas of Environment. Editorial team Dariusz Bochenek et al. (13 persons) supervised by Wiesława Domańska. Warszawa: Główny Urząd Statystyczny, 2021, 119 pp. (All titles and explanations in Polish and English).

Complex regional atlases

Atlas Karkonoszy. Atlas Krkonoš. Editing / Připrava wydáni Waldemar Spallek. Authors of maps Paweł Aleksandrowski et al. (23 persons). Jelenia Góra–Vrhlabi: Karkonoski park Narodowy, Správa Krkošského národního parku, 2021, 128 pp. (*Atlas of Karkonosze Mountains*).

Atlas Wyszehradzki. Visegrad Atlas. Scientific editors: Przemysław Śleszyński, Konrad Czapiewski. Cartogr. Editing: Jolanta Korycka–Skorupa, Tomasz Nowacki, Agnieszka Adamiak. Warszawa: Instytut Współpracy Polsko–Węgierskiej im. W. Falczaka, Polskie Towarzystwo Geograficzne, 2021, 303 pp., 128 maps (*Complex atlas of the Visegrad Group*).

Other thematic atlases

Atlas osuwisk miasta Krakowa. Collective elab., edited by Antoni Wójcik. Authors of maps: Antoni Wójcik, Sylwester Kamieniarz et al. (6 persons). Państwowy Instytut Geologiczny,. Kraków: Urząd Miasta Krakowa, Wydział Kształtowania Środowiska, 2019, 192 pp. (*Atlas of landslides of the City of Cracow*).

High mountain vascular plants of the Carpatians. Atlas of distribution. Editor Zbigniew Mirek, Authors: Zbigniew Mirek, Agnieszka Nikel et al. (11 persons). Kraków: Szafer Institute of Botany, Polish Academy of Sciences, 2020, 406 pp., 736 maps.

Atlas of changes in the glaciers of Kaffiøyra (Svalbard, the Arctic). Editor Ireneus Sobota, Marek Keina, Marek Nowak, Krzysztof M. Różański. Toruń: Nikolaus Copernicus University Press, 2021, 216 pp.

Geograficzno–polityczny atlas Polski. Polska w świecie współczesnym. Perspektywa 2022. Atlas of Poland's political geography. Poland inn the modern world. 2022 Perspective. Scientific editor Marcin W. Solasz. Elab. M. Zych, J. Talacha et al. Warszawa: Uniwersytet Warszawski, Wydział Geografii i Studiów Regionalnych, Trzecia strona, 2022, 392 pp. (all text and explanations in Polish and English).

Atlas 1020. Mapy dla małych jednostek. Od Zatoki Pomorskiej do Mierzei Helskiej. Collect. Elab. Gdynia: Biuro Hydrograficzne Marynarki Wojennej, 2022, (*Atlas 1020. Charts for small crafts. From Gulf of Pomerania to Hel Penisula*. 8 sheets with charts at different scales in plastic cover).

Tourist atlases

Atlas. Warszawa i okolice. Plan miasta XXL. 1: 13,500 and 1: 17,000. Collective elab. Warszawa: Jokart, 2022 *(Warsaw and surroundings. City atlas 1: 13,500 + 59 town maps at 1: 17,000 scale).*

Europa. Atlas samochodowy. 1: 800,000. Collective elab. Express Map, 2021. (*Poland. Road atlas*).

Polska. Atlas samochodowy dla profesionalistów. 1: 200, 000. 2022/2023. Collective elab. Warszawa: Express Map, 2023. (*Poland. Road atlas for professionalists*).

Polska. Atlas samochodowy. 1: 250, 000. 2021/2022. Collective elab. Warszawa: Express Map, 2021. (*Poland. Road atlas*).

Polska. Atlas samochodowy. 1: 300, 000. Collective elab. Warszawa: Demart S A, 2021. (*Poland. Road atlas*).

Warszawa. Atlas miasta XXL. 1: 13,000, city center 1: 8,000. Collective elab. Warszawa: Demart S A, 2022 *(Warsaw. City atlas 1: 13,000).*

School atlases

Mój pierwszy atlas geograficzny. Szkoła podstawowa, klasa 5. Editors of the atlas: Ewa Lodzińska, Marzena Wieczorek. Elab. and editing of maps Bogdan Horodyski et al. (9 persons). Warszawa: Demart SA, 2021/2022, 48 pp. (*My first geographical atlas. Primary school, grade 5*).

Atlas geograficzny. Szkoła podstawowa, klasy 6–8. Editors of the atlas: Ewa Lodzińska, Marzena Wieczorek. Elab. and editing of maps Małgorzata Chrześlińska et al. (6 persons, team of Demart, Cartographia Budapest). Warszawa: Demart SA, 2021/2022, 160 pp. (*Geographical atlas. Primary school, grades 6–8*).

Atlas geograficzny. Polska, kontynenty, świat. Szkoła podstawowa. Klasy 5–8. Concept Jarosław Jakubiak Elab. And editing of maps: Mikołaj Cocopulos et al. (8 persons). Warszawa: Nowa Era Sp. z o.o., 2022, 200 p p. (*Geographical atlas. Poland, continents, the world. Elementary and secondary school. Grades 5–8).*

Atlas geograficzny dla *liceum ogólnokształcącego i technikum.* Editing and elab. Mikołaj Cocopulos, Krystian Chanza et al. (25 persons). Warszawa: Nowa Era Sp. z o.o., 2022, 256 pp (*Geographical atlas for liberal and technical secondary school*).

Atlas geograficzny. *Liceum, technikum. Nowa podstawa programowa.* Editors: Ewa Lodzińska, Marzena Wieczorek. Warszawa: Demart S A, 2022/2023, 232 pp. (*Geographical atlas. Secondary school, technical school. New programme base*).

Duże mapy do nauki geografii. Editors: Beata Bohdanowicz, Marzena Wieczorek. Warszawa: Demart SA, 2020, (*Large maps for learning geography*). Collection of 8 foldet detailed chorographic maps of Poland, all continents and the world at different scales (e.g. Poland 1: 1,500,000) with sets of thematic maps on reverses, and also setr of 30 outline maps (without names) – all in cardboard box.

Atlas. Historia i współczesność 1945–2015. Szkoły podstawowe. Editorial elab. Marzena Wieczorek., Piotr Wójcik. Elab. and editing of maps Bogusława Karlicka et al. (9 persons. Warszawa: Demart SA, 2022, 186 pp. (*Atlas. History and present times 1945–2015. Primary schools*).

Atlas historyczny. Szkoła podstawowa, klasy 5 – 8. Concept and editing Elżbieta Olczak. Elab. and editing of maps team of Demart. Warszawa: Demart SA 2020/2021, 166 pp. (*Historical atlas. Primary school, grades 5 – 8*).

Atlas historyczny. Liceum i technikum. Zakres podstawowy i rozszerzony. Editors: Beata Jankowiak–Konik, Witold Sienkiewicz. Warszawa: Demart SA 2019/2020, 240 pp. (*Historical atlas. Secondary school, technical school.Basic and enlarged range*).

Atlas. Wiadomości o społeczeństwie. Szkoła podstawowa. Liceum Ogólnokształcące i technikum. Zakres podstawowy i rozszerzony. Collective elab. Warszawa: Nowa Era Sp. z o.o., 2022, 72 pp. (*Atlas. Informations about socjety. Primary school. Secondary liberal and technical school. Basic and enlarged range*).

B. MAPS

Topographic maps

Mapa topograficzna 1:10 000. 968 sheets of Topographical map of Poland at the scale 1:10,000 edited by Marshal's Offices of Voivodships (Urzędy Marszałkowskie Województw) in 2019–2022

Thematic maps

Przeglądowa mapa geologiczna Karpat. Mapa odkryta, bez utworów czwartorzędowych, 1: 500,000. Elab. Leszek Jankowski, graphic design Małgorzata Jurgowiec. Annex: Szkic geologiczny, 1: 500,000, graphic elab. Małghorzata Tałt, *Objaśnienia do mapy geologicznej Karpat*, 52 ppWarszawa: Państwowy Instytut Geologiczny, 2021 (*General geological map of north–western Carpathians with geological skech and brochure with explanations*).

Szczegółowa mapa geochemoiczna Górnego Śląska. Detailed geochemical map of Upper Silesia. 1: 25, 000. Editors: Anna Psieczna, Agnieszka Konon. Sheets: Bytom, Piekary Śląskie, Świerklaniec, Tarnowskie Góry. Warszawa: Państwowy Instytut Geologiczny, 2021 (Continuation of the series).

Asia. Europe–Asia. Mapa sieci kolejowej. Railway map. Eisenbahnkarte. Karta zheleznykh dorog. Europe and West Asia 1: 10,500,000, Asia 1: 13,900,000. Collective elab. Katowice. Wydawnictwo Kartograficzne Karta, 2021.

Odrzańskie porty, mariny i przystanie turystyczne. Mapa szlaku wodnego. 1: 750,000. Szczecin i Wrocław water junctions 1:200,000. Cooperation Włodzimnierz Gryner. Warszawa–Szczecin: Wydawnictwo Kartograficzne Polkart, 2019/2020 (*Odra River – parts, marinas and tourist havanas. Map of waterway*).

Bałtyk Południowy i Południowo–Wschodni. 1: 500,000. International Chart Series (INT 1021 500). Collective elab. Gdynia: Biuro Hydrograficzne Marynarki Wojennej, 2021 (*Southern and South–eastern Baltic Sea*).

Bałtyk. Zatoka Gdańska. *1: 50,000. Plan Portu Gdynia 1: 10,000.* International Chart Series (INT 12 901). Collective elab. Gdynia: Biuro Hydrograficzne Marynarki Wojennej, 2022 (*Baltic Sea, Gulf of Gdańsk. Chart of Port of Gdynia*).

Tourist maps

Biebrzański Park Narodowy. Mapa Turystyczna. 1: 85,000. Elab. Katarzyna Janicka, Maciej Janicki. Warszawa: ExpressMap Polska Sp. z o.o., 2021 (*Biebrza National Park. Tourist map*).

Bieszczady. Połoniny. Mapa aktualizowana w terenie. 1: 25,000. Editing and cartography Grzegorz Zwoliński. Wrocław: Studio Plan, 2021 (*Bieszczady Mountains. High pastures. Map up–to–dated in terrain*).

Europa. Mapa samochodowa. 1: 3,400,000. Collective elab. Warszawa: Demart, 2022. (*Europe. Road atlas*).

Góry Świętokrzyskie. Mapa turystyczna. 1: 75,000. City map of Kielce 1: 20,000. Cartogr. Elab. Karolina and Remigiusz Kieltyk. Comfort map. ExpressMap Polska Sp. z o.o., 2021 (*Świętokrzystkie Mountains. Tourist Map*).

Jezioro Śniardwy. Mapa żeglarska. 1: 25,000. Editorial elab. Centrum Kartografii Henryk Kowalski, Sailing content and bathymetry Jan Szajkowski. Warszawa: Centrum Kartografii, 2021, (*Lake Śniardwy. Yachting map*).

Kampinoski Park Narodowy. Mapa turystyczna. 1: 50,000. Editing Piotr Pietroń, cartogr. Elab. Jerzy Parzewski. Kraków: Wydawnictwo Compass, 2022 (*Kampinos National Park. Tourist map*).

Karkonoski Park Narodowy. Mapa turystyczna dla aktywnych. 1: 33,000. Collective elab. Jelenia Góra: Plan, 2020 (*Karkonosze National Park. Tourist map for actives*).

Kaszuby Południowe. Mapa rowerowa. 1: 50,000, 1: 60 000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Southern Kashubia. Bicycle map*).

Kaszuby Północne. Mapa rowerowa. 1: 55,000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Northern Kashubia. Bicycle map*).

Kaszuby Zachodnie. Mapa rowerowa. 1: 50,000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Western Kashubia. Bicycle map*).

Kociewie i Powiśle. Mapa rowerowa. 1: 55,000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Kociewie and Powiśle. Bicycle map*).

Mapa Korony Gór Polski. General map of southern Poland. 1: 680,000. Detailed maps of 28 individual mountains at 1: 35,000 or 1: 50,000 scale. Collective elab. Kraków: Wydawnictwo Compass, 2022 (*Map of the Crown of Mountains in Poland*).

Mierzeja Wiślana i Wyspa Sobieszewska. Mapa turystyczno–krajoznawcza. 1: 20,000 and

1: 50,000. Cartogr. Elab. Artur Sikorski. Kartuzy: Eko–Kapio, 2022 (*Vistula River Spit and Sobieszewska Island. Tourist and sightseeing map*).

Okolica Warszawy. Mapa turystyczna. 1: 75,000. Cartogr. elab. and editing Krzysztof Radwański, Warszawa: ExpressMap Polska Sp. z o.o., 2022, Series Comfort map (*Environs of Warsaw. Tourist map*).

Podkarpackie. Mapa turystyczna polsko–słowackiego pogranicza. 1: 100,000. Elab Stowarzyszenie Pro–Carpatia, Rzeszów. Editing Małgorzata Pociask et al. Rzeszów: Urząd Marszałkowski Województwa Podkarpackiego, 2020 (*Subcarpatians. Tourist map of Polish–Slovakian borderland*).

Polska. Mapa samochodowa. 1: 650,000. Cartogr. elab. Piotr Pietroń. Kraków: Wydawnictwo Compass, 2022, (*Poland. Road map*).

Rabka–Zdrój i okolice and Vicinity. Mapa turystyczna 1: 40,000. Collective elab. Kraków: Compass, 2021 *(Rabka–Zdrój and Vicinity. Tourist map).*

Roztocze Wschodnie. Ziemia Lubaczowska. Okolice Jarosławia. Mapa turystyczna. 1: 50,000. Editing Piotr Banaszkiewicz. Kraków: Wydawnictwo Compass, 2021 (*Eastern Roztocze, Lubaczów Land, Environs of Jarosław. Tourist map*).

Sudety. *Mapa turystyczna*. 1: 120,000. 12 city maps 1: 10,000 or 1: 15,000. Cartogr. Elab. Jan Ufnal and al. (8 persons). Editors: Eliza Bagieńska, Katarzyna Stalęga. Warszawa: ExpressMap Polska Sp. z o.o., 2022 (*Sudety Mountains. Tourist map*).

Tatry i Zakopane. 2 w 1, przewodnik I mapa. 1: 55,000, Zakopane 1: 15,000. Editing Łukasz Korolewski. Warszawa: ExpressMap Polska Sp. z o.o., 2021 (*Tatra Mountains and Zakopane. 2 in 1, guide and map*).

Tatry. Mapa panoramiczna. Mapa turystyczna. 1: 28,000, 10 panoramic photos. Concept and projection Wojciech Kowalski. Cartogr. editor Turzyniecki, Warszawa: ExpressMap Polska Sp. z o.o., 2022 (*Tatra Mountains. Bird's eye view map. Tourist map*).

Tatrzański park Narodowy. Mapa turystyczna. 1: 30,000. City map of Zakopane 1: 15,000. Collective elab. Krakow: Wydawnictwo Gauss, 2019 (*Tatra National Park. Tourist map*).

Trójmiejski Park Krajobrazowy. *Mapa rowerowa*. 1: 20,000, 1: 25,000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Tri-City Landscape Park. Bicycle map*).

Wielkie Jeziora Mazurskie. Grosse Masurische Seenplatte. Mapa Turystyczna / Touristenkarte. 1: 50, 000. Editing Anna Dębska, Cartogr. Editors Monika Sibielec, Anna Dębska. Wrocław: Studio Plan, 2020 (*Great Masurian lakes. Tourist map.* Titles and legend in Polish and German).

Wybrzeże Bałtyku. Atlas rowerowy. 1: 50, 000. Collective elab. Wrocław: Wydawnictwo Kartograficzne Eko–Graf, 2021 (*Baltic Sea Coast. Bicycle atlas*. 25 map sheets).

Wyspa Wolin. Mapa turystyczna. 1: 50,000. Elab. Paweł Jończy, Rafał Fronia, Tomasz Wojtasik. Wrocław: Wydawnictwo Turystyczne Plan, 2021 (*Island Wolin. Tourist Map*).

Ziemia Słupska i Pobrzeże Słowińskie. Mapa rowerowa. 1: 50,000, 1; 60 000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Słupsk Land and Słowińskie Coast. Bicycle map*).

Żuławy i Mierzeja Wiślana. Mapa rowerowa. 1: 50,000. Collective elab. Gdańsk: Pomorska Regionalna Organizacja Turystyczna, Kartuzy: Wydawnictwo Eko–Kapio, 2020 (*Lowlands and Vistula River Spit. Bicycle map*).

City maps

Berlin. Plan miasta. 1: 22,000. Collective elab. Warszawa: Demart SA, 2022 *(Berlin. City map).*

Białystok. Plan miasta +7: Bielsk Podlaski, Drohiczyn, Hajnówka, Łapy, Siemiatycze, Sokółka, Supraśl. 1: 17,000. Collective elab. Warszawa: Demart SA, 2022 (*Białystok. City map +7 town maps: Bielsk Podlaski, Drohiczyn, Hajnówka, Łapy, Siemiatycze, Sokółka, Supraśl).*

Bielsko–Biała. Plan miasta. 1:20 000. Collective elab. Kraków: Compass, 2022 *(Bielsko–Biała. City map).*

Brodnica. Plan miasta + 1: Inowrocław. 1: 12,000. Collective elab. Warszawa: Demart SA, 2021 *(Brodnica. Town map + 1 town map: Inowrocław).*

Busko–Zdrój Plan miasta i mapa okolic. City Map and Vicinity. 1: 10,000. Collective elab. Kraków: Compass, 2022 *(Busko Zdrój. City map).*

Bydgoszcz. Plan miasta +5: Koronowo, Nakło n. Notecią, Soleck Kujawski, Tuchola, Żnin. 1: 23,000. Collective elab. Warszawa: Demart SA, 2022 (*Bydgoszcz. City map +5* town maps: *Koronowo, Nakło n. Notecią, Soleck Kujawski, Tuchola, Żnin).*

Chełm. Plan miasta + 9: Biłgoraj, Hrubieszów, Krasnystaw, Rejowiec Fabryczny, Szczebrzeszyn, Tomaszów Lubelski, Włodawa, Zamość, Zwierzyniec. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 *(Chełm. City map + 9 town maps: Biłgoraj, Hrubieszów, Krasnystaw, Rejowiec Fabryczny, Szczebrzeszyn, Tomaszów Lubelski, Włodawa, Zamość, Zwierzyniec).*

Elbląg. Plan miasta + 7: Braniewo, Frombork, Krynica Morska, Malbork, Morąg, Nowy Dwór Gdański, Pasłęk. 1: 15,000, Collective elab. Warszawa: Demart SA, 2021 *(Elbląg. Town map + 7 town maps: Braniewo, Frombork, Krynica Morska, Malbork, Morąg, Nowy Dwór Gdański, Pasłęk).*

Gdańsk, Gdynia, Sopot. Plan miasta + 3: Reda, Rumia, Wejherowo. 1: 23,000. Collective elab. Warszawa: Demart SA, 2022 *(Jelenia Góra. City map + 3 town maps: Reda, Rumia, Wejherowo).*

Jelenia Góra. Plan miasta + 5: Karpacz, Kowary, Lubań, Szklarska Poręba, Świeradów–Zdrój. 1: 20,000. Collective elab. Warszawa: Demart SA, 2021 *(Jelenia Góra. Town map + 5 town maps: Karpacz, Kowary, Lubań, Szklarska Poręba, Świeradów–Zdrój).*

Kalisz. Plan miasta + 1: Ostrów Wielkopolski. 1: 14,000. Collective elab. Warszawa: Demart SA, 2020 *(Kalisz. City map + town map of Ostrów Wielkopolski).*

Katowice. Plan miasta. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 *(Katowice. City map).*

Kazimierz Dolny, Nałeczów, Puławy. Plan miasta. City Map. 1: 35,000. Collective elab. Kraków: Compass, 2021 *(Kazimierz Dolny, Nałeczów, Puławy. City map).*

Kielce. Plan miasta + 6: Busko–Zdrój, Jędrzejów, Opatów, Pińczów, Staszów, Suchedniów. 1: 18,000. Collective elab. Warszawa: Demart SA, 2021 *(Kielce. City map + 6 town maps: Busko–Zdrój, Jędrzejów, Opatów, Pińczów, Staszów, Suchedniów).*

Konin. Plan miasta + 3: Koło, Słupica, Turek. 1: 15,000. Collective elab. Warszawa: Demart SA, 2022 *(Konin. City map + 3 town maps: Koło, Słupica, Turek).*

Kraków. Plan miasta. City map. 1: 20,000. Collective elab. Kraków: Compass, 2021 *(Kraków. City map).*

Krynica– Zdrój. Plan miasta. City map. 1: 17,500. Collective elab. Kraków: Compass, 2022 *(Krynica– Zdrój. City map).*

Lądek–Zdrój. Plan miasta i mapa okolic. City Map and Vicinity. 1: 15,000. Collective elab. Kraków: Compass, 2019 *(Lądek–Zdrój. Town map and vicinity).*

Legnica. Plan miasta + 3: Bolesławiec, Głogów, Lubin. 1: 15,000. Collective elab. Warszawa: Demart SA, 2021 *(Nowy Sącz. City map +3 town maps: Bolesławiec, Głogów, Lubin).*

Lublin. Plan miasta +5: Kraśnik, Lubartów Łęczna, Puławy, Świdnik. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 (*Lublin. City map +5 town* maps: *Koronowo, Nakło n. Notecią, Soleck Kujawski, Tuchola, Żnin).*

Łódź. Plan miasta. 1: 21,000. Collective elab. Warszawa: Demart SA, 2021 (*Łódź. City map).*

Nowy Sącz. Plan miasta + 9: Gorlice, Grybów, Krościenko, Krynica–Zdrój, Limanowa, Muszyna, Piwniczna–Zdrój, Stary Sącz, Szczawnica. 1: 18,000. Collective elab. Warszawa: Demart SA, 2021 *(Nowy Sącz. City map + 9 town maps: Gorlice, Grybów, Krościenko, Krynica–Zdrój, Limanowa, Muszyna, Piwniczna–Zdrój, Stary Sącz, Szczawnica).*

Nowy Targ. Plan miasta + 3: Mszana Dolna, Rabka–Zdrój, Zakopane. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 *(Nowy Targ. Town map + 3 town maps: Mszana Dolna, Rabka–Zdrój, Zakopane).*

Olsztyn. Plan miasta +6: Kętrzyn, Lidzbark Warmiński, Mrągowo, Nidzica, Ostróda, Szczytno. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 (*Olsztyn.* City *map +6 town maps: Kętrzyn, Lidzbark Warmiński, Mrągowo, Nidzica, Ostróda, Szczytno).*

Opole. Plan miasta + 3: Nysa, Krapkowice, Strzelce Opolskie. 1: 17,000. Collective elab. Warszawa: Demart SA, 2021 *(Opole. City map + 3 town maps: Nysa, Krapkowice, Strzelce Opolskie).*

Oświęcim. Plan miasta + 3: Brzeszcze, Chełmek, Libiąż. 1: 15,000. Collective elab. Warszawa: Demart SA, 2020 *(Oświęcim. Town map + 3 town maps: Brzeszcze, Chełmek, Libiąż).*

Piotrków Trybunalski. Plan miasta + 4: Bełchatów, Rawa Mazowiecka, Skierniewice, Tomaszów Mazowiecki. 1: 20,000. Collective elab. Warszawa: Demart SA, 2021 *(Piotrków Trybunalski. City map + 4 town maps: Bełchatów, Rawa Mazowiecka, Skierniewice, Tomaszów Mazowiecki).*

Płock. Plan miasta + 2: Kutno, Włocławek. 1: 18,000. Collective elab. Warszawa: Demart SA, 2019 *(Płock. City map + 2 town maps: Kutno, Włocławek).*

Poznań. Plan miasta. 1: 20,000. Collective elab. Warszawa: Demart SA, 2022 *(Poznań. City map).*

Rybnik. Plan miasta + 5: Pszów, Radlin, Rydułtowy, Wodzisław Śląski, Żory. 1: 25,000. Collective elab. Warszawa: Demart SA, 2021 *(Rybnik. Town map + 5 town maps: Pszów, Radlin, Rydułtowy, Wodzisław Śląski, Żory).*

Rymanów–Zdrój i okolice. Plan miasta. City Map and Vicinity. 1: 20,000. Collective elab. Kraków: Compass, 2021/2022 *(Rymanów–Zdrój. City map).*

Rzeszów. Plan miasta +3: Biecz, Jasło, Krosno. 1: 15,000. Collective elab. Warszawa: Demart SA, 2021 (*Rzeszów.* City *map +3 town* maps: *Biecz, Jasło, Krosno).*

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Szczyrk i okolice. Plan miasta. Town Map and Vicinity. 1: 10,000. Collective elab. Kraków: Compass, 2021/2022 *(Szczyrk. Town map and vicinity).*

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Toruń. Plan miasta + 4: Brodnica, Chełmża, Ciechocinek, Inowrocław. 1: 18,000. Collective elab. Warszawa: Demart SA, 2021 *(Toruń. City map + 4 town maps: Brodnica, Chełmża, Ciechocinek, Inowrocław).*

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