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Aim and scope

Series „Administratio Locorum" is concerned with the social, economic, geographic, legal, environmental and planning aspects of land administration. The aim of the journal is to provide an interdisciplinary platform for the exchange of ideas and information among scientists representing various disciplines, whose ideas and discoveries tribute to effective land administration. Thus, journal publishes both reviews and empirical studies presenting the results of surveys and laboratory works. Topics covered by our Authors include, i.e.: land administration, technical and social infrastructure, spatial economics, social-economic geography, land management, real estate management, rural areas, environmental protection, protection of historical buildings, spatial planning, local and regional development, sustainable development, urban studies, real estate market, transport systems, legal regulations for the land administration, and spatial management.
The primary aim of the journal and its mission are to spread information and guidance relevant both for authorities responsible for the effective land administration (local, regional and central), scientists and teachers.

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ul. Jana Heweliusza 14, 10-718 Olsztyn, Poland

e-mail: wydawca@uwm.edu.pl, www.uwm.edu.pl/wydawnictwo/

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A LAND CONSOLIDATION GEOPORTAL AS A USEFUL TOOL IN LAND CONSOLIDATION PROJECTS – A CASE STUDY OF VILLAGES IN SOUTHERN POLAND

Izabela Basista[1]✉, Monika Balawejder[2]✉, Anna Kuchta[3]✉

[1] ORCID: 0000-0002-0820-5380
[2] ORCID: 0000-0001-7515-1557
[1,3] AGH University of Science and Technology
Mickiewicza Street, 30, 30-059 Kraków, **Poland**
[2] State University of Applied Sciences in Jaroslaw
Czarnieckiego Street, 16, 37-500 Jarosław, **Poland**

ABSTRACT

Motives: The area of consolidated land plots as well as numerous social and legal factors prolong and complicate land consolidation projects. Land consolidation projects require massive investment and the involvement of consolidation experts and all landowners. The required information can be made available online to streamline this process. The data available in an online map portal can be used to perform visual and substantive analyses of spatial changes in land consolidation projects.
Aim: This study addresses the issues related to the design of a map portal for a land consolidation project covering villages in southern Poland. The proposed geoportal will support communication between land consolidation participants and surveyors.
Results: The geoportal is available at: https://arcg.is/15Wirj1, and it provides users with access to information about the land consolidation project. Portal users can submit their opinions and objections online.

Keywords: web map, social communication, land consolidation, online services, Poland

INTRODUCTION

Recent years have witnessed significant social and economic changes in Poland (Bieda et al., 2014; Buśko et al., 2022; Pawlikowska et al., 2017). These changes were undoubtedly driven by the European Union funds which supported the development of many cities and villages. Land consolidation is one of the most effective measures which supports the restructuring and modernization of rural areas (Basista & Balawejder, 2020). The first law regulating the process of land consolidation in Poland was the Law of 1923, and land consolidation has been performed in rural areas for almost 100 years (Balawejder et al., 2021).

Land consolidation and land exchange became priority measures in land management to improve land-use conditions in agricultural and forest areas. The main objective of land consolidation is to reduce the number of land plots in a farm and to provide

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

them with access to a public road (Harasimowicz et al., 2021; Janus & Ertunç, 2023). The high fragmentation of land plots, especially in southern Poland, calls for urgent land consolidation measures (Balawejder & Leń, 2016; Cienciała et al., 2022; Gniadek et al., 2017; Janus, 2018; Janus & Taszakowski, 2018; Noga et al., 2017; Stręk & Noga, 2019). According to the literature, excessive land fragmentation is a problem that affects many countries, including Bulgaria (Di Falco et al., 2010; Moteva, 2020), in the Republic of Belarus (Hrybau et al., 2022), Cyprus (Demetriou, 2016), Czech Republic (Sklenicka, 2016), Estonia (Jürgenson, 2016), Finland (Hentunen & Konttinen, 2022), Hungary (Cegielska et al., 2018), Latvia (Jankava et al., 2014), Lithuania (Pašakarnis & Maliene, 2010), the Netherlands (Stańczuk-Gałwiaczek et al., 2018), Slovakia (Muchová & Petrovič, 2019), Spain (Touriño et al., 2003), Turkey (Boztoprak et al., 2016), and Ukraine (Martyn et al., 2022).

The area covered by land consolidation and land exchange projects, as well as numerous social and legal factors prolong and complicate the implementation of these projects (Balawejder & Noga, 2016; Çoruhlu et al., 2019; Janečková Molnárová et al., 2023; Yin et al., 2022). Land consolidation projects require massive investment and the involvement of consolidation experts and all landowners. To streamline this process, various solutions should be considered to identify the participants of the consolidation project (Basista, 2013). The required information can be made available online to facilitate the process. Online data can be used to perform in-depth analyses of spatial changes in individual cadastral units.

A map portal aggregating land data would support both visual and factual analyses of spatial changes. In an era of widespread Internet access, interactive maps are becoming increasingly popular (Bieda et al., 2021). Interactive maps differ in scope and subject matter, ranging from national services presenting geodetic and cartographic data, through administrative geoportals of individual municipalities and counties, to thematic maps relating to various industries (Çoruhlu & Çelik, 2022; Dawidowicz et al., 2022; Dudzińska et al., 2020; Ogryzek et al., 2020).

During a consolidation project, surveyors meet with landowners several times to appraise their land, inquire about the desired location of their land, present the consolidation project, or consider the landowners' objections to the project. However, it is often the case that the interested parties are unable to attend the meeting to review the land consolidation draft, or need more time to analyse the proposed changes. In addition, the communication process during land consolidation can be disrupted by factors that remain beyond the parties' control, as was the case during the recent COVID-19 pandemic. This problem could be resolved by making land consolidation drafts available online in a dedicated geoportal.

An analysis of the literature indicates that most of the institutions involved in land consolidation do not make scale projects available, and projects that are made available consist only of raster images in pdf format. Consolidation drafts do not contain personal data; therefore, they can be made available online without violating legal regulations. However, the access to the geoportal can be restricted to a specific group of users.

Various IT solutions (Bacior et al., 2019), especially geographic information systems (GIS) (Çelik & Yakar, 2023; Coruhlu et al., 2022), have been proposed to support the land consolidation process (Basista, 2015, 2020; Cui et al., 2022; Dou et al., 2007; Jiang et al., 2021; Touriño et al., 2003). However, these solutions have been designed specifically for planning the structure of rural areas (Dudzińska et al., 2018), without taking into account the accessibility of information for landowners participating in consolidation projects. A limited number of online maps supporting the land consolidation process have been described in the literature, but they are based on other web solutions and do not enable the participants to submit objections (Basista, 2013).

In this study, an online map portal was developed for a land consolidation project in the villages of Słupia Jędrzejowska (Słupia) and Wielkopole in Poland. This land consolidation geoportal was designed to support communication between landowners and surveyors. The map portal was developed based

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

on data from a land consolidation exercise. However, the actual land consolidation geoportal was not used in this process. The geoportal can be accessed at: https://arcg.is/15Wirj1, and it provides users with access to information about the land consolidation project. Portal users can submit their opinions and objections online.

STUDY AREA

The map portal for the land consolidation project covers the area of two cadastral districts: Słupia Jędrzejowska (Słupia) and Wielkopole. These districts belong to the cadastral unit of Słupia in Jędrzejów county, Świętokrzyskie Voivodeship, Poland (Fig. 1).

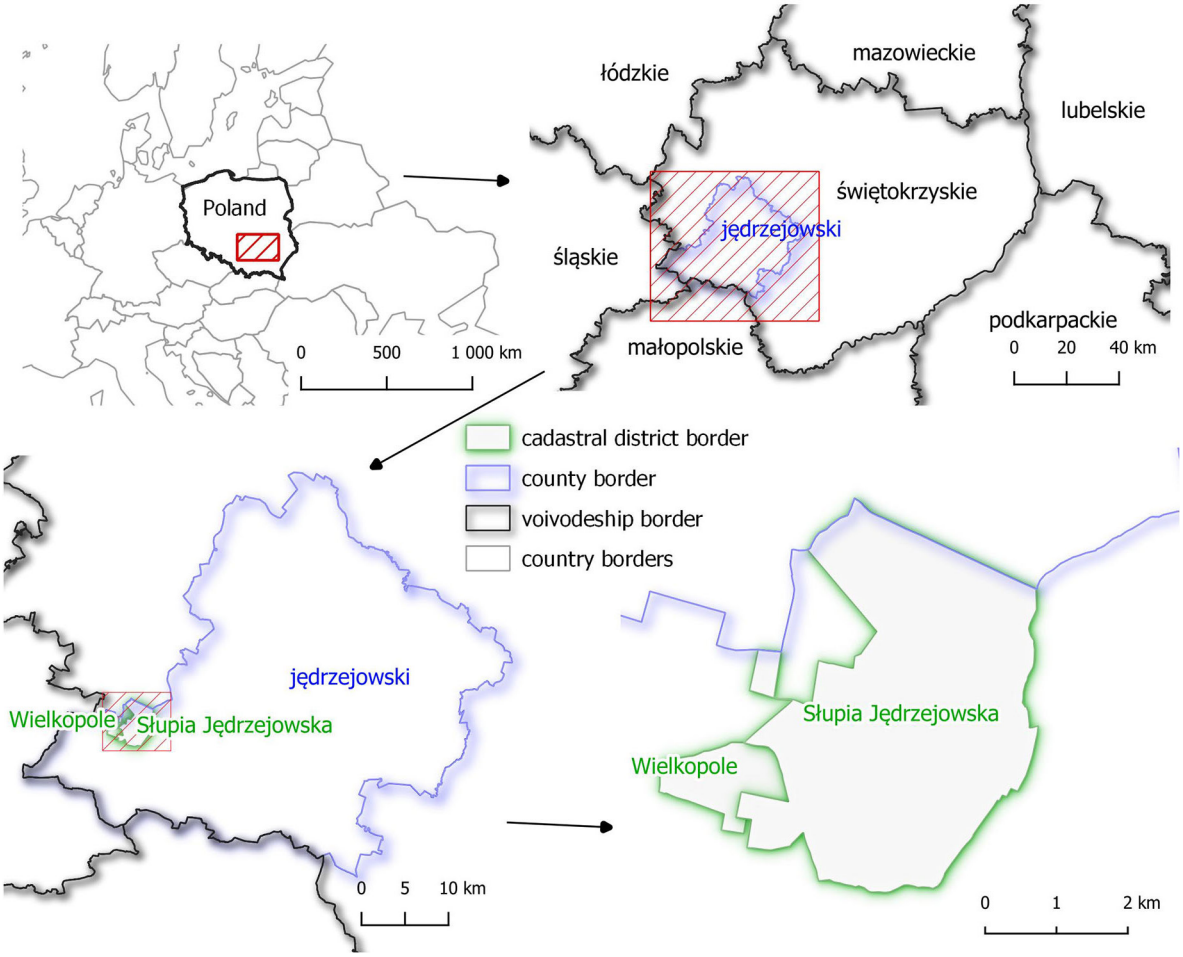

Fig. 1. Location of the area covered by the land consolidation project
Source: own elaboration.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

The Słupia cadastral unit has an estimated area of 1,447.5 ha, and the Wielkopole cadastral unit has an estimated area of 130.5 ha. The land consolidation project was conducted over a period of 5 years, from 2015 to 2020. The number of plots decreased by 31.7%, from 1,720 before consolidation to 1,175 plots after consolidation.

METHODS

The geoportal was developed with the use of data acquired from the Department of Geodesy and Agricultural Land of the local branch of the Małopolska Voivodeship Office in Tarnów which conducts consolidation works in Małopolska. The data were acquired in two formats: shapefile and dgn. The following information was obtained: location of land plot boundaries before and after consolidation (shapefile format), location of buildings (dgn format), and land-use boundaries (dgn format). Spatial data were recorded in the PL-2000 coordinate system, zone 7 (EPSG code: 2178) (Maciuk et al., 2023).

Five layers of data were generated for the needs of the developed geoportal:

1. land plots before consolidation and exchange process (current state);
2. land plots after consolidation and exchange (planned);
3. land use before consolidation and exchange (current state);
4. land use after consolidation and exchange (planned);
5. buildings.

The acquired data were imported into the file geodatabase (Fig. 2). The topology of buildings in each layer was checked and corrected during data preparation. Redundant fields in the layer attribute table were removed. The names of individual columns were changed to improve readability and facilitate data analysis by geoportal users.

The development of the land-use layer was the most time-consuming task (Fig. 3). The layer had to be prepared based on the boundaries of the designed plots and the existing land-use classes. All land-use boundaries were moved to the boundaries of the designed plots. The snapping tool was used to maintain the proper topology of objects.

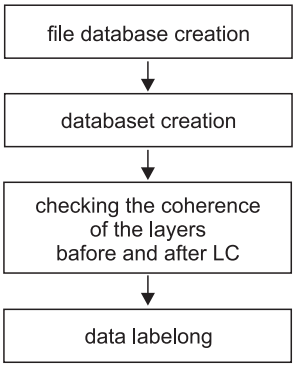

Fig. 2. General diagram for the preparation of layers
Source: own elaboration.

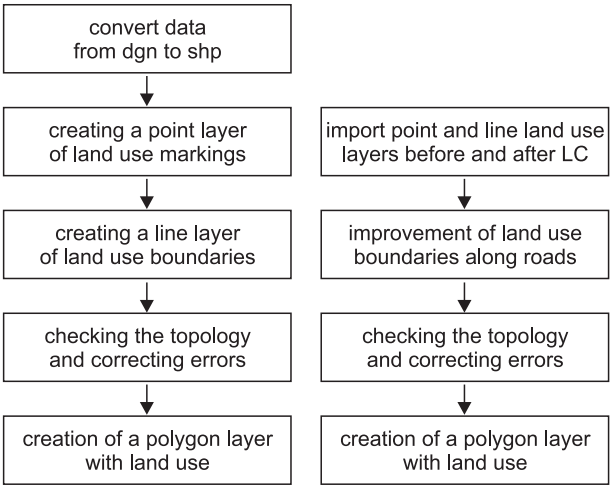

Fig. 3. General diagram of land-use layers. The layers for the existing plots are presented in the left column, and the layers for the designed plots are presented in the right column
Source: own elaboration.

This classification proved to be very problematic because some of the newly created roads divided land-use classes into two or more parts (Fig. 4). In addition, the location of many agricultural roads was corrected, and the boundaries of neighbouring land-use areas had to be snapped (Fig. 5).

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

Fig. 4. Error correction in the land-use layer. Improvement of the land-use layer (red colour) to the parcel layer (black colour) *Source*: own elaboration.

Fig. 5. Error correction in the land use layer. Improvement of the land use layer (red colour) to the parcel layer (black colour) *Source*: own elaboration.

A spatial intersection GIS tool was used in the initial step to create new layers showing cadastral units and their estimated values before and after land consolidation. Parcel and land-use layers were intersected to obtain a single layer containing the numbers of cadastral units and land-use values in each of the obtained fragments of these units. To obtain the estimated values of land in a given cadastral unit, a "Value" column was created in the attribute table of the newly created layers from the spatial intersection. The estimated values of all unit fragments were then calculated with a field calculator (by multiplying land-use values by land area). All parts of cadastral units were combined by summing up the land area and all fragment values based on the field with the numbers of cadastral units.

The resulting layer was generated in the form of tables containing 631 cadastral units before land consolidation and 644 units after land consolidation. Information about the total area and the estimated value of all land plots in cadastral units was provided for each object. An aggregation GIS tool was used to obtain a polygon class of objects for cadastral units. This was done based on a layer of plots, where the number of cadastral units was indicated in the aggregation field. In the final step of the process leading to the creation of an optimal layer of cadastral units, the polygon layer created by aggregation was merged with the generated table of estimated values based on the common field in the attribute tables (number of cadastral units) (Fig. 6). Information about the area and estimated value of the entire cadastral

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

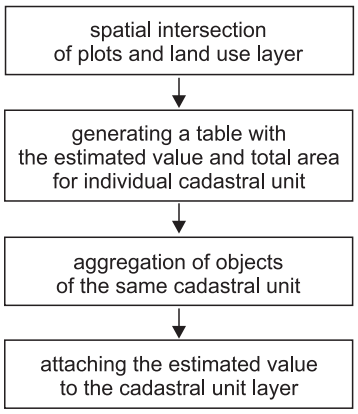

Fig. 6. General diagram for creating layers with cadastral units
Source: own elaboration.

unit is displayed in a pop-up window when the user selects a plot belonging to a given cadastral unit.

The resulting object layers presenting cadastral units before and after the land consolidation process are polygons that contain all land plots in a given unit. When a plot is selected, other plots in the same unit are automatically highlighted. The layer attribute table includes information about the area and the estimated value of the entire cadastral unit.

Development of a Land Consolidation Map Portal

The land consolidation geoportal was developed with the use of Web AppBuilder and Survey123 applications available from the ArcGIS Online service. A web application presenting spatial data was prepared in several steps. First, a map (Web Map) was created using the Map Viewer application as the basis for the geoportal. Next, a website was created in the Web AppBuilder application containing the base map (Web Map) and a set of necessary widgets. To enable future users to submit their objections to the land consolidation project, a survey was developed in Survey123, and it was attached to the land consolidation portal. Figure 7 presents the services and applications used in the process of developing a map portal for the land consolidation project in Słupia and Wielkopole.

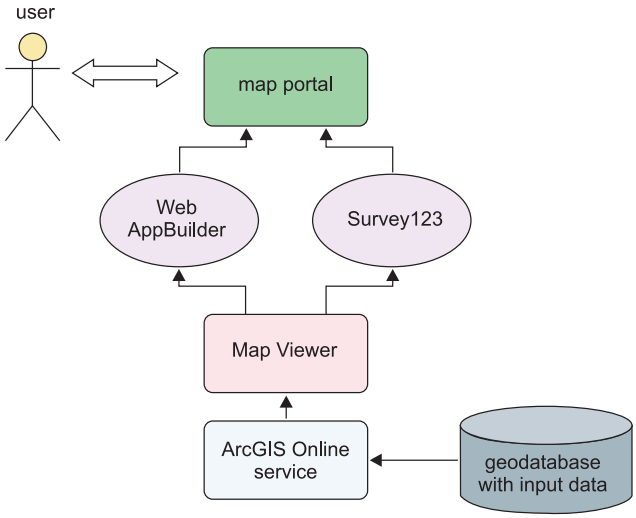

Fig. 7. Diagram of the process of developing a map portal
Source: own elaboration.

In the first step, two base maps were prepared as the main elements of the geoportal. The first base map (Web map) contains the map base (topographic map) and the previously generated layers:
- buildings;
- land plots before consolidation;
- land plots after consolidation;
- land use before consolidation (double layer for large-scale and small-scale visualisation);
- land use after consolidation (double layer for large-scale and small-scale visualisation).

Subsequently, pop-up windows displaying object information were configured for each layer. When all layers were enabled, only parcel information was displayed when an object was selected. The objects were provided with the appropriate symbols, and a range of scales for displaying individual objects and their labels was established. The map has several zoom levels. Double layers were added for land-use classes to ensure that the presented geographical information is legible. Objects were displayed on a smaller scale for illustrative purposes only; therefore, they were not labelled, and information on individual land-use classes was included in the legend. Labels and land use symbols are displayed (second layer with land-use classes) by zooming in on the map view.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

A similar approach was used to create the second base map (Web Map) displaying cadastral units before and after consolidation. Four layers were added to the map viewer:
– cadastral units before consolidation;
– cadastral units after consolidation;
– land plots before consolidation;
– land plots after consolidation.

The purpose of the second base map was to facilitate the analysis of gains and losses resulting from the land consolidation process. The map contains information about the location of all parcels in each cadastral unit, as well as their estimated value and total area. Parcel layers were added to the map for illustrative purposes only, and they are disabled by default in the application. These layers are displayed at a scale of 1:5,000 and smaller. The layers were provided with the same symbols as those applied in the first base map. The pop-up windows in each layer were configured to display only information about a selected object in a cadastral unit when all layers are enabled.

The Web Map application was used to develop two key maps: the master map which constitutes the basis of the land consolidation geoportal, and a map of cadastral units which facilitates an analysis of gains or losses resulting from the consolidation procedure.

In the next stage, the created base maps were used to develop two web applications in Web AppBuilder. The first application enables the users to conduct a visual and factual analysis of land plots/land-use classes before and after consolidation. The application features various tools for viewing, searching and analysing objects, including *zoom in/zoom out, home (default view), my location, legend, layer list, overview map*, *coordinates, scale, search tool, compare before/after, measure, filter, base map gallery,* and *print*. The second application is based on a map of cadastral units, and it features only the necessary widgets – *zoom in/zoom out, home (default view), my location, legend, layer list, overview map, coordinates, scale, search tool,* and *compare before/after*. Object information was provided in two different applications to ensure the legibility of the final map portal.

In the subsequent step, a survey was developed with Survey123 to obtain feedback from geoportal users who are land consolidation participants. The respondents can submit their objections to the consolidation project and to mark the appropriate location on the map.

In the last step, three applications were developed: the main map ("Land consolidation web map – Słupia and Wielkopole"), a map of cadastral units ("Cadastral units"), and a questionnaire survey enabling the participants to submit their objections to the consolidation project ("Objections to the consolidation project"). The main map contains a link to the map of cadastral units and the survey, and the map of cadastral units contains a link to the main map and the survey. The links ensure seamless transition between applications.

RESULTS

The developed geoportal supports communication between land consolidation participants and surveyors (consolidation contractors). The homepage of the application, where maps with parcel and land-use layers can be compared before and after land consolidation, is presented in Figure 8. In the default map view, only graphic land-use symbols are displayed on a scale smaller than 1:7,000, and they are not labelled. This solution was adopted to preserve legibility. In addition, all widget icons are displayed in the user's line of sight. The scale and the coordinates are displayed in the bottom left corner, and the overview map is displayed in the bottom right corner. The legend and the list of layer icons are displayed in the top right corner, and the remaining tools are displayed on left side.

When the user zooms in gradually on the map view, other layers that can be viewed on a larger scale are displayed. In Figure 9, the objects are shown on a scale larger than 1:4,500. All layers are displayed with the accompanying labels. Graphic land-use symbols were replaced by no-fill land-use symbols to improve the legibility of data display.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

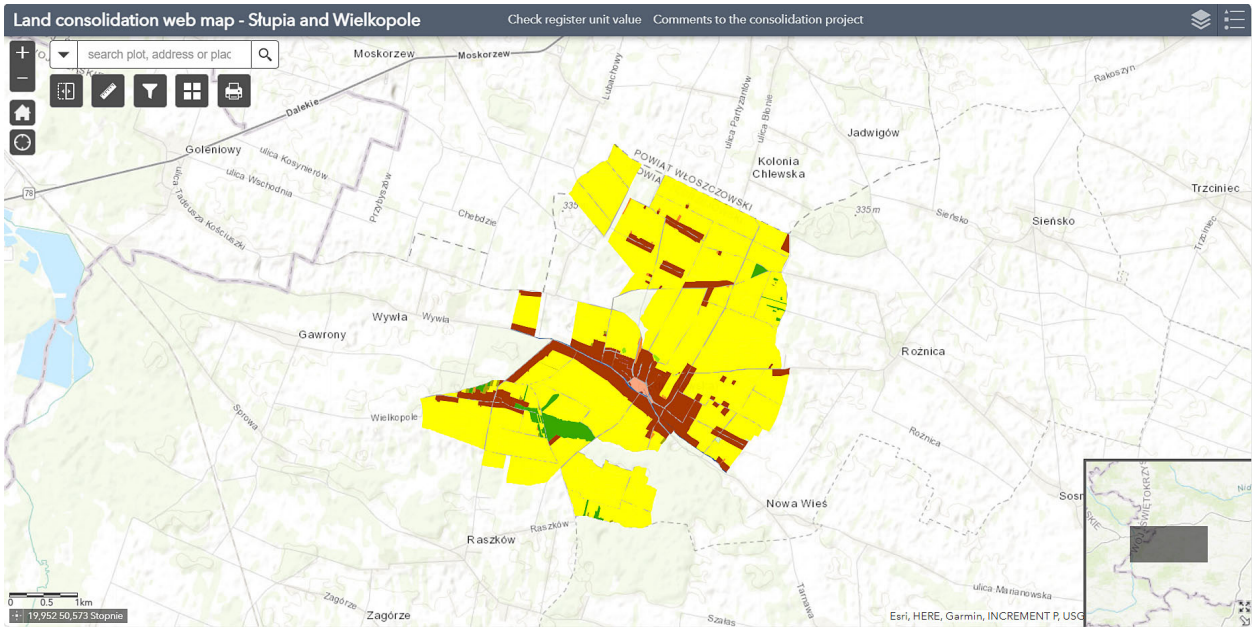

Fig. 8. Homepage of the land consolidation map portal
Source: own elaboration.

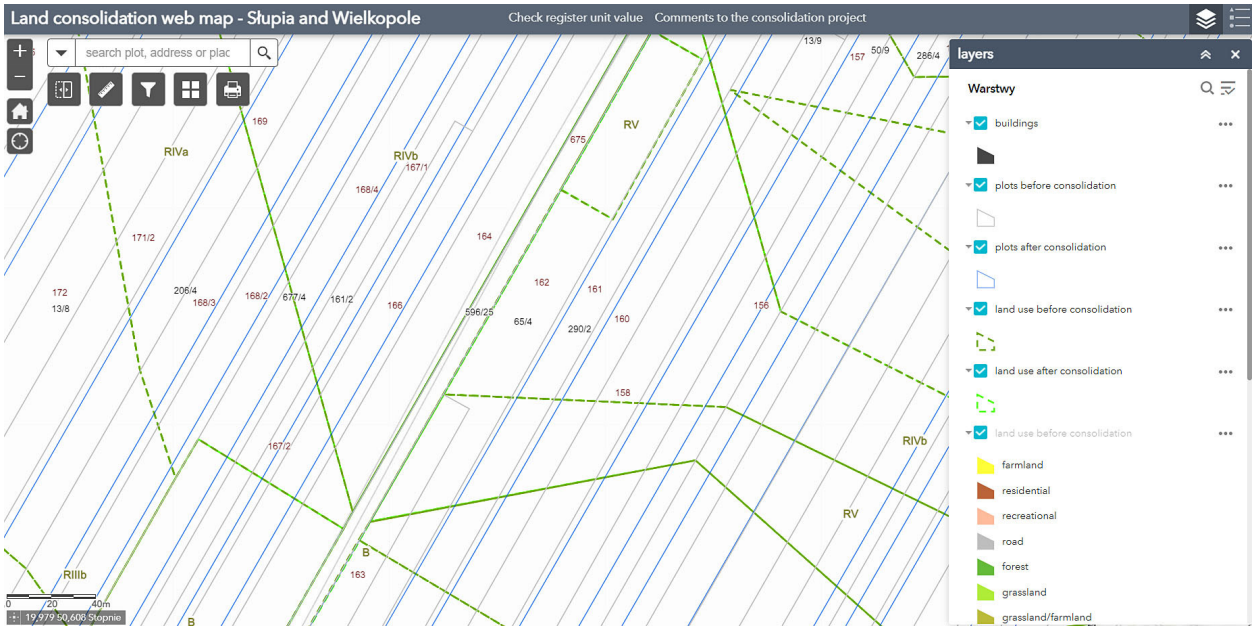

Fig. 9. Zoom-in view of the map on the homepage of the land consolidation geoportal
Source: own elaboration.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

Pop-up windows are presented in Figure 10. A pop-up window containing information about a given object is displayed with the user hovers the cursor over a selected land plot.

The functionality of the map portal has been enhanced by adding widgets. In addition to the standard view navigation tools (*zoom in/zoom out, home (default view)* and *my location*), *search*, *compare before/after* (slider for comparing objects), *measure, filter, base map gallery* and *print* tools are displayed in the top left corner. The search function enables the user to find specific addresses, places, and plots on the map, based on plot numbers before and after land consolidation (Fig. 11).

The *compare-before/after* widget is a quick and convenient tool for comparing land plots before and after consolidation with the use of a moving slider (Fig. 12).

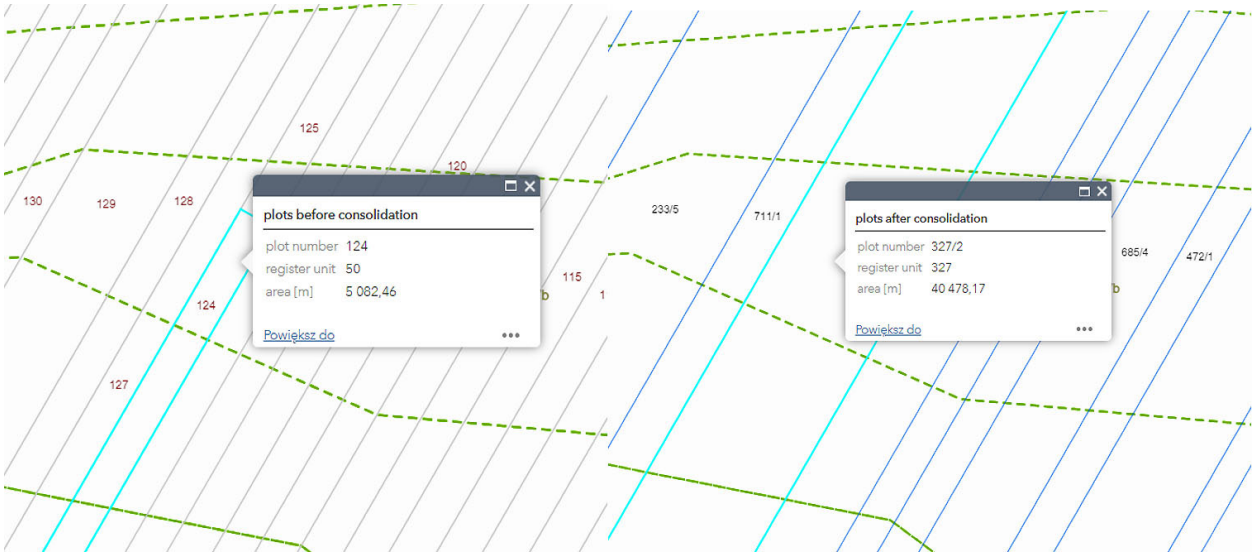

Fig. 10. Comparison of plots using pop-up windows
Source: own elaboration.

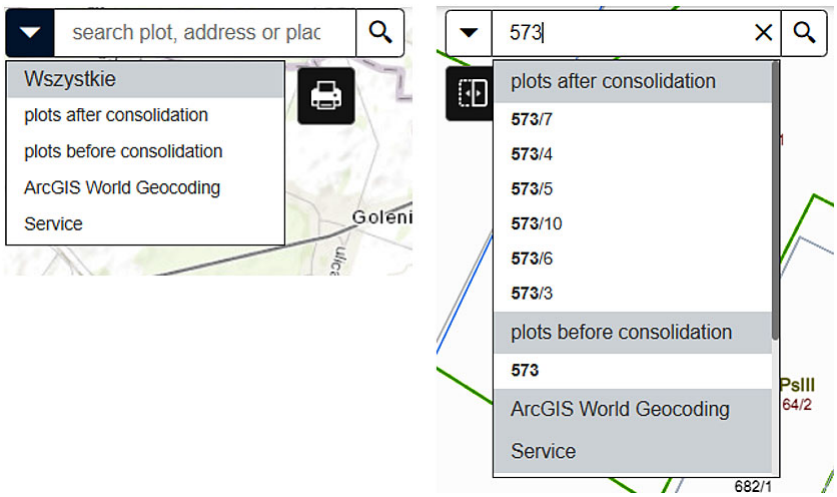

Fig. 11. Object search tool
Source: own elaboration.

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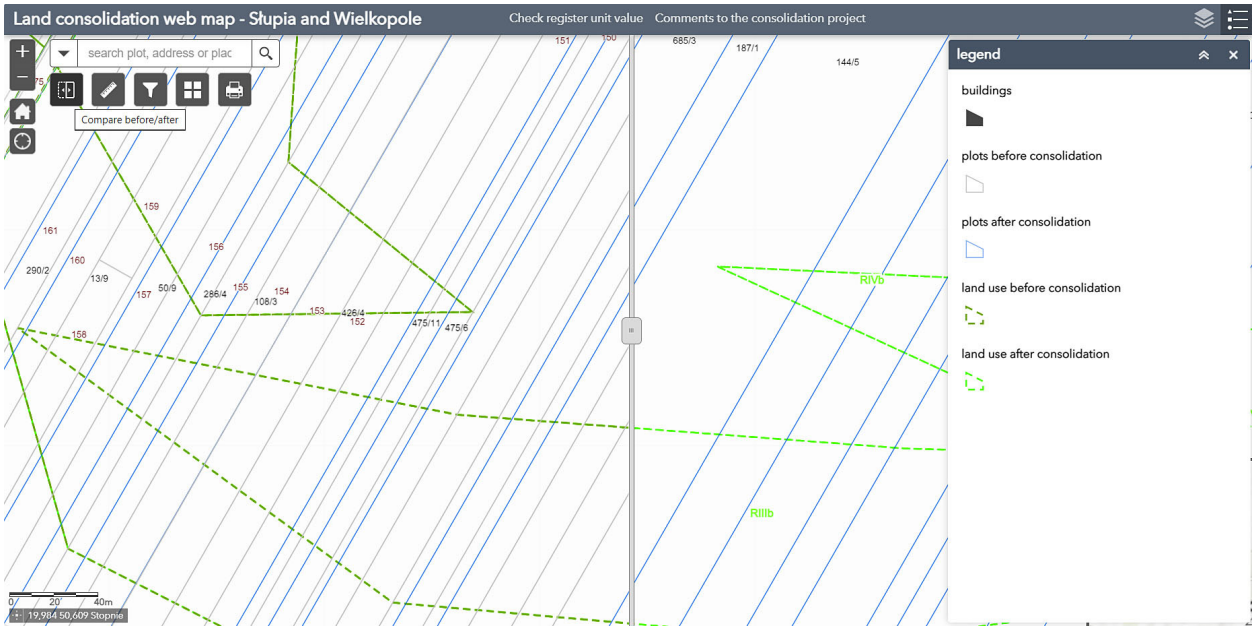

Fig. 12. *Compare before/after* tool
Source: own elaboration.

The *measure* tool enables the user to determine the area, length and coordinates on the map. The *filter* widget displays land plots in a selected cadastral unit based on the number of the cadastral unit entered by the user. The *base map gallery* contains a large collection of base maps that can be used as a reference. The current map view can be saved in pdf format with the use of the *print* tool.

The geoportal header features two links: "Check cadastral unit value" and "Objections to the consolidation project". By clicking on the "Check cadastral unit value" link on the homepage, the user opens an application displaying cadastral units before and after consolidation, including information about their area and estimated value (Fig. 13).

The application interface features fewer options than the homepage. By default, only the layers presenting cadastral units before and after land consolidation are displayed. The legend also includes the parcels, but these are blanked out by default. The *compare before/after* widget on the left can be used to compare cadastral units before and after consolidation.

The main purpose of this portal is to compare the point values of individual cadastral units to analyse the gains/losses resulting from the land consolidation process (Fig. 14).

The "Objections to the consolidation project" redirects the user to the survey (Fig. 15). The survey questionnaire consists of two elements: a description field, where the user enters objections to the project, and a map field, where the area in question can be marked.

The submitted objections are reviewed by surveyors with the use of Survey123. All objections are presented in the form of an interactive list. A number of tools are available for identifying users, objections, and locations that the objections refer to (Fig. 16). The survey application enables users to express their opinions and comments on the preliminary design of the land consolidation project. All geoportal users participating in the consolidation process will be provided with login/authentication details.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

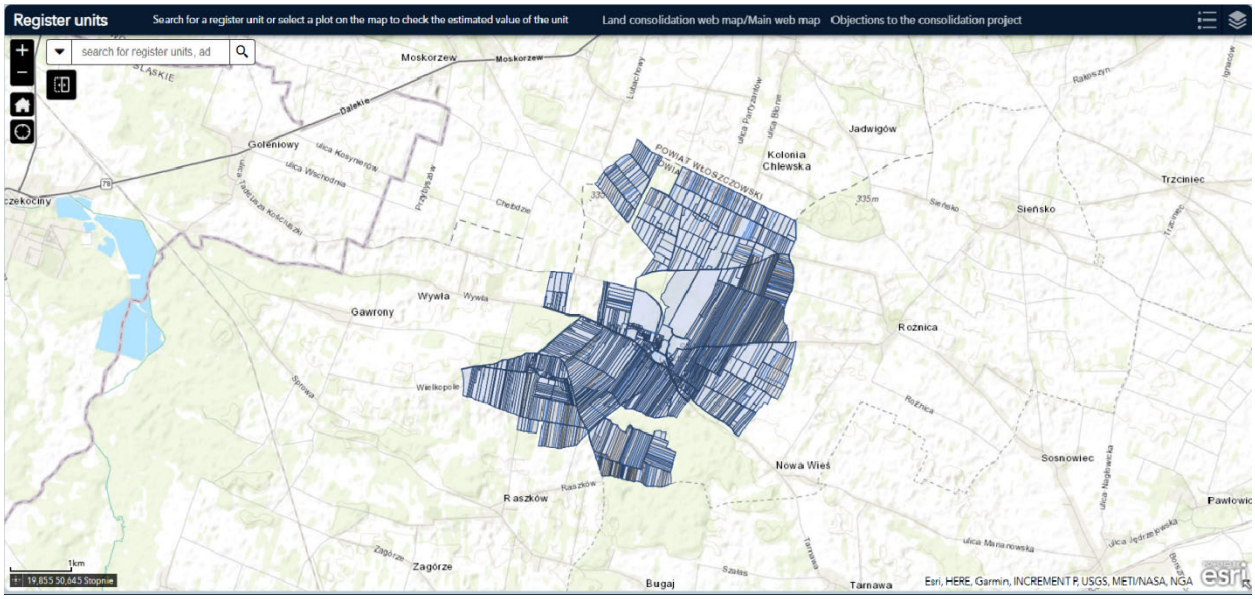

Fig. 13. Homepage of the web application presenting cadastral units
Source: own elaboration.

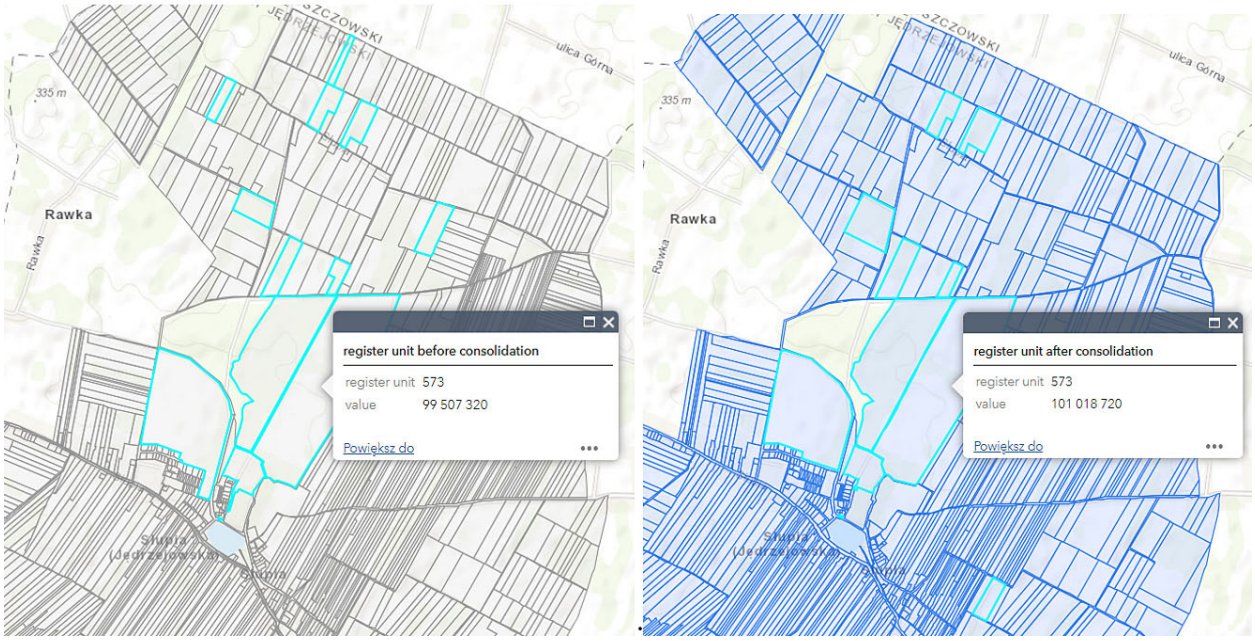

Fig. 14. Comparison of cadastral units before and after land consolidation
Source: own elaboration.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

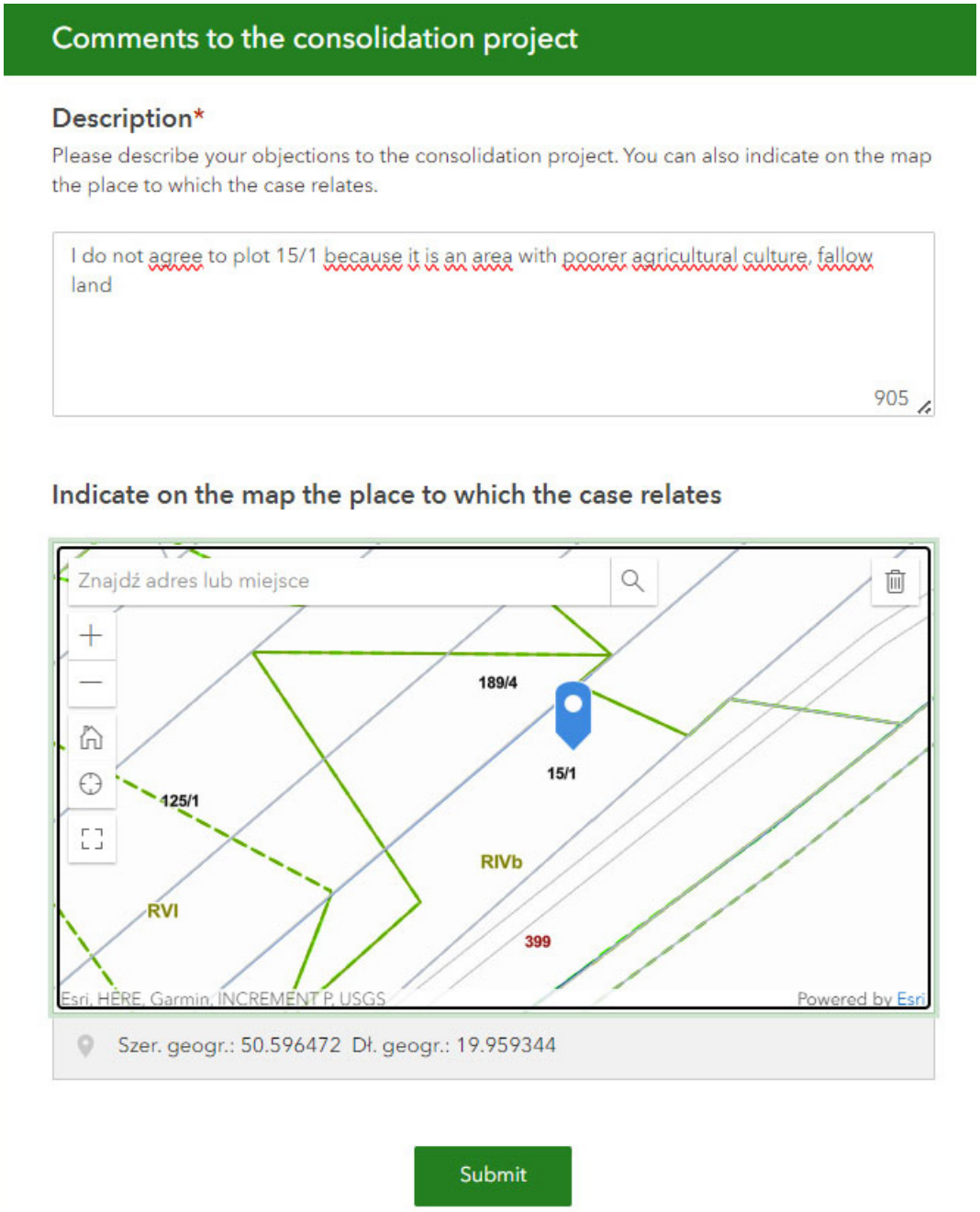

Fig. 15. View of the survey window for submitting objections to the consolidation project
Source: own elaboration.

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

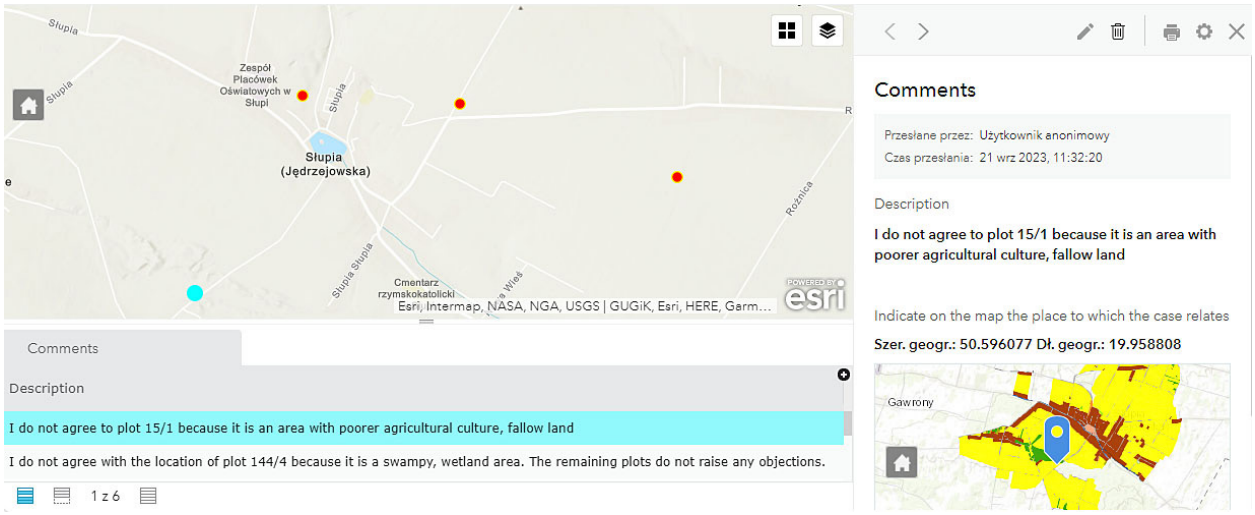

Fig. 16. View of the survey window for submitting objections to the consolidation project. A number of tools are available for identifying users, objections, and locations that the objections refer to

Source: own elaboration.

DISCUSSION

In Poland, land consolidation projects have been implemented for 100 years based on the legal regulations adopted in 1923 (Balawejder et al., 2021). Land consolidation has long been regarded as the optimal land management method for resolving land fragmentation problems and improving land cultivation practices (Jiang et al., 2021, 2022). Land consolidation decreases the cost of farming operations by improving the system of agricultural roads (Janus & Ertunç, 2023; Warchoł & Balawejder, 2022). Modern land consolidation practices have been introduced over the years (Li & Song, 2023). The Internet is not only as an additional channel for distributing information, but also a means of interactive communication (Hącia & Łapko, 2023). In an era of widespread Internet access, map portals are a functional and transparent way of presenting reality (Dawidowicz & Kulawiak, 2018; Izdebski, 2022; Senetra et al., 2023). Geoportals facilitate browsing, and they enable users to analyse and search for multidimensional information about space. Therefore, a land consolidation geoportal is an excellent solution that can significantly improve the efficiency of this process (Basista, 2020). The access to an online land consolidation geoportal could increase public interest in land consolidation (Dudzińska, 2016). Various IT solutions (Bacior et al., 2019), especially GIS (Çelik & Yakar, 2023; Coruhlu et al., 2022), have been proposed to support the land consolidation process (Basista, 2015, 2020; Cui et al., 2022; Dou et al., 2007; Touriño et al., 2003). However, these solutions have been designed specifically for planning the structure of rural areas (Dudzińska et al., 2018), without taking into account the accessibility of information for landowners participating in consolidation projects. A limited number of online maps supporting the land consolidation process have been described in the literature, but they are based on other (than those described in this study) web solutions and do not enable the participants to submit comments on consolidation projects (Basista, 2013).

CONCLUSIONS

The study presents the process of designing and implementing a map portal for a land consolidation project in villages in southern Poland: Słupia Jędrzejowska (Słupia) and Wielkopole. A land consolidation geoportal was created to support communication between land consolidation participants and surveyors. The land consolidation geoportal is available

✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

at https://arcg.is/15Wirj1, and it provides users with access to information about the land consolidation project. Portal users can submit their opinions and objections online.

The main advantage the developed land consolidation portal is that it provides users (landowners participating in a land consolidation project) with quick and easy access to information about the distribution of land plots in cadastral units, before and after consolidation. The map portal developed for the purpose of land consolidation is based entirely on commercial ESRI software that requires the purchase of a license. The applications and tools available on the ArcGIS Online platform do not require installation and are available from a web browser.

The ArcGIS Online environment meets the current requirements because it enables users to browse or search for individual objects. This fully functional tool contains windows that are tailored to the users' individual needs. In addition, geoportals do not have to be designed or administered by IT experts or individuals with computer programming skills. Service users can rely on templates that have been previously developed by experts. Geoportal designers are tasked only with selecting tools and functions to be included in the map portal. The map portal has been developed for research purposes. Data from a real-life consolidation project that was carried out in 2015–2020 was used in the study, but the developed geoportal was not used in that project. However, the proposed geoportal can be applied in real-life consolidation projects by replacing the relevant data layers and providing a link to the geoportal on the website of the company implementing the land consolidation process. The participants would be able to view the prepared project and forward their comments directly to the surveyor. User accounts would have to be created, and land consolidation participants would have to be authenticated to ensure that the submitted comments are not anonymous.

The presented solution significantly facilitates communication between the parties. The purpose of the developed land consolidation geoportal was to demonstrate that a functional map portal can be developed without knowledge of a programming language. All tools and functions were discussed in detail to demonstrate the capabilities of the ArcGIS Online platform. The proposed solution was developed to raise awareness about the existing tools and their applicability in the land consolidation process. A short implementation training should be sufficient to teach project staff to use these tools in practice.

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✉basista@agh.edu.pl, ✉monika.balawejder@pwste.edu.pl

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OCCUPATIONAL MOBILITY AND THE QUALIFICATIONS OF POLISH CITIZENS

Łukasz Cywiński[1]✉, Ewa Gałecka-Burdziak[2]✉, Robert Pater[3]✉

[1] ORCID: 0000-0003-2920-3509
[2] ORCID: 0000-0001-9020-8486
[3] ORCID: 0000-0001-7619-9843
[1,3] University of Information Technology and Management in Rzeszów
Sucharskiego Street, 2, 35-225 Rzeszów, **Poland**
[2] Warsaw School of Economics
Niepodległości Avenue,162, 02-554 Warsaw, **Poland**

ABSTRACT

Motives: Little is known about the occupational mobility of Poles. In the literature, only the impact of socio-demographic factors on occupational mobility has been investigated. Occupational mobility may be influenced by educational attainment and the type of acquired qualifications, but these considerations have not been studied to date.
Aim: The article examines occupational mobility, namely changes in occupation in a person's professional history, as well as declared willingness (readiness) to change occupation within 12 months. The presented results of empirical research are based on a unique set of data collected during a CAWI survey performed on a sample of 16,119 Poles aged 18-65. An event history analysis and a logit model were used to analyse occupational mobility and its determinants.
Results: The event history analysis revealed that Poles often change their learnt occupation. The results of the logit model indicate that the occupational mobility of Poles is influenced not only by demographic factors, but also by the acquired qualifications. Occupational mobility differed among respondents who acquired their qualifications at university, in a secondary school, or through vocational training. University graduates were characterized by the highest occupational mobility. Occupation mobility was influenced not only by educational attainment, but also by the type of acquired qualifications. Occupational mobility was highest among services and humanities graduates, and lowest among education and health graduates. Moreover, we found no evidence of significant spatial differences in occupational mobility in Poland.

Keywords: labour market, occupational mobility, qualifications

INTRODUCTION

Intensive labour mobility is often considered to affect the labour market positively because it allows the labour supply to adapt more readily to changing conditions from the demand side of the market. A change of occupation, however, comes with a high opportunity cost (vom Lehn et al., 2019). On one hand, job-takers forgo the benefits of the intellectual capital accumulated from the previously learnt occupation.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

On the other hand, they must quickly assimilate to learn the qualifications necessary for the new job. This trade-off is one of the main reasons why job takers' adjustment to new demand conditions takes such a long time.

In the economic literature, occupations are repeatedly used to explain a wide range of economic phenomena – for example, the development of modern technologies or changes in international trade. In the case of international trade, the liberalisation of world trade causes lower-wage pressure (Ebenstein et al., 2014). In the case of technology, occupations can be grouped according to routine and non-routine tasks, and this can be used to assess the chance of replacing work with technology (Acemoglu & Autor, 2010).

Job-takers choose occupations based on the acquired level of education and accumulated human capital (e.g. through training), and match their skills with tasks performed in the specific occupations (Lin, 2019). Economists sometimes point out that regarding the matching process, there are more questions than explainable answers. For instance, Maczulskij (2019) points out that we do not know the implication of the popularity of work[1], especially on the individual level and for occupations requiring less knowledge. The empirical findings indicate that for the occupational mobility of routine workers, upward mobility is more commonly observed than downward mobility [2].

The empirical studies of occupational mobility are not a popular topic of economic research, mainly due to the unavailability of data[3]. In this research, we present findings based on a relatively large survey dataset. We define occupational mobility as a real change of occupation in the active employment history of a respondent, and as a declared willingness (readiness) to change their occupation (Kucharski, 2014, p. 93). This readiness has multiple determinants, including those of a random nature (cultural or institutional).

Our work aims to explore the real mobility scale of Poles, and to deepen our knowledge about the determinants of a willingness (readiness) for occupational mobility. To achieve this goal, the research is divided into two parts. The first one is based on the event history analysis (the sequence of mobility). The main question this part addresses is related to performing a learnt occupation: Is it occurring commonly in the Polish economy? We also tried to determine in what stages of the professional career Poles are more likely to change occupation, and whether this includes change within major occupational groups.

Next, we inspect the factors that determine the propensity for occupational mobility. For this, we utilize a method based on the logit model, which allows us to examine demographic factors and regional differentiation (analysis on the voivodeship level). Our main contribution is connected with the analysis of occupational and qualification mobility. We deepen knowledge of how qualifications determine occupational mobility. This is done in two dimensions – levels and fields of qualifications according to the International Standard Classification of Education ISCED-F 2013. The main argument for using this nomenclature is that we expect different results (different determinants) in other countries because of different educational systems, national innovation systems, etc. This article is therefore a contribution to a larger stream of research but adds insight about the Polish case.

We have collected the data using CAWI (Computer-Assisted Web Interview) survey conducted in 2017. The survey was based on a nationwide random-quota sample of 16,119 people ranging in age from 18 to 65, of which 9,788 were working.

The article consists of the following parts. In the next section, we present a literature review. This review

[1] The term "popularity of work" refers to a situation in which employees' decisions regarding the choice of the education path or acquiring skills and qualifications are influenced by the popularity of certain occupations. The examples that have been analysed most deeply empirically are information and communication technologies occupations (see Autor et al., 2003).

[2] Upward mobility is a promotion to a higher position (see Ng et al., 2007).

[3] Previous research frequently used data from longitudinal surveys, household panel studies, and labour force surveys.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

is assisted by text mining[4] of titles, keywords, and abstracts of a large number of scientific articles from Web of Science. The next section presents the data and methods used. Then, we analyse the sequence of occupational mobility, followed by the results obtained with econometric modelling of determinants of occupational mobility. The final section is reserved for concluding remarks.

LITERATURE REVIEW

To identify streams of research associated with labour mobility, we apply a text mining method based on the PICO search approach (Population/Problem, Intervention/Exposure, Comparison, and Outcomes) adopted from Grames et al. (2019) (see Table 1). This allows us to conduct a preliminary screening of the literature, and helps in more intensive, in-depth research of determinants during the empirical analysis. In other words, this method allows us comparing more efficiently our results with other research findings, and to draw from a larger pool of findings.

Table 1. Keywords used in the PICO search

Category	Keywords
Population	population ages 15–64
Exposure	desire to change job
Comparison	performed occupation; learnt occupation
Outcomes	occupational mobility

Source: own preparation.

The main aim of the PICO keyword search method is to break down the research question into categories. The main argument for this method is that it allows for a more systematic review and thus a quicker assessment of the findings. We used the *Web of Knowledge* database because it is currently one of the largest repositories of scientific periodicals in the world, and because it allows Boolean searches (i.e., using the logical operators "or" and "and").

The PICO search (see Table 1) allows us to collect abstracts, keywords, and titles of 424 scientific articles. We use these data to estimate n-grams using the algorithm proposed by Grames et al. (2019). N-grams are sequences of words that are used most frequently in a large corpus of text; in our case, the text contained in the collection of abstracts, so that:

$$p(x_1 \dots x_n) = \prod_{i=1}^{n} q(x_i \vee x_{i-2}, x_{i-1}), \qquad (1)$$

where:

$x \in V$ – all words used in the analysis, $i = 1 \dots (n-1)$.

The use of the algorithm created by Grames et al. (2019) in the R programming language allows us to collect trigrams (three-word phrases) which we next use to create a Document-Feature Matrix (DFM). We then use the obtained DFM to produce a keyword co-occurrence network (see Fig. 1).

In the selected economic literature, "labour mobility" is frequently associated with "human capital theory" (Adair & Bellache, 2018; Evertsson et al., 2015). Scientific literature differentiates between horizontal labour mobility (change across job positions at a similar level of company hierarchy) and vertical labour mobility (change across levels of job position, most often indicating a promotion). Vertical mobility may be understood as "upward occupational mobility" or "downward occupational mobility," of which the former is explored more frequently (in the tested sample, the ratio was 10 to 4). Other research streams include "intergenerational occupational mobility" and "intergenerational income mobility". Both phrases indicate intensive research about social mobility (change in social status).

What are the determinants of labour mobility? It turns out that regarding empirical research, occupational mobility is researched jointly with other types of mobility. Kettunen (2002), for instance, concentrate mainly on spatial mobility, but also include other types of mobility in their research. One of the conclusions from their research is that age significantly influences spatial mobility: The older

[4] Text mining or text analytics is a process that leads to "the discovery by computer of new, previously unknown information, by automatically extracting information from different written resources" (Hearst, 2003).

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

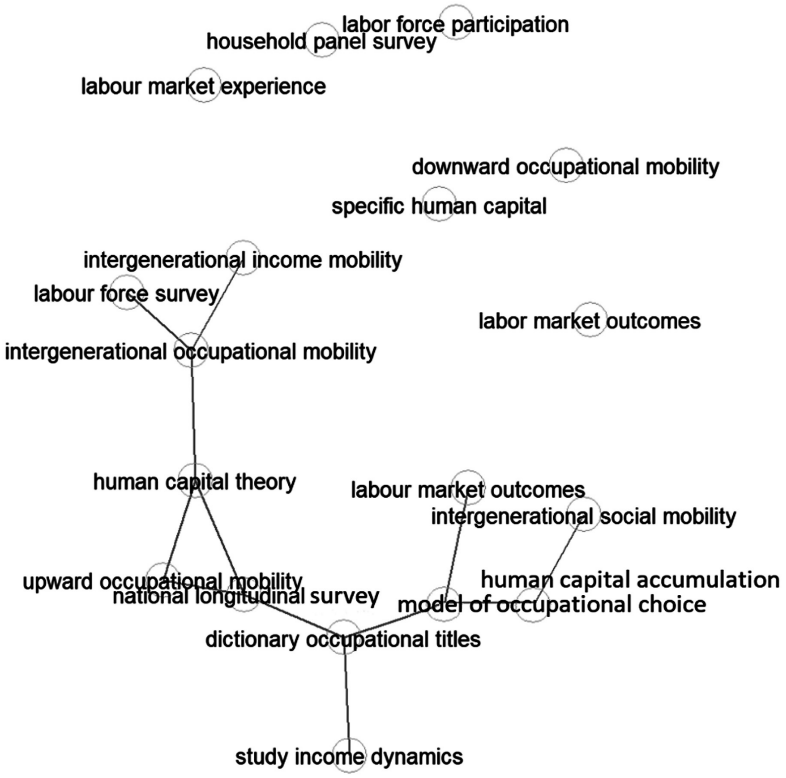

Fig. 1. Keyword co-occurrence network
Source: own preparation.

the people studied, the less spatially mobile they were. Kettunen (2002) demonstrate that occupational mobility is greatly influenced by the amount of demand for occupations.

Bergin (2008) shows that in Ireland, the propensity to change work position is determined by the time of activity in the labour market and experience. Bergin (2008) also shows that people employed in the public sector are less willing to change jobs than people employed in the private sector are. Moreover, the results of her research indicate that people with qualifications higher than their job position requires are also more likely to change their jobs than people who do not have qualifications higher than required. In the study by Bergin (2008), gender is not a statistically significant factor influencing occupational mobility.

Ferreira (2006) focuses on finding factors that determine occupational and "inter-company" mobility (positions within the same company). She presents a literature review in which she categorises the determinants of mobility into statistically significant and not significant groupings. However, this research is not conclusive as to gender differences in mobility. Shin (2007), in turn, examines how structural changes, primarily in the form of mergers and acquisitions, influence professional and inter-company mobility. His research shows that the factors determining inter-company mobility are gender, age, previous mobility experience, seniority, education, wages, as well as the unemployment rate and growth dynamics in the sector in which the respondents are employed. According to Shin (2007), occupational mobility depends on union status, age, length of service, level of education, and the occurrence of acquisitions or mergers in the sector.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

According to Groes et al. (2014), occupational mobility is a U-shaped curve for most occupations. This means it is greater in the case of lowest-paid and highest-paid occupations (the extremes of the curve). This finding arises from research based on a panel of Danish companies. In the case of Poland Rokicka & Starosta (2000) show that among factors that determine general labour mobility are: the socio-professional affiliation of respondents, sector of the economy (private or public), and education level.

During the corona virus pandemic researchers mostly focused on the very popular mobility from traditional work to remote work and its efficiency. For example, Bloom et al. (2022) report that in the USA hybrid work increased job satisfaction, significantly reduced attrition rates, altered the structure of hours worked rather than changing their number, intensified video communication (both while working at home and at the office), and did not affect performance and promotions significantly. Barrero et al. (2022) show that the shift to remote work decreases wage-growth pressure.

Occupational mobility is rarely a sole research topic. Other types of mobility have been primarily analysed to this point, with occupational mobility researched rather incidentally. As a result, existing research often considers only whether occupational mobility occurs vertically or horizontally. Very few studies give insights into the relationship between qualifications and job (occupational) mobility. To our knowledge, there are no studies at the level of detail proposed by us.

DATA AND METHODS

This article uses data from the study of the occupational and educational situation of Poles. The study was performed in 2017 using a computer-assisted web interview (CAWI) method on a nationwide random-quota sample of N=16,119 people aged 18-65. The shares of surveyed persons according to sex, age and size of the place of residence were consistent with the shares in the Polish population. The survey questionnaire was divided into four parts:

1. Demographics;
2. Occupational situation;
3. Qualifications;
4. Competences.

The core of the classification of individual respondents was their professional situation. First, they were divided into "working / not working", then "not working" was further subdivided into "working in the past / without work experience". Almost two-thirds (60.7%) of respondents indicated that they were working; 4.5% indicated unemployment (which is a similar result to the Labour Force Survey statistics for Poland at that time). Among the economically inactive persons, the categories with the highest shares were old-age and disability pensioners (37.9% of the inactive), homemakers (23.9% of the inactive), and school and university students (17.4% of the inactive). The significant share of retirees was primarily explained by the retirement age of men and women, as the sample covered people up to 65 years of age. In Poland, the minimum retirement age is 65 for men and 60 for women. In the context of questions about qualifications and professional competences, it is worth noting that 87.5% of not working respondents were economically active in the past.

Among 16,119 participants of this study, 8,144 were women (50.5%) and 7,975 men (49.5%). Within each age group, the number of respondents ranged from 177 to 713. Over one-third (36.3%) of the respondents lived in villages, 13.1% in small towns (up to 20,000 inhabitants), 20.2% in medium-sized cities (up to 99,999 inhabitants), 18.3% in large cities (100,000–500,000 inhabitants), and 12.2% in cities with more than 500,000 inhabitants. The respondents from Warsaw, the capital city of Poland, constituted 4.2% of all surveyed persons. The respondents represented the inhabitants of all 16 voivodeships.

Only 1.1% of respondents had at most primary or incomplete primary education, 1.9% had only lower secondary education, and 23% of the respondents declared vocational education (either basic or secondary); 10.7% declared general secondary education, 8.6% post-secondary, 17.6% undergraduate,

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

and 36.2% indicated higher education. 0.9% of people in the sample had doctorate degree.

The demographics section of the survey contains eight questions about sex, age, place of residence, size of residence, education (also as a control question for answers provided in the "qualifications" section), marital status, number of children (if any), and average net income.

The "professional situation" section includes two sets of questions; one for people declaring employment, and one for those who were not employed. Employed people were asked 19 questions concerning the current form of employment, industry, sector, conditions, previous experience (if any), reasons for changing employment or occupation, as well as potential future plans concerning the place of employment and occupation. Non-working people (unemployed and economically inactive) were asked 13 questions about reasons for their unemployment or inactivity, previous professional experience (if any), whether they searched for jobs, and how they looked for a job.

The "qualifications" section included questions about types of attended courses and trainings, areas of vocational education, secondary and post-secondary education, and fields of completed higher education. The respondents were asked to classify all obtained qualifications. This approach guarantees detailed knowledge of the range and diversification of formal professional qualifications. The section contained 44 questions.

To explore the determinants of occupational mobility, we utilize two variables. The first one indicates the propensity to change one's occupation, as illustrated by the following question in the survey:

Do you intend to change your occupation within the next 12 months?
a) Definitely not
b) Rather not
c) It's difficult to say
d) Rather yes
e) Definitely yes.

The second variable represents the actual or historical mobility of respondents. We used the following question, for which the surveyed person answered with a number:

How many times have you changed your occupation? (Please note that the question concerns the occupation, and not the place or form of employment).

In both cases – readiness and actual change of an occupation in the past – occupational mobility is represented by an ordinal variable y_i, taking values $j = 1, ..., J$ for $i = 1, ..., N$ respondents. Therefore, we use a logit model of the form (Greene, 2002: 736):

$$y^* = m'\alpha + \varepsilon, \tag{2}$$

where:

y^* – an unobservable dependent variable;
y_i – the observed variable;
m – a vector of explanatory variables, which include socio-demographic variables, occupation and qualifications of respondents. α is a vector of parameters to be estimated;
$y_i = j$ if $\mu_{j-1} < y^* \leq \mu_j$, where μ includes parameters to estimate with α;
the probability of choosing a different value of j is $p_j = p(y = j \vee m) = p(\mu_{j-1} < y^* \leq \mu_j) = \Lambda(\mu_j - m'\alpha) - \Lambda(\mu_{j-1} - m'\alpha)$;

$\Lambda(m'\alpha) = \frac{exp\ (m'\alpha)}{1 + exp\ (m'\alpha)}$ is the logistic function.

RESULTS

Occupational sequence analysis

The questionnaire allows us to analyse the occupational mobility over the life cycle according to ISCO classification. We understand occupational mobility, as single or multiple changes in occupation. To this end, we follow each change in occupation since workers entered the labour market among those who were employed at the time of the questionnaire being conducted. We compare learnt (educated) occupations among major occupational groups, the occupation the person was employed in at the time of survey, potential intended changes in occupation within the following 12 months.

The sample consists of 9,788 workers, 46% of whom were females. The age distribution was quite even, with each age cohort 25–34, 35–44 and

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

45–54 consisting of 25–30% of the sample, while 18–24 and 56–65 cohorts each consisted of 10% of the sample. One in three workers resided in rural areas, and one in five workers resided in big cities (from 100,000 to 500,000 inhabitants). The net monthly median salary was 2,500–3,000 PLN. Almost 40% of the sample did not change their occupation during their professional career, whereas 50% changed their occupation from 1 to 3 times (Fig. 2).

For our analysis, we construct a model of potential trajectories of occupational mobility (Fig. 2). The initial state is the information of occupation learnt, according to ISCO classification, at the beginning of labour force participation. Since the beginning of the professional activity until the moment of the survey, occupation status may have altered in four ways:

1. Respondent's occupation did not change since the beginning of labour force participation, but the occupation performed differed from the occupation learnt;
2. Respondent's occupation performed did not change since the beginning of labour force participation, and the occupation performed was compatible with the occupation learnt;
3. Respondent's occupation performed changed since the beginning of labour force participation, but the occupation performed differed from the occupation learnt;
4. Respondent's occupation performed changed since the beginning of labour force participation, but occupation performed was compatible with the occupation learnt.

In the next step, we accounted for intended changes of occupation in the following 12 months. We assume that respondents would change the occupation if they indicated choices "yes" or "rather yes". The answers "no" and "rather no" were ascribed to intentions of not changing occupation. Next, workers who indicated intentions of changing occupation were assigned to one of three categories:

1. Change of occupation and new occupation would be compatible with currently performed occupation according to ISCO classification;
2. Change of occupation and new occupation would differ from the currently performed occupation according to ISCO classification, but new occupation would still be compatible with the occupation learnt;
3. Change of occupation and new occupation would differ from the currently performed occupation according to ISCO classification, and new occupation would also differ from the occupation learnt.

Figure 3 presents potential trajectories with the percentage share of workers in particular states.

We also analyse occupational mobility by applying sequence analysis methods. The results indicate that more than 60% of the workers changed occupation since the beginning of their professional activity, and almost 70% of these (42% of the overall sample) changed to an occupation different from the one learnt. One in five workers did not change occupation since the beginning of their professional activity, but were simultaneously working in an occupation different form the one learnt. Summary statistics further indicate that only 40% of the entire sample was working in occupations compatible with occupations learnt, according to major occupational groups.

Fig. 2. Number of occupation changes over the professional life cycle
Source: own preparation.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

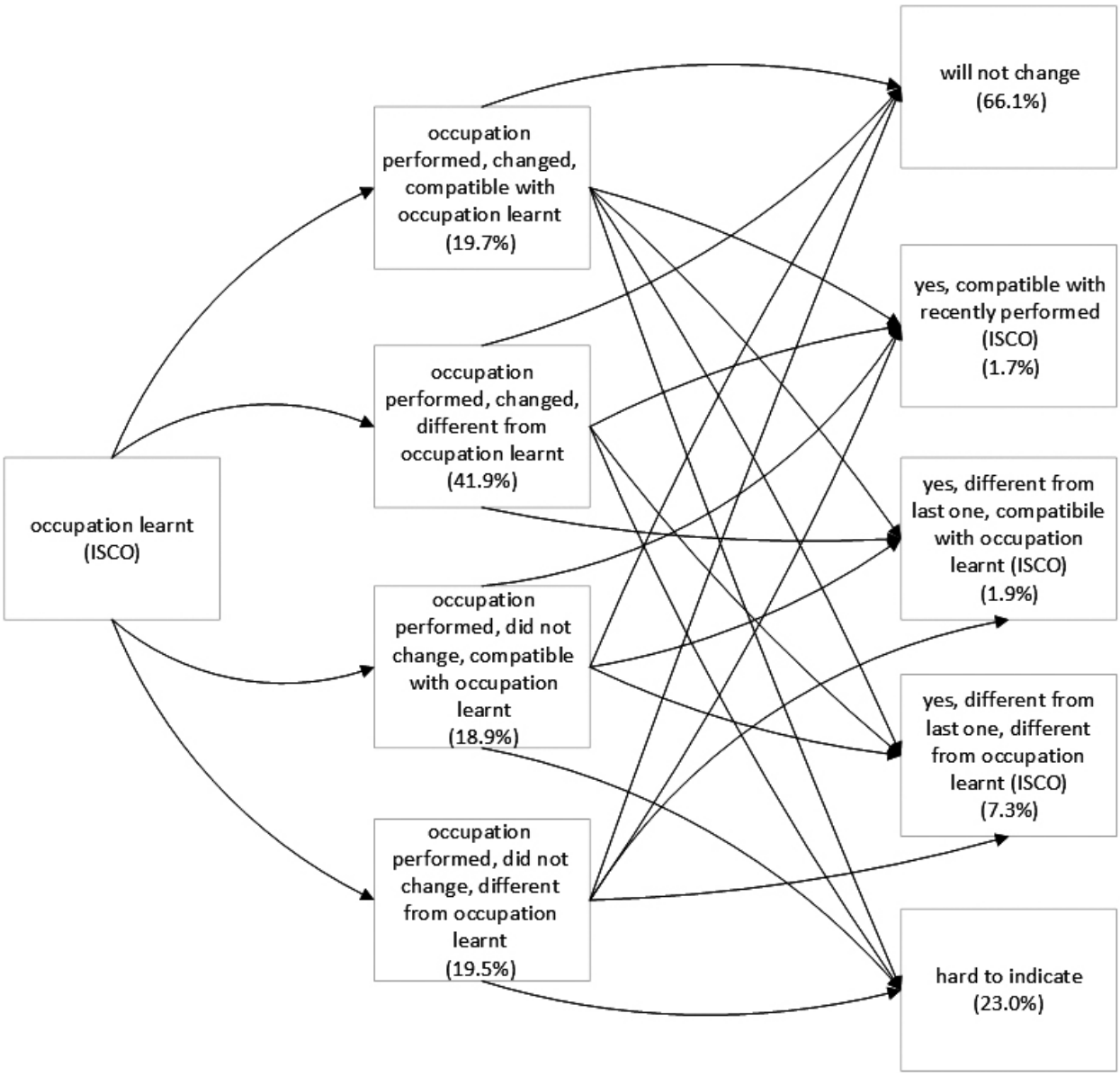

Fig. 3. Model showing intended occupational mobility since the beginning of labour force participation
Source: own preparation.

To complement the transitions between occupations learnt and performed, we present in Table 2 the combination of occupation transitions. We also computed simple indicators to determine mobility to higher or lower major occupation groups. Workers educated in occupations classified as higher predominantly remained in the same group or moved to lower classified occupations, though percentage shares differed considerably depending on the major group. Workers originally classified as lower migrated more often to occupations classified as higher, although changes mostly occurred between adjacent or similar groups. Tables 4 and 5 in the Appendix provide analogous results for workers, who changed occupation and the occupation performed differed from the occupation learnt; and for workers who did

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

Table 2. Occupational mobility between occupations learnt and performed, according to major occupational groups

Occupation learnt	Occupation performed										Mobility to group (%)		
	1	2	3	4	5	6	7	8	9	10	Higher	No changes	Lower
1	15	9	24	6	7	1	0	2	0	1	–	23.08	76.92
2	353	1983	997	443	394	37	149	130	93	21	7.67	43.11	49.22
3	149	353	781	374	477	23	157	154	161	8	19.04	29.62	51.35
4	7	21	25	45	20	0	0	6	10	0	39.55	33.58	26.87
5	27	46	66	60	340	7	30	25	84	1	29.01	49.56	21.43
6	8	16	20	8	26	31	12	9	18	1	52.35	20.81	26.85
7	53	82	107	84	173	16	532	198	122	8	37.45	38.69	23.85
8	9	5	15	12	12	3	11	39	8	0	58.77	34.21	7.02
9	1	2	3	5	2	0	2	1	4	0	80.00	20.00	0.00
10	1	0	1	0	2	0	1	0	0	3	62.50	37.50	–

Note: 1 – Managers, 2 – Professionals, 3 – Technicians and Associate Professionals, 4 – Clerical Support Workers, 5 – Services and Sales Workers, 6 – Skilled Agricultural, Forestry and Fishery Workers, 7 – Craft and Related Trades Workers, 8 – Plant and Machine Operators and Assemblers, 9 – Elementary Occupations, 10 – Armed Forces Occupation

Source: own elaboration.

Table 3. Occupational mobility between occupation performed and planned change in occupation, when the new expected occupation differs from current and learnt occupations

Occupation learnt	Occupation performed										Mobility to group (%)		
	1	2	3	4	5	6	7	8	9	10	Higher	No changes	Lower
1	0	0	2	10	2	8	0	2	0	0	–	0.00	100.00
2	0	54	0	46	26	24	0	4	4	0	0.00	34.18	65.82
3	0	42	10	0	48	12	2	4	4	4	33.33	7.94	58.73
4	2	16	20	34	0	30	2	6	10	0	31.67	28.33	40.00
5	8	20	26	36	50	0	2	2	16	8	53.57	29.76	16.67
6	0	0	0	2	0	0	0	0	2	2	33.33	0.00	66.67
7	0	2	8	10	12	14	0	0	14	2	74.19	0.00	25.81
8	2	8	2	4	12	8	0	10	0	0	78.26	21.74	0.00
9	0	4	14	2	28	10	0	4	10	0	86.11	13.89	0.00
10	0	0	0	0	0	0	0	0	0	0	–	0.00	0.00

Note: 1 – Managers, 2 – Professionals, 3 – Technicians and Associate Professionals, 4 – Clerical Support Workers, 5 – Services and Sales Workers, 6 – Skilled Agricultural, Forestry and Fishery Workers, 7 – Craft and Related Trades Workers, 8 – Plant and Machine Operators and Assemblers, 9 – Elementary Occupations, 10 – Armed Forces Occupations

Source: own preparation.

not change occupation since the beginning of labour force participation, and the occupation performed differed from the occupation learnt.

Following that, we analyse the expectations of changing occupation within the following 12 months. Depending on the initial state, between 60% and 80% of the workers did not plan any changes in occupation soon. Among those who did not change occupation since the beginning of their professional activity, and were working in occupations compatible with the occupation learnt, 79% did not plan changes in occupation. Another 15% of workers answered

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

occupational groups. Relatively few workers planned to remain in the same occupational group. Whether they planned to move up or down in the classification depended on their initial state.

For robustness check of the results, we performed the analogous two-step analysis for four major occupational groups (occupation learnt). We wanted to determine if trajectories of transitions differed among these groups. The example chosen was based on the frequencies, and we examined the following groups: 2 – Professionals (4,600 workers), 3 – Technicians and Associate Professionals (2,637 workers), 5 – Services and Sales Workers (686 workers), 7 – Craft and Related Trades Workers (1,375 workers). No other major group consisted of more than 150 workers. The structure of answers was similar to overall indications, so were the trajectories of transitions.

Determinants of occupational mobility

Table 6 in the Appendix presents the results of modelling the propensity of employed persons to change occupation. The table indicates that readiness to change occupation increases with age only up to the age of 24. From the age of 25, the likelihood of change decreases. This may be related to the "job-shopping" phenomenon, i.e., the fact that young people often change jobs and experiment in the labour market, gaining experience (see Fitzenberger et al., 2015), and looking for the job that satisfies them in various perspectives. After a few years of frequent job changes, they become less likely to change jobs, settling in the enterprise they consider most appropriate. Declared occupational mobility increases with the size of the place of residence. People with an unmarried civil status (unmarried/single, widow/widower) showed a higher propensity to change their profession. The exception to this are divorced people, who showed a lower propensity of changing occupation. The occupational mobility was not significantly diversified regionally. The lowest negative coefficients, although statistically insignificant, were related to less economically developed regions.

The level of education by itself does not significantly affect the readiness to change occupation. This readiness is rather a function of the type of education (qualifications). The questions about qualifications were divided into three groups. The first group contained people who received training programmes and took classes over the course of their careers. Among this group, the willingness to change occupation was most often indicated by people who had received training in the arts and humanities, and the second most in information and communication technologies and services. People from the second group – those with secondary and vocational education, who finished business, administration, and law courses, as well as social sciences, journalism, and information – indicated the greatest willingness to change their profession. Those from the third group were representatives of the service occupations. From the point of view of higher education, graduates of technical sciences (including industry and construction) were most willing to change their profession, followed by service professions. At all qualification levels, people with qualifications in health, social welfare and education had a low propensity to change their profession.

The modelling results of the historical change of occupation are presented in Table 7 in the Appendix. Men changed jobs more often than women did. The respondents were more eager to change their profession until the age of 50. After age 50, this level decreased; respondents more often decided to stay with their last occupation. The size of the place of residence was conducive to professional mobility. Interestingly, education had a negative impact on historical occupational mobility. This negative impact might be due to Poland's unique history. During the centrally planned economy before 1989, higher education often secured more stable positions, thereby reducing the need to change occupations. This legacy continues to shape today's labor market dynamics in Poland. Historical conditions, in which higher education resulted in a much better labour market status, as well as a reduced the need to change profession, may have contributed to this finding. Divorce favoured a change of profession, and having a spouse was not favourable to occupational change. Having children was also

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

not conducive to professional mobility. In the Polish context, traditional values and social expectations often encourage stability when family is involved and, consequently, lower readiness to make occupational changes. People could have also been more reluctant to changes being afraid of potential hindrances for a successful transition. The low spatial mobility of Poles may also contribute to this, especially in previous decades, when having a family could hinder migration to a new job. Generally, representatives of less economically developed regions had lower, though mostly insignificant, rates of historical professional mobility. This is possibly related to the economic transformation that Poland underwent after the fall of communism, which led to uneven regional development. In less developed regions, fewer job opportunities and lower internal mobility could make changing occupations more challenging. This may be related to more difficult job change conditions, low internal regional mobility, and low rates of change to and out of employment in such labour markets.

CONCLUSIONS

Occupational mobility is connected to eagerness and readiness to change an individual's current occupation. This eagerness reflects the readiness to bear all the opportunity costs associated to the matching process between labour supply and demand. In this article, we empirically explore people's past occupational mobility, the eagerness for such mobility in the near future and its determinants. These patterns may be strongly influenced by economic transformation Poland underwent after 1990, shifting from a centrally planned to market-based economy. This transition led to the redefinition of job roles and affected how individuals perceive occupational mobility. During the centrally planned economy employment had been ensured, and there had been no direct need to change qualifications. In 1990s the situation changed drastically. Productivity changes in the companies led to mass layoffs and low labour demand. Labour market situation was very unpredictable with high competition between job seekers. This gradually changed during next decades, but surely affected the psychology of older job seekers.

Occupational sequence analysis indicates the direction of occupational mobility among major groups. While accounting for the high degree of data aggregation, the main following conclusions emerge. First, relatively few workers worked in occupations compatible with their learnt (educated) occupations and have not changed occupation since the beginning of their professional activity. These workers are least eager to change their occupation within the following 12 months. In contrast, there are also workers who changed their occupation since the beginning of the professional activity, and plan to change occupation again within the following 12 months. Among these workers, characterized by high occupational mobility, most plan the change to an occupation different from both the current occupation and the one learnt. Other workers are characterized by moderate occupational mobility. The sequence of changes between occupational groups did not differ significantly with respect to educational level attained nor occupation learnt. The sequence of trajectories has only correlational instead of causal character, however.

The sequence analysis results indicate that in the past, more than half of the workers in the sample changed their occupation at least once during their professional life cycle. Moreover, when workers changed occupation, it most often differed from the one learnt. This could be partially explained by the dynamic changes in the Polish labour market facing economic transformation. It created new occupations and modified existing ones, making some skills obsolete while putting premium on others. Among workers who did not change occupation, 20% were working in an occupation that differed from the occupation learnt. Our results also indicate that working in the learnt occupation during one's entire professional career was quite rare.

We found that sociodemographic features and family status significantly determine occupational mobility. Unmarried people are more eager to change occupation than married workers with children are. However, occupational mobility is mainly affected by

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

the level and type of qualifications acquired during secondary and tertiary education and training. People with secondary or vocational qualifications are less likely to change jobs than those with higher education levels. The results also show that, after an initial increase in job mobility up to age 24, job mobility then declines with age. This finding is important for shaping educational and economic policy.

Which workers were most eager to change their occupation, regarding fields of education? Irrespective of the level of education, graduates from the service sector were most eager to change occupation. This may be related to the fact that acquired qualifications are not as specialized and may be used across different occupations. In the case of tertiary education and training courses, humanities and science graduates were most eager to change occupation. In the case of secondary and vocational education, business, administration, law and social science graduates were most eager to change occupation.

Finally, some research questions emerge that may indicate potential routes for future research: To what extent labour market matching process in Poland affects eagerness and readiness to change occupation (e.g. time-consuming job matching process and long mean job search duration)? To what extent initial unsuccessful educational choices (as relatively few workers work in their learnt occupation) affect occupational mobility? Causal research on these aspects would contribute to better understanding of determinants of job occupation mobility.

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✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

APPENDIX

Table 4. Occupational mobility between occupation learnt and occupation performed across major occupational groups, for individuals that changed occupation since the beginning of their professional activity, and current occupation differed from learnt occupation

occupation learnt	occupation performed										mobility to group (%)		
	1	2	3	4	5	6	7	8	9	10	higher	no changes	lower
1	2	0	2	0	4	0	2	0	0	0	–	20.00	80.00
2	0	10	28	8	6	0	0	4	0	0	0.00	17.86	82.14
3	464	0	1224	602	544	42	206	176	140	28	13.54	35.73	50.73
4	210	462	0	486	682	18	232	220	220	12	26.44	19.12	54.45
5	6	32	32	0	24	0	0	8	18	0	58.33	20.00	21.67
6	32	76	98	96	0	10	44	38	120	2	58.53	1.94	39.53
7	4	16	28	10	30	0	10	16	24	2	62.86	7.14	30.00
8	82	110	162	138	292	10	0	290	182	4	62.52	22.83	14.65
9	8	6	24	18	14	6	18	0	12	0	88.68	11.32	0.00
10	2	4	6	8	2	0	2	0	0	0	100.00	0.00	–

Note: 1 – Managers, 2 – Professionals, 3 – Technicians and Associate Professionals, 4 – Clerical Support Workers, 5 – Services and Sales Workers, 6 – Skilled Agricultural, Forestry and Fishery Workers, 7 – Craft and Related Trades Workers, 8 – Plant and Machine Operators and Assemblers, 9 – Elementary Occupations, 10 – Armed Forces Occupations

Source: own preparation.

Table 5. Occupational mobility between occupation learnt and occupation performed across major occupational groups, for individuals that did not change occupation since the beginning of their professional activity, but current occupation differed from learnt occupation

occupation learnt	occupation performed										mobility to group (%)		
	1	2	3	4	5	6	7	8	9	10	higher	no changes	lower
1	0	8	20	4	8	2	0	0	0	2	–	0.00	100.00
2	242	0	770	284	244	32	92	84	46	14	13.38	0.00	86.62
3	88	244	0	262	272	28	82	88	102	4	28.38	0.00	71.62
4	8	10	18	0	16	0	0	4	2	0	62.07	0.00	37.93
5	22	16	34	24	0	4	16	12	48	0	54.55	0.00	45.45
6	12	16	12	6	22	0	14	2	12	0	70.83	0.00	29.17
7	24	54	52	30	54	22	0	106	62	12	56.73	0.00	43.27
8	10	4	6	6	10	0	4	0	4	0	90.91	0.00	9.09
9	0	0	0	2	2	0	2	2	0	0	100.00	0.00	0.00
10	0	8	20	4	8	2	0	0	0	2	–	0.00	0.00

Note: 1 – Managers, 2 – Professionals, 3 – Technicians and Associate Professionals, 4 – Clerical Support Workers, 5 – Services and Sales Workers, 6 – Skilled Agricultural, Forestry and Fishery Workers, 7 – Craft and Related Trades Workers, 8 – Plant and Machine Operators and Assemblers, 9 – Elementary Occupations, 10 – Armed Forces Occupations

Source: own preparation.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

Table 6. Results of modelling the propensity for employed persons to change occupation

variable	estimate	Z-statistic	
1	2	3	4
Socio-demographic variables			
Sex (woman)	-0.05	-1.3	
Age	0.05	3.8	***
Age2	-0.001	-6.3	***
Size of place of residence	0.04	3.8	***
Education level	0.02	0.8	
No. of children	-0.23	-4.3	***
Unmarried / single			
Married	-0.23	-2.8	**
Divorced	-0.40	-2.7	**
Widow / widower	0.09	9.7	***
Region			
Zachodniopomorskie			
Dolnośląskie	-0.14	-1.2	
Kujawsko-pomorskie	0.02	0.2	
Lubelskie	0.08	0.6	
Lubuskie	0.01	0.1	
Łódzkie	-0.05	-0.4	
Małopolskie	0.00	0.0	
Mazowieckie	-0.09	-0.6	
Opolskie	-0.21	-1.6	
Podkarpackie	-0.18	-1.3	
Podlaskie	0.08	0.6	
Pomorskie	-0.17	-1.6	
Śląskie	-0.09	-0.6	
Świętokrzyskie	-0.20	-1.4	
Warmińsko-mazurskie	-0.13	-1.1	
Wielkopolskie	-0.03	-28.0	***
Qualifications			
Training Education	-0.09	-1.3	
Training Humanities	0.37	3.5	***
Training Social sciences	0.02	0.2	
Training Business	0.15	2.6	*
Training Life sciences	0.14	1.2	
Training ICT	0.29	3.4	***
Training Technical	0.19	2.9	**
Training Agriculture	-0.03	-0.2	
Training Health	0.01	0.2	
Training Services	0.24	3.9	***
Secondary Education	0.13	1.9	.
Secondary Humanities	0.07	0.8	
Secondary Social sciences	0.25	2.3	*
Secondary Business	0.28	4.5	***
Secondary Life sciences	0.09	1.1	
Secondary ICT	0.14	1.7	.
Secondary Technical	0.07	1.3	
Secondary Agriculture	0.07	0.7	
Secondary Health	0.04	0.5	
Secondary Services	0.18	3.1	**
Tertiary Education	0.01	0.1	
Tertiary Humanities	0.29	3.7	***
Tertiary Social sciences	0.13	1.5	
Tertiary Business	0.13	2.1	*
Tertiary Life sciences	0.24	3.0	**
Tertiary ICT	-0.06	-0.6	
Tertiary Technical	0.39	5.6	***
Tertiary Agriculture	0.30	2.3	*
Tertiary Health	0.02	0.2	
Tertiary Services	0.33	4.0	***

Significant at: *** 0.1%, ** 1%, * 5%, 10%. Qualifications are presented according to their type or level, and by field or area. The description starts with type of qualification: Training means trainings and courses; Secondary means vocational or secondary education; Tertiary means higher education. It is supplemented with educational field: Education; Humanities means arts and humanities; Social sciences means social sciences, journalism and information; Business means business, administration and law; Life sciences means life sciences, mathematics and statistics; ICT means information and communication technologies; Technical means technology, industry, and construction; Agriculture; Health means health and social care; Services.
Source: own preparation.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

Table 7. Results of modelling the historical change of occupation

variable	estimate	Z-statistic	
Socio-demographic variables			
Sex (woman)	-0.30	-9.8	***
Age	0.13	14.8	***
Age2	0.00	-12.6	***
Size of place of residence	0.05	6.0	***
Education level	-0.04	-4.5	***
No. of children	0.02	1.0	
Unmarried / single			
Married	-0.08	-1.7	.
Divorced	0.36	5.5	***
Widow / widower	-0.004	-0.04	
Employment status (employed)	0.56	15.3	***
Region			
Zachodniopomorskie			
Dolnośląskie	0.05	0.6	
Kujawsko-pomorskie	-0.09	-1.0	
Lubelskie	-0.14	-1.5	
Lubuskie	0.19	1.6	
Łódzkie	0.10	1.1	
Małopolskie	-0.05	-0.5	
Mazowieckie	0.02	0.2	
Opolskie	-0.11	-0.9	
Podkarpackie	-0.25	-2.5	*
Podlaskie	0.07	0.6	
Pomorskie	0.15	1.6	
Śląskie	-0.06	-0.7	
Świętokrzyskie	-0.14	-1.2	
Warmińsko-mazurskie	0.08	0.7	
Wielkopolskie	-0.04	-0.5	

Significant at: *** 0.1%, ** 1%, * 5%, 10%.
Source: own preparation.

✉lcywinski@wsiz.edu.pl, ✉eburdz@sgh.waw.pl, ✉rpater@wsiz.edu.pl

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SECURITY MEANS AGE-FRIENDLINESS. ANALYSIS OF OLDER PEOPLE'S NEEDS REGARDING THE SAFE INFRASTRUCTURE OF OPEN RESIDENTIAL SPACES. A CASE STUDY OF POLAND, THE EU MEMBER COUNTRY

Marta Czaplicka[1]✉, Agnieszka Dawidowicz[2]✉, Małgorzata Dudzińska[3]✉, Adam Senetra[4]✉

[1] ORCID: 0000-0001-8952-0675
[2] ORCID: 0000-0002-8445-3095
[3] ORCID: 0000-0002-1140-0435
[4] ORCID: 0000-0001-5379-9600
[1,2,3,4] University of Warmia and Mazury in Olsztyn
Romana Prawocheńskiego Street, 15, 10-720 Olsztyn, **Poland**

ABSTRACT

Motives: In the era of ageing population and threats arising from economic and geopolitical circumstances there is a need to adapt housing estates to different social groups, especially older persons as a particularly vulnerable group.
Aim: The research objective of the article was to study the relevance of selected elements of infrastructure in open residential spaces regarding the safety in the eyes of older people in the face of various threats, such as pandemics and military conflicts.
Methods: A questionnaire was developed to investigate the level of significance of selected elements of infrastructure based on in-depth literature research. The questionnaire survey was conducted twice on two random population samples (October 2021 and March/April 2022) in five chosen Polish cities (capitals of voivodeships).
Results: Changes in the perceived importance of factors associated with residential safety were identified in the face of two types of threats. Urban planning solutions that contribute to a sense of security were identified in different gender and age groups. Public open spaces in cities should be accessible, user-friendly, and safe; they should promote social interactions with other residents, be aesthetically appealing, and encourage social activation.

Keywords: older people, open residential spaces, age-friendly city, user-friendly space, threats, security

INTRODUCTION

Number of people older than 60 in the global population continues to increase steadily (He et al., 2016). It is projected to increase from 12% to 22% in 2050. The share of people older than 80 is expected to triple and reach 2.1 billion by 2050 (Wang et al., 2022; World Health Organization, 2018). Rapid population ageing is a process that began in the last years of the previous millennium, but global

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

research efforts aiming to improve the older adults welfare and safety have been initiated only after 2000. The World Health Organization (WHO) has been leading international action plans targeting the older population, and it has recommended that older people's needs in the area of health protection, financial welfare, social and cultural activity, and the living environment be regularly analysed and monitored (World Health Organization, 2007). The United Nations has implemented the "Decade of Healthy Ageing (2021–2031)" initiative to promote global cooperation between various organisations to ensure that older people and ageing are included in the Sustainable Development Goals (World Health Organization, 2021). This initiative was introduced to tap into the potential of the older population, to recognize older adults as equal members of society, and to ensure that older citizens age with dignity in a healthy and friendly environment. Buildings and streets without architectural barriers promote the mobility and independence of disabled citizens, regardless of their age. In safe residential districts, people aged 60+ can enjoy outdoor recreational activities and interact with other community members. Older people's needs and problems should be surveyed to design effective programs and measures that improve the quality of life of older persons, their families, and local communities.

The need to monitor older people's needs became particularly evident during the COVID-19 pandemic. This health crisis revealed gaps in legal and social welfare systems of different countries, and it exposed the inequities in access to safe outdoor spaces for vulnerable populations, including older adults (Batsis et al., 2021; Levinger et al., 2022). In cities, public open spaces, including in residential estates, should be accessible, aesthetically appealing, and safe; they should promote social interactions with other residents and encourage social activation (Bierwiaczonek, 2016). Social, economic, environmental, infrastructural, and biological threats (such as the COVID-19 pandemic), as well as threats arising from extreme weather events, natural disasters, military and economic conflicts, can undermine urban residents' sense of security in public space. These threats pose new challenges for urban planners and managers, and they necessitate new solutions to ensure that cities are safe and healthy living environments. Therefore, the needs of city residents should be monitored, and new methodological approaches should be developed with the use of smart tools to ensure that cities are age-friendly and safe for residents of all ages.

The COVID-19 pandemic and the military conflict in Ukraine have emerged as new threats that undermine urban residents' sense of security. These have discouraged many city dwellers, in particular older citizens, from using public open spaces. Therefore, the following research question was formulated: which solutions in open residential spaces exert a positive and a negative effect on perceptions of public safety? The results obtained will provide an answer to the next strategic question: Should outdoor spaces for older people be modified in the face of new threats? The main aim of this study was to examine older persons' needs regarding safety of residential open spaces to determine the age-friendly residential areas (AFRA). The purpose was to determine the impact of two different threats on the perceived importance of functional and landscape attributes associated with a sense of security in residential estates. The detailed goal was to identify solutions that provide city dwellers with a sense of security in public open spaces in residential estates.

The study involved empirical qualitative research methods (literature review and a questionnaire survey conducted on a random group of the 55+ population). The questionnaire survey was conducted twice on two random population samples. The first survey was conducted in October 2021 during the third wave of the COVID-19 pandemic, and the second survey was conducted at the turn of March and April 2022. The respondents were 585 older adults residing in the capital cities of five Polish voivodeships. The double randomized study aimed to identify changes in urban residents' sense of security after the outbreak of the military conflict in Ukraine.

To the best of the authors' knowledge, this is the first study to examine the impact of two different

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

threats on city dwellers' sense of security. In the literature, the safety of public urban space has been evaluated in the context of functionality (Buckner et al., 2019), neighbour relations and a sense of community (Yu et al., 2019), smart solutions (Ivan et al., 2020), the physical and social environment (Kano et al., 2018; Wong et al., 2015), as well as the quality of life and equality based on the core indicators proposed by the WHO for measuring the age-friendliness of cities (World Health Organization, 2015a). However, older people's sense of security in the face of a global pandemic or a military threat has not been examined to date, and the undertaken research is innovative.

The research hypothesis states that older persons' sense of security differs across age groups. An attempt was made in the study to determine whether the type of threat influences the perceived importance of functional and landscape attributes of open spaces in residential estates.

LITERATURE REVIEW

The literature review focused on the profile of older people in Polish, their observed lifestyles (in terms of safety), their financial status and economic situation. This information is very important and should always be analysed before conducting a study, as it is the factor that most influences people's ability to be active, their life choices and their perception of reality, including certain elements of their environment, and thus the regulation of their needs.

Lifestyle and sense of security of older people in Poland

An analysis of the literature indicates that lifestyles and needs of older adults differ depending on lifetime habits, health, exposure to culture, and sense of security. Leisure activities of older people are largely shaped by their previous lifestyles, including habits that have been ingrained in early adulthood and in years when they were professionally active (Czerniawska, 1998). The habits that were shaped during the reminiscence bump (between the ages of 15 and 27) (Draaisma, 2010) influence decision-making processes in late adulthood (Niezgoda & Jerzyk, 2013).

Lifestyles of older population also differ across countries (Gorgol, 2016; Punyakaew et al., 2019; Rzepko et al., 2017). The lifestyles of older persons in Poland differ significantly from the lifestyles of older adults in other EU countries, in particular in Western Europe and the Nordic countries. Above all, Polish older adults have very low awareness of the health benefits of physical activity, and their lifestyles are influenced by different cultural and historical factors, as well as insufficient access to social support and healthcare services. Many adults aged 60+ have physical disabilities, but access to physiotherapy is limited, which is why the majority of Polish older adults engage in passive recreation, mostly at home (Gorgol, 2016).

However, a 2019 study revealed that a growing number of Polish older persons remain professionally active, enrol in educational programs, and pursue active recreational interests (Dawidowicz et al., 2020). 44% of retired adults remain professionally active (Figurska et al., 2022). Older people value independent living, but the COVID-19 pandemic significantly decreased activity levels of older people (Zych, 2020). Older persons are gradually returning to pre-pandemic activity levels, which can be partly attributed to the "Active+ 2022" government program that channelled PLN 38 million to projects aiming to mobilize older adults (Ministerstwo Rodziny i Polityki Społecznej [Ministry of Family and Social Policy], 2022).

Financial status of Polish older adults

In a study by Figurska et al. (2022), more than 90% of the surveyed Polish older citizens declared to have a satisfactory financial status despite the fact that Polish incomes were considerably below the EU average in 2018 and 8% of older adults were at risk of poverty. The average old-age pension in Polish regions is presented in Figure 1.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

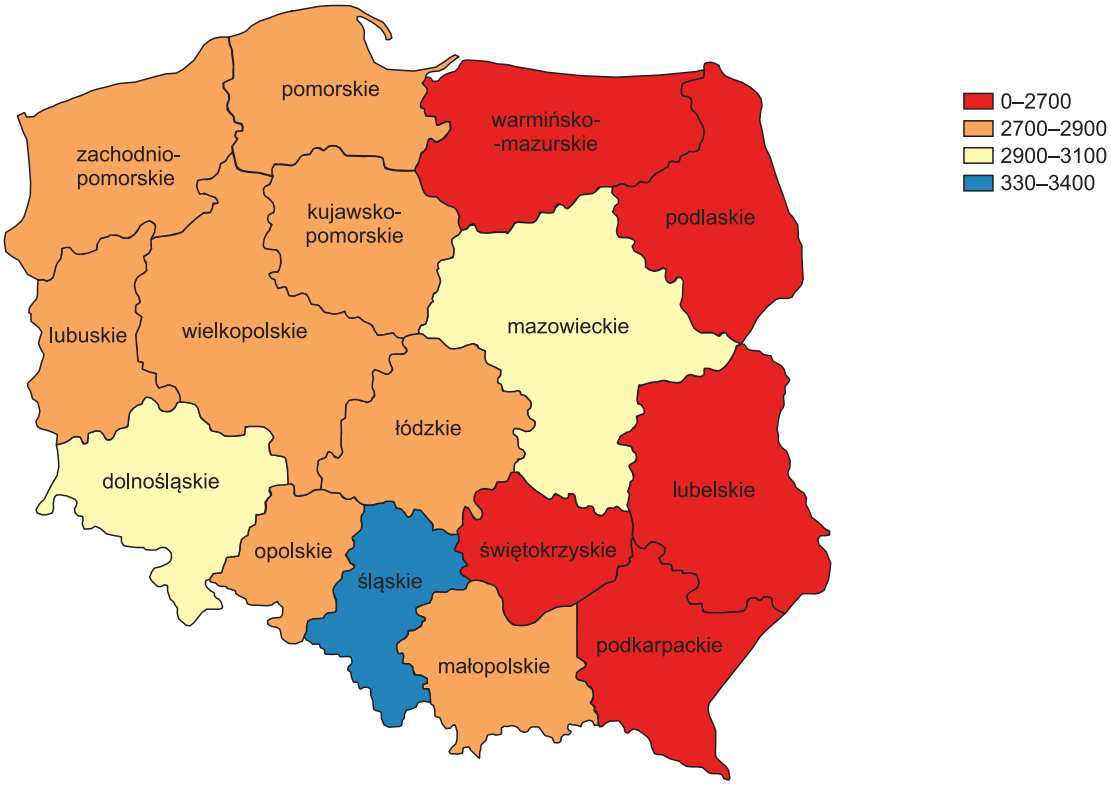

Fig. 1. Average old-age pension in Polish voivodeships (in PLN)
Source: own elaboration based on Główny Urząd Statystyczny [Statistics Poland] (2020).

Eurostat does not provide information about the absolute income poverty of older people, but data about relative income poverty in this population group are available. Relative income poverty is determined based on the at-risk-of-poverty rate which is set at 60% of the national median annual income in a given country. In 2018, around 16% of older persons in Poland and the EU-28 lived in such households (Statistics Poland, 2020). Even if a similar proportion of older people in Poland and the EU were at risk of poverty, the disposable incomes of Polish older citizens were significantly lower in comparison with the more affluent Western European countries such as Luxembourg, Germany, and France. Therefore, the relative poverty rate is greater among Polish older people than older adults residing in Western Europe.

Legal support for older people during the pandemic

During the COVID-19 pandemic, legal support for Polish older persons was based on the recommendations of the Commissioner for Human Rights (Table 1) (Kubicki & Szweda-Lewandowska, 2022) and the measures initiated by the Polish government (access to health care services, including telehealth services, introduction of "older-people-only" hours in retail and service outlets) (Website of the Republic of Poland, 2020).

In the event of a military conflict, older citizens are not entitled to special protection pursuant to the provisions of domestic or international humanitarian law. These laws, including European Civil Protection and Humanitarian Aid Operations (2023), apply equally to all social groups, and provide assistance

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

Table 1. Recommendations of the Commissioner for Human Rights on support for older people during the COVID-19 pandemic

Types of support	Recommended support services
Right to live with dignity	The needs and opinions of older people should be considered in the process of developing and implementing public policies.
Right to information	Effective methods and information channels should be developed to reach older people living in one-person households. Many of these older persons have physical disabilities, visual impairments, and a limited ability to perform basic daily life activities.
Right to healthcare	Older citizens should have access to general practitioners and specialists, including mental health practitioners because older people living in one-person households are at a high risk of depression.
Right to social inclusion	At the local level, older adults should receive support from personal assistants to promote integration within the older people community, and to build strong links between older citizens and their family members, public service employees, and volunteers. Alternative recreational activities and community-building measures should be promoted at home during the lockdown. Computer literacy courses should be organised to teach digital skills to older adults.
Right to equal treatment	Older adults should have guaranteed access to public services, including healthcare, as well as support services to eradicate discrimination on grounds of age, gender, disability, ethnicity, race, and sexual orientation, including all cross-cutting issues when the barriers associated with more than one trait (such as age and disability) overlap and additionally limit access to goods and services. Older citizens living in one-person households and disabled older adults should receive help from personal assistants in performing daily life activities, such as shopping, transport to healthcare facilities, vaccination centres, and public administration facilities.

Source: own elaboration based on Kubicki & Szweda-Lewandowska (2022).

to civilians and former combatants (wounded soldiers, refugees, prisoners of war). However, humanitarian laws recognize the special needs of vulnerable populations. Unlike other socially vulnerable groups, such as women and children, older people are classified based on the provisions of the Universal Declaration of Human Rights. There are three main acts of international humanitarian law: International Humanitarian Law (IHL) which protects civilians, the Refugee Law (RL) which protects civilian refugees, and the Human Rights Law (HRL) which applies in situations of conflict and natural disaster. These contain provisions that directly address the rights and needs of older adults in a crisis and their protection as members of the civilian population (Krill, 2001). The IHL does not define a chronological age at which a person is classified as a older citizen. Several provisions, including hospital care and evacuation of civilians from occupied territories, directly address older persons. According to the RL, older refugees are eligible for retirement income under national retirement laws of the host country (Nicholson & Kumin, 2017). Pursuant to the provisions of the HRL, older people are entitled to basic human rights, including the right to non-discrimination.

The fact that very few legal acts directly address older persons is not a weakness of international law, but it results largely from the lack of awareness about the specific needs and problems of the older population, as well as the failure to observe the provisions of international law, in particular by the parties to the conflict.

Various United Nations (UN) agencies implement programs and measures that promote dignified ageing. However, these measures differ in scope and effectiveness. Most UN agencies do not have specific policies or operational procedures addressing the older adults, and examples of operations where older adults were a party to the conflict are difficult to find. However, the WHO and the United Nations Development Program (UNDP) provide support networks for the older people, and in 2002, the WHO developed a policy framework to inform discussion and the formation of action plants that promote healthy and active ageing (World Health Organization, 2002).

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

MATERIALS AND METHODS

Empirical qualitative and quantitative research methods were used to verify the research hypothesis and answer the research question. The adopted methodology was based on a review of the literature, including Statistics Poland and Eurostat data (social and economic factors), and the results of a questionnaire survey. The survey questionnaire was developed by members of the research team who relied on their expert knowledge as investigators in a research project based on the results of previous studies examining older people's activity levels (Dawidowicz et al., 2020; Figurska et al., 2022), urban landscape components (Senetra et al., 2015), and the functional and spatial indicators of residential estates in cities (Dawidowicz & Dudzińska, 2022). The results were processed statistically in a comparative analysis. The respondents were divided into groups based on age and type of residential estate. The survey involved 585 older people aged 55+ residing in the capital cities of five Polish voivodeships. Two population samples were selected randomly, and survey data were collected with the use of the Computer-Assisted Personal Interviewing (CAPI) methodology. The study involved two surveys that were separated by a period of six months. The first survey was conducted during the third wave of the COVID-19 pandemic in October 2021. The second survey was conducted at the turn of March and April 2022, two months after the outbreak of the military conflict in Ukraine.

Survey questionnaire

The questionnaire for surveying older people's needs regarding safe residential infrastructure in cities was developed based on an analysis of Polish and international literature published in the last 20 years. The following key words were used in the literature search: age-friendly city/district, age-friendly residential communities, and age-safe city. The following Polish legal acts were also analysed: Act of 27 March 2003 on spatial planning and development (Journal of Laws, 2021, item 741, as amended) and the Construction Law of 7 July 1994 (Journal of Laws, 2020, item 1333, as amended).

Four main categories of factors that contribute to the safety of urban dwellers in residential estates were identified: (1) Technical protective infrastructure without architectural barriers and safe shelters, (2) Safe transport solutions, (3) Social support and welfare (social infrastructure), and (4) Perceptions of the neighbourhood. These categories comprised 16 criteria: architectural solutions and assistive technologies, basic recreational infrastructure, civil defence infrastructure and sanitation infrastructure, traffic routes, availability of transport and transport information, age-friendly parking, signposts, reference points, landmarks, retail and service outlets, healthcare facilities, social welfare, social relations and social participation, cleanliness and sanitation, neighbourhood safety, and good/bad neighbourhood.

The importance of each criterion was ranked with the use of dedicated indicators. The questionnaire was designed to collect the opinions of older citizens residing in differently sized cities and belonging to different social groups. The questionnaire contained eight questions, mostly closed-ended, single-choice.

In the first two questions, the respondents were asked to indicate their gender and age in the following age intervals: 55–59, 60–75, 76–89, and 90+ years. This division is consistent with the WHO classification, where the population of older adults is divided into pre-seniors (55–59) and three life-stage subgroups: the young old (60–74), the old (75–89), and the old-old (90+) (Olejniczak, 2015; World Health Organization, 2002). The study involved older adults who enjoy full civil rights, including the right to sell or buy real estate.

In the third question, the respondents were asked to describe other household members, choosing from six options: spouse, partner, parents, children, living alone or with other household members. In nearly 5 million Polish households (39% of all Polish households), at least one household member is 60 or older. The above applies to 50% of rural households and a third of urban households (Twardzik, 2017).

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

The fourth question was designed to elicit information about older people's activities, and the following options were provided: full-time employment, part-time employment, business owner, skill development courses, senior organisations (such as universities of the third age), caring for grandchildren, volunteer work, and other types of activity. Polish older citizens are characterized by low levels of activity, and age-friendly cities promote the active ageing strategy to help older persons lead independent lives in their place of residence, motivate older people to become physically and professionally active, and encourage older citizen participation in social and professional activities to improve their quality of life (Labus & Szewczenko, 2017; Tomczyk & Klimczuk, 2016).

In the fifth question, the respondents were asked to rank the importance of technical and protective infrastructure, and buildings without architectural barriers on a five-point scale (from very important to unimportant). The following infrastructure components were assessed: assistive technologies (lifts, automatic doors, number of street lamps and other light sources, surveillance), architectural solutions (ramps, handrails, no thresholds or curbs), recreational infrastructure (benches, picnic areas, outdoor gyms, playing fields, cycle paths), basic sanitation infrastructure (public toilets, waste bins), and safe shelters (basements, shelters). The respondents could also list other solutions that enhance older adults' mobility in residential estates.

The sixth question concerned safe transport solutions in residential estates. The respondents were asked to rank the importance of local traffic solutions. The following elements were evaluated: route directions, traffic signs, information boards, signposts, audible traffic signals, condition of sidewalks, curbs and ramps, parking space (including age-friendly parking), taxi stops, public transport stops, and public transport timetables. The respondents were asked to assess the safety of narrow streets, including streets with narrow lanes and dense vegetation, dense development, spaces with limited visibility, reference points and landmarks (large and characteristic buildings and structures).

In the seventh question, the respondents were asked to rate the importance of the following social infrastructure components: proximity of a police station, fire station, and hospital emergency department (social services); proximity of friends, family members, and other older people; emotional attachment to one's place of residence; easy access to healthcare facilities and pharmacies (health and life protection); volunteer organisations or community clubs; availability of retail and service outlets.

The last question was designed to validate the results. The respondents were asked to evaluate cleanliness, sanitation standards, and public safety in their neighbourhoods.

Several key strategies were adopted to minimise bias in this research. Firstly, random sampling was used, meaning that the selection of respondents for the study was done randomly, minimising the risk of bias. Secondly, respondents were divided into different age groups and by settlement type, which took into account the diverse perspectives of the respondents.

Additionally, the research questionnaire was carefully constructed with clear questions, eliminating potential ambiguity. The survey was conducted in two phases, allowing for potential changes in respondents' answers over different time periods.

The survey took into account various aspects of security and infrastructure, eliminating bias through a comprehensive approach. In addition, literature and legislation were referred to in the development of the questionnaire, ensuring the objectivity and reliability of the results.

Study area

The survey was conducted in Poland to determine older people's perceptions of residential safety in the face of two major threats: the COVID-19 pandemic and the war in Ukraine which led to a massive influx of Ukrainian refugees into Poland. Poland has an area of 312,696 km^2, and it is the 69th largest country in the world and the 9th largest country in Europe. Poland has a population of 37,019,327 (Statistics Poland, 2021), and it is the 38th most populous country in the world and the 5th most populous country in Europe.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

According to Statistics Poland (2021), citizens aged 65+ will account for more than 23% of the Polish population by 2030 (most older citizens will live in cities). In 1990, a mere 13.9% of Poland's population were aged 65 and more. According to demographers, population ageing is inevitable. Life expectancy will most likely continue to increase, which will increase both the total number and the percentage of older citizens.

The survey targeted older adults residing in Olsztyn, Gdańsk, Warsaw, Cracow, and Poznań, which are large or medium-sized cities in geographically distant Polish regions (Fig. 2). All five cities are voivodeship capitals. The basic geographic and demographic characteristics of the surveyed cities are presented in Table 2.

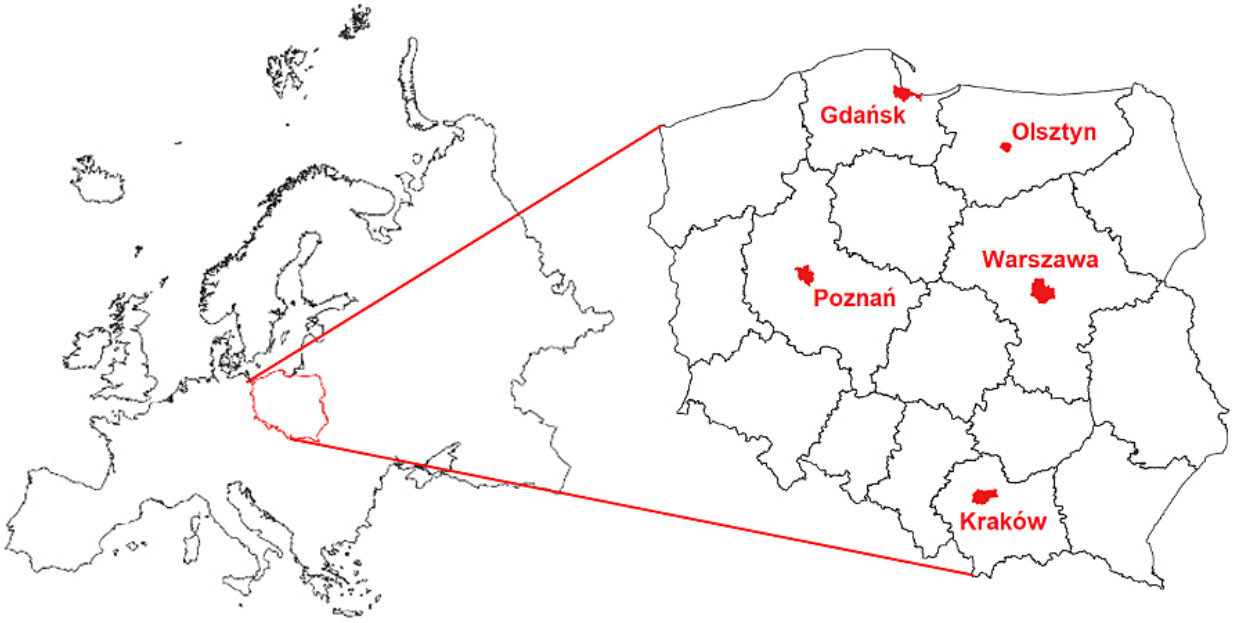

Fig. 2. Poland on a map of Europe (left) and the location of the surveyed Polish cities (right)
Source: own elaboration.

Table 2. Basic geographic and demographic characteristics of the surveyed cities

City	Area (km^2)	Population	Population density (persons/km^2)	Older (retired) population*	Share of older population in total population (%)*
Gdańsk	263.44	486,022	1845.0	119,075	24.5
Kraków	326.85	802,800	2,456.2	144,504	18.0
Olsztyn	88.33	170,622	1911.0	25,875	16.0
Poznań	261.91	546,859	2,031.4	109,372	20.0
Warsaw	517.20	1,863,056	3,602.0	465,764	24.5

* In Poland, the retirement age is 60 years for women and 65 years for men.
Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

RESULTS AND DISCUSSION

Identification of residential infrastructure components that affect the residents' sense of security

Infrastructure components that enhance older people's safety in the place of residence are the key criteria that contribute to a sense of comfort and wellbeing (Bierwiaczonek, 2016). Safety and wellbeing are determined by various factors, and older persons have different needs and expectations than other age groups. Older people's wellbeing is influenced by mobility limitations, fitness levels, health status (physical and mental), individual needs, and financial capabilities. These factors were divided into four main groups which are consistent with the determinants of an age-friendly city proposed by the WHO (2007) (Table 3).

The first group of factors was subdivided into architectural structures that facilitate mobility and basic recreational infrastructure (Table 4). Buildings and streets without architectural barriers enhance the mobility and independence of older citizens and disabled residents. Solutions that improve walkability and mobility promote outdoor recreation. Such solutions enable older persons to participate in active recreation and social activities, and they facilitate daily activities that are necessary for independent living (World Health Organization, 2007).

Solutions that guarantee the residents' safety also play a very important role in periods of unrest and possible military conflicts. In Europe, conflict and violence have escalated to the highest levels in decades (acts of terrorism, war), which increased the demand for civilian safety facilities, both inside and outside cities. However, civil defence infrastructure has been largely defunct for many years, and many

Table 3. Groups of factors that ensure older people's safety in open residential spaces

Groups of safety factors			
1) Protective infrastructure, infrastructure without architectural barriers, safe shelters	2) Safe transport solutions	3) Social support and welfare (social infrastructure)	4) Perceptions of the neighbourhood (Cleanliness and sanitation)

Source: own elaboration.

Table 4. Protective infrastructure, infrastructure without architectural barriers, safe shelters

Category	Description	Factors
1A) Architectural structures	Architectural solutions for wheelchair users; stairs with handrails; even surfaces; sidewalk barriers; low curbs, stairs and sidewalks adapted to the needs of disabled users.	1. Absence of architectural barriers. 2. Tall sidewalk curbs that obstruct mobility and walkability.
1B) Assistive technologies	Automated and smart solutions, including lighting, lifts, ramps, wide passageways, automatic doors and windows, surveillance.	1. Adequate number of street lamps and other light sources.
1C) Basic recreational infrastructure	Sports and recreational areas.	1. Benches and rest areas. 2. Picnic areas (barbecue and fire pits). 3. Cycle paths. 4. Sports facilities (outdoor gyms, playing fields).
1D) Civil defence infrastructure	Safe shelters.	1. Shelters, tunnels, basements, underground stations, underground passageways.
1E) Sanitation infrastructure	Infrastructure for maintaining clean and hygienic public spaces.	1. Disabled toilets. 2. Sewage systems. 3. Waste collection systems.

Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

of the existing facilities pose a considerable burden (Banaszkiewicz & Semik, 2019).

The second group of factors includes solutions that promote the safe and comfortable mobility of older people (Table 5).

In a study of Swedish older people (Consortium, 2012), public transport was regarded as expensive, unsafe, and difficult to access due to insufficient route information. Older adults had a preference for private transport as drivers or passengers. Walking was the second most preferred transport option. Cycling and public transport were evaluated as the least comfortable options. These results indicate that older residents should have access to safe and comfortable parking spaces in residential estates.

Comfortable transport solutions are addressed by the Smart City concept. These solutions make cities friendly for the residents, and they promote older people's mobility. Smart cities rely on advanced technologies, which could pose certain difficulties for the older persons. However, smart solutions are increasingly accessible and easy to use (Skouby et al., 2014). In modern cities, smart mobility solutions such as digital information boards, integrated timetables, free transport, and audible traffic signs are being introduced to promote older people's activities and social participation.

The condition of transport infrastructure also plays a very important role in this group of factors. Well-designed ramps, sidewalks, public transport stops, and the availability of taxi services facilitate older people's mobility. Infrastructure components that improve the safety of urban travellers are equally significant. Inadequate street lighting and dense development that limits visibility can discourage older citizens from venturing outside (Gehl, 2011). Traditional urban development, where the city is divided into regular blocks, is most conducive to older people's mobility because urban structures can be easily identified in space, which promotes orientation, social contact, and community integration (Komar, 2014).

The second group of factors also contains reference points and landmarks. These factors are particularly important for older adults who are often affected by visual impairment and limited spatial orientation skills. Visible and adequately signposted streets, stops, traffic routes, and pedestrian passageways are essential for safe transport. In turn, landmarks facilitate orientation in space, and they affect social behaviour

Table 5. Safe transport solutions

Category	Description	Factors
2A) Pedestrian routes	Passages, sidewalks, footpaths.	1. Distance between buildings. 2. Condition of sidewalks, curbs, and ramps. 3. Vegetation density. 4. Sunlight access in streets and residential estates.
2B) Availability of transport and transport information	Access to bus stops, information about routes, and timetables; access to taxi stops; transport for older citizens and disabled citizens, including free/community transport options.	1. Adequate access to information about public transport (timetables, routes, delays, changes). 2. Free transport for older citizens. 3. Public transport stops (bus, tram, metro). 4. Taxi stops.
2C) Age-friendly parking	Parking spaces for older citizens and disabled persons in the vicinity of buildings.	1. Public parking. 2. Age-friendly parking.
2D) Signposts, reference points, landmarks	Traffic signs that are visible for older drivers; reference points; landmarks (buildings, structures, and natural landmarks).	1. Landmarks that facilitate orientation (such as church towers, tall buildings, old trees). 2. Warning signs and audible traffic signals (including at pedestrian crossings). 3. Route directions, traffic signs, information boards, signposts.

Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

by eliciting emotional and aesthetic responses (Czarnecki, 1960), both positive and negative. On the micro scale, contemporary urban landmarks consist mostly of buildings and architectural complexes, as well as street furniture. Natural landmarks include tall trees and landform features. Prominent landmarks are the focal points in urban space that enhance the clarity and legibility of urban design. Landmarks are distinctive elements of space that highlight the importance of a given location (Bala, 2016; Sorrows & Hirtle, 1999).

Social support and welfare are the third group of factors that contribute to older citizens' safety in urban space (Table 6). Independent living influences older adults' wellbeing and life satisfaction. Easy access to retail and service outlets enables older people to keep up with their daily routines. Shops located on the ground floor with easily accessible entrances are best suited to the functional capacity of the older adults (World Health Organization, 2007). Older people's clubs mobilise older adults to remain active and socially involved. Volunteer work also enhances wellbeing, promotes a sense of security, and prevents the social marginalization of older citizens (Dovey, 2016).

Easy access to healthcare facilities, emergency rooms, and rescue services plays a fundamental role in building a sense of security in the place of residence (Morris et al., 2012). Surveillance systems in public open spaces also enable the older people to feel safe and comfortable in the residential environment. Surveillance systems affect general perceptions of safety and opinions about different city districts.

Cleanliness and sanitation are the last group of the factors that affect older citizens' sense of residential security (Table 7). Older persons are discouraged from visiting public spaces that produce unpleasant odours, are not regularly cleaned and maintained in good order. Noise pollution is one the greatest environmental problems in cities, exerting a particularly detrimental effect on older people (Szczepańska et al., 2015). Noise contributes to health problems, sleep disorders, loss of productivity, and physiological stress.

Table 6. Social support and welfare (social infrastructure)

Category	Description	Factors
3A) Retail and service outlets	Local shops (grocery stores and other), basic services (such as repair shops).	1. Proximity to retail and service outlets.
3B) Healthcare	Outpatient clinics, hospitals, emergency rooms.	1. Access to healthcare facilities and pharmacies.
3C) Social security	Access to emergency services in the residential estate (City Guard, Police, security guards).	1. Rapid Police and City Guard response to calls for service.
3D) Social relations and social participation	Good neighbourly relations contribute to local safety; local volunteer services (shopping, cleaning, etc.).	1. Local volunteer services (shopping, cleaning, etc.). 2. Community or district clubs. 3. Social bonds, proximity of friends and family.

Source: own elaboration.

Table 7. Perceptions of the neighbourhood (cleanliness and sanitation)

Category	Description	Factors
4A) Cleanliness and sanitation	Urban spaces are free of waterlogging, animal faeces, and waste.	1. The residential estate is clean and well-maintained.
4B) Neighbourhood safety	The areas surrounding the residential estate are safe.	1. Sense of security in the neighbourhood.
4C) Good/bad neighbourhood	Subjective assessment of the neighbourhood.	1. Perceptions of the neighbourhood (good/bad).
4D) Sources of noise.	Sources of residential noise.	1. Sources of residential noise, such as busy streets.

Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

RESULTS OF THE QUESTIONNAIRE SURVEY

The questionnaire survey was conducted twice, during the COVID-19 pandemic and after the outbreak of the war in Ukraine, on a population sample with the same size and age distribution. A total of 585 respondents participated in the survey, and 77% of the participants were women. The age structure of the population sample was as follows: 55–59 – 14%, 60–75 – 68%, 76+ – 18%. Most female (75%) and male (43%) respondents belonged to the young-old group (60–75) (Fig. 3).

Most respondents (68%) lived in apartments, and the remaining participants (31%) inhabited single-family homes, semi-detached houses, or terraced houses (Fig. 4).

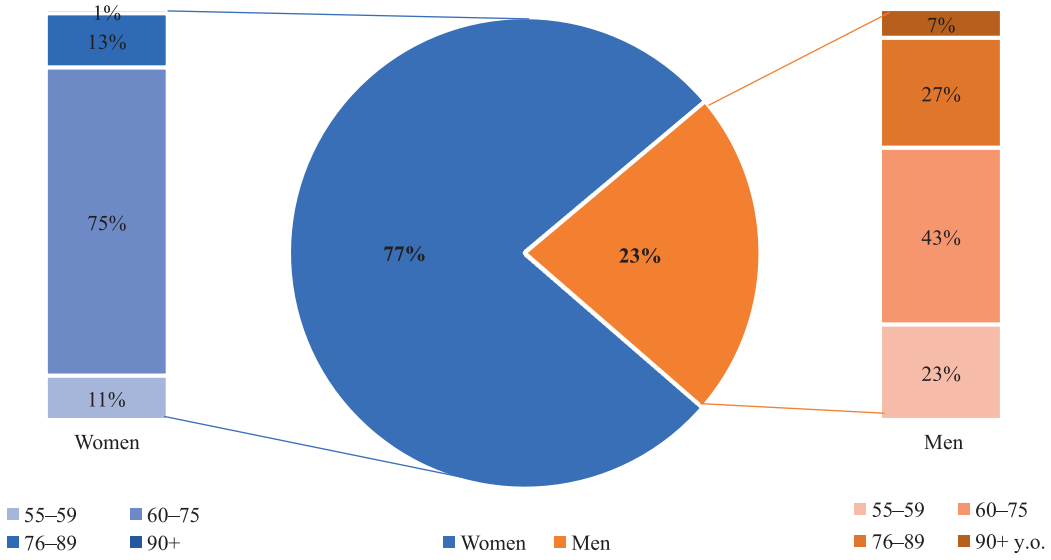

Fig. 3. Age and gender of the surveyed pre-seniors and seniors
Source: own elaboration.

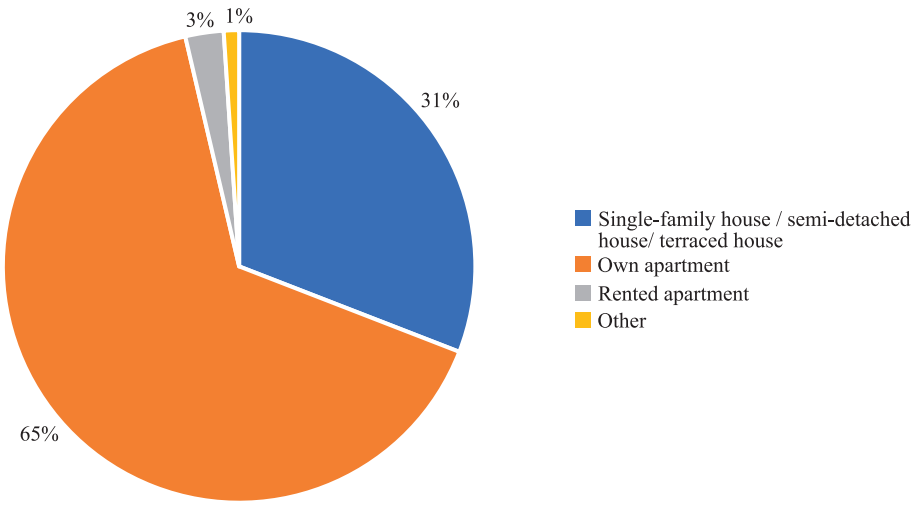

Fig. 4. Types of dwellings occupied by the respondents
Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

Most respondents lived with spouses (55%) or alone (47%), whereas the smallest proportion of the surveyed older people lived with parents (2%) or partners (3%) (Figure 5). Cohabitation patterns differed between the genders. Most women lived alone (55%), whereas most men lived with wives (69%). Both female and male respondents were least likely to live with parents (1% and 4%, respectively) or partners (3% and 5%, respectively). Considerable differences were also observed between older citizens living in apartment blocks and single-family homes. The majority of apartment dwellers lived with spouses (42%) or alone (47%), whereas most respondents residing in single-family homes lived with their spouses (71%). The answers in Figure 5 do not sum up to 100% because the respondents could give more than one answer (such as living with a spouse and children).

In the question regarding older adults daily activities, most respondents declared that they belonged to senior organisations (41%), were not professionally active and were not enrolled in educational programs (30%). In the surveyed group, 13% of the respondents were business owners or were employed part-time. Only 10% and 8% of older people worked as volunteers or attended courses to improve their professional qualifications, respectively (Fig. 6). The answers do not sum up to 100% because the respondents could choose more than one answer.

Most women were members of senior organisations (43%) or were not involved in any type of professional or educational activity (34%). Very few older females were business owners or were employed part-time (4% and 5%, respectively). In turn, most male respondents were professionally active (35%) or belonged to senior organisations (33%), whereas the smallest percentage of retired men improved their professional qualifications (6%) or were involved in volunteer work (7%).

Similarly to the previous question, older citizens residing in apartments and houses also differed in the type of undertaken daily activities. In addition to membership in senior organisations, 28% of apartment dwellers were not involved in any type of professional or educational activity, whereas 29% of house dwellers took care of their grandchildren.

In the following question, the respondents were asked to evaluate the extent to which residential infrastructure components contribute to their safety. The responses given by the residents of the analysed cities largely overlapped, and they were pooled. The study revealed that the size and geographic location of cities had no influence on the perceived importance of infrastructure components that

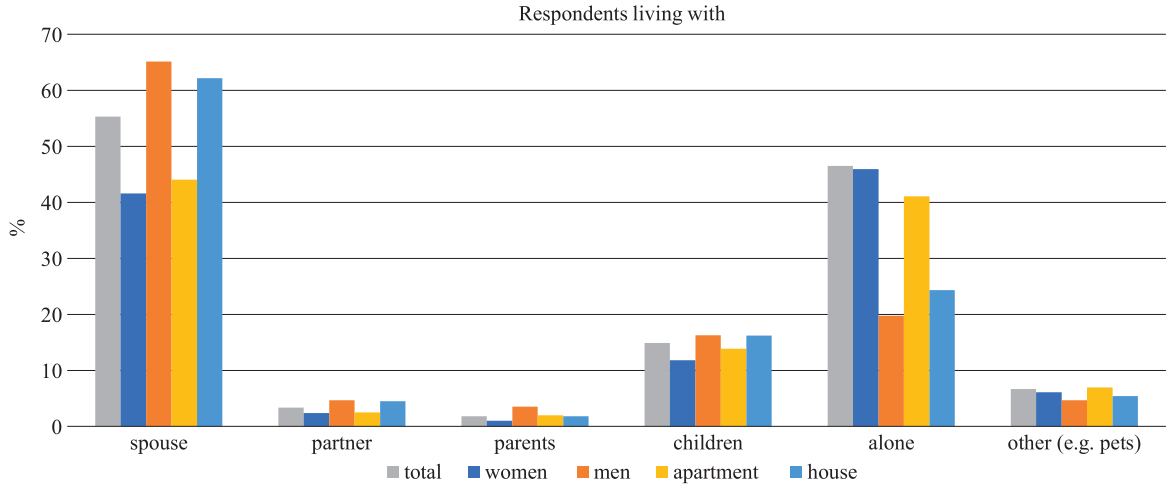

Fig. 5. Household members indicated by the surveyed pre-seniors and seniors
Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

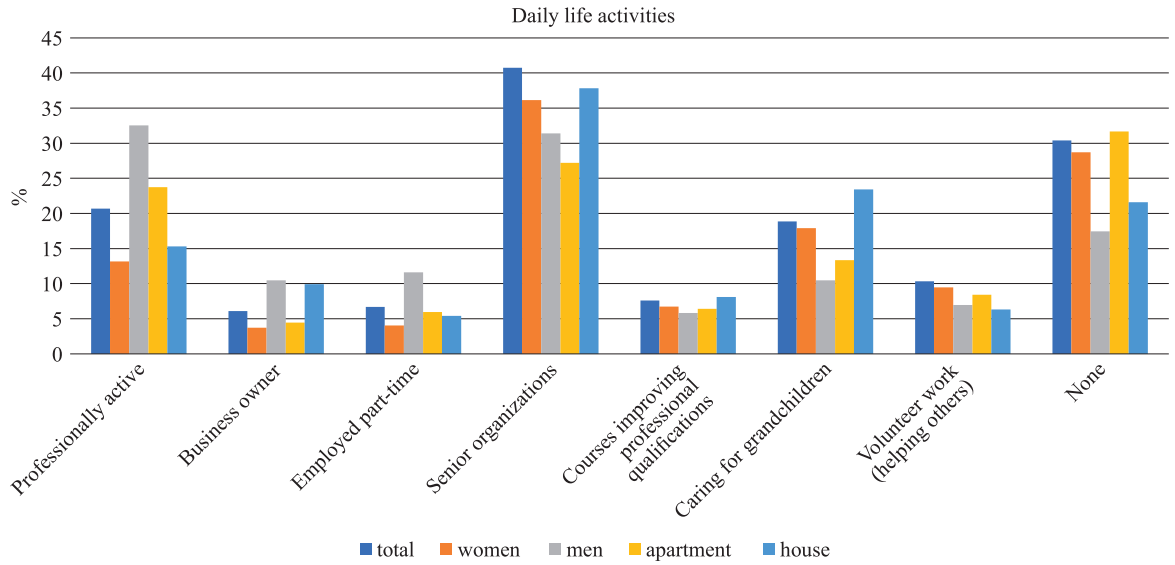

Fig. 6. Daily life activities of the surveyed pre-seniors and seniors
Source: own elaboration.

enhance older people's safety in residential estates. In contrast, the respondents' sense of security was significantly influenced by the type of potential threat. The differences in the participants' opinions regarding the importance of residential infrastructure components between the first (during the COVID-19 pandemic) and the second (after the outbreak of the war in Ukraine) survey are presented in Figure 7. The changes in older people's perceptions of safety in open residential spaces are presented in Table 8.

The greatest increase in perceived importance was observed in civil defence infrastructure (up by 14 places in the ranking) such as basements, underground tunnels, and shelters (47%), basic recreational infrastructure such as picnic areas (barbecue and fire pits) (up by 7 places in the ranking, 43%), and sanitation infrastructure (up to 9 places in the ranking). These three infrastructure categories were regarded as particularly important in the face of a threat. The greatest decrease in perceived importance was noted in the presence of community and district clubs (21%) and perceptions of the neighbourhood (19%). No considerable differences in the perceived importance of infrastructure components were noted between the genders in the first survey, but they were observed in the second survey. However, the identified differences were not significant. In the second survey, both male and female respondents attached greater importance to civil defence infrastructure (49% and 43%, respectively) and picnic areas (44% and 42%, respectively). Women were more likely to recognize the importance of sanitation infrastructure (17%), whereas warning signs and audible traffic signals were regarded as less important (16%). Men attached greater importance to sports facilities (27%) and taxi stops (25%), and less importance to community and district clubs (27%), free transport for older citizens (26%), and vegetation density (17%).

The perceived importance of infrastructure components that contribute to older people's sense of security did not differ significantly between apartment dwellers and respondents residing in houses. However, these groups differed in their perceptions regarding the importance of distance between buildings (20% and 10%, respectively) and the presence of community and district clubs (15% and 12%, respectively). In the second survey, a much greater decrease in importance of warning signs and audible traffic signals was noted among apartment dwellers than older citizens residing in houses (17% and 1%, respectively). The greatest

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

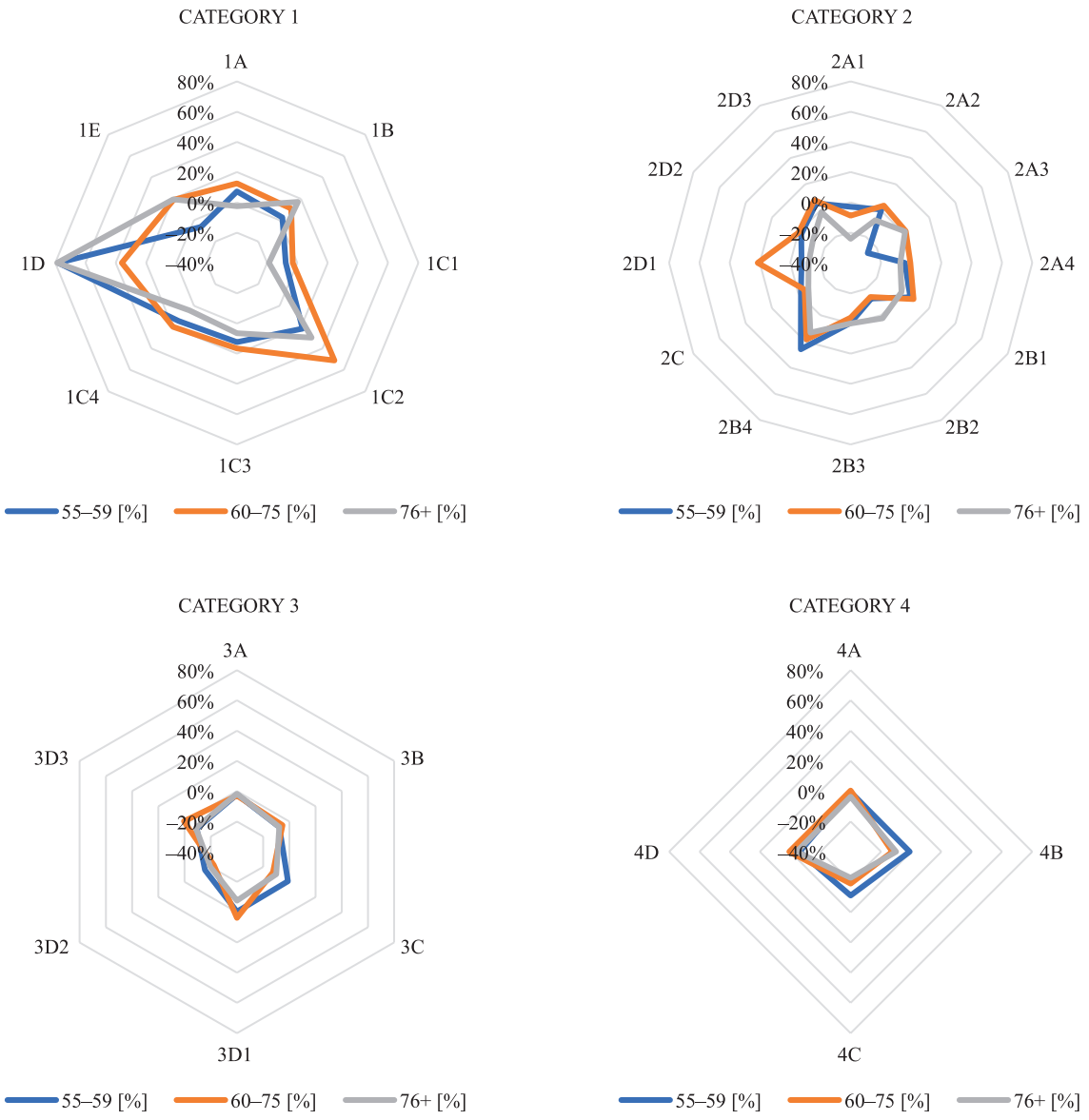

Fig. 7. Differences in the perceived importance of residential infrastructure components that contribute to the safety of pre-seniors and seniors (before and after the outbreak of the war in Ukraine)
Source: own elaboration.

difference was observed with regard to local volunteer services which importance decreased by 17% among apartment dwellers and increased by 6% among house residents.

The most significant differences were observed between age groups, which could be attributed to health factors as well as generational differences. In the pre-senior group (55–59), the greatest increase in perceived importance was noted for safe shelters (+78%), taxi stops (+26%), and picnic areas (+21%), whereas vegetation density (-27%) and perceptions of the neighbourhood (-11%) were regarded as far less important in the second survey. The importance of public transport stops (0%) and the condition of sidewalks, curbs and ramps (+1%) did not change significantly between the surveys.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

Table 8. Perceived importance of selected infrastructure components that contribute to pre-seniors' and seniors' sense of security

No.	Hierarchy of factors in survey I*	Hierarchy of factors in survey II*	Changes in perceived importance***
1	Rapid Police and City Guard response to calls for service	Traffic routes. Sunlight access in streets and residential estates	↑3
2	Neighbourhood safety	Traffic routes. Condition of sidewalks, curbs, and ramps	↑6
3	Access to healthcare facilities and pharmacies	Access to healthcare facilities and pharmacies	→
4	Traffic routes. Sunlight access in streets and residential estates	Public transport stops (bus, tram, metro, etc.)	↑1
5	Public transport stops (bus, tram, metro, etc.)	Access to retail and service outlets	↑1
6	Access to retail and service outlets	Sources of noise, such as busy streets	↑3
7	Traffic routes. Distance between buildings	Rapid Police and City Guard response to calls for service	↓6
8	Traffic routes. Condition of sidewalks, curbs, and ramps	Neighbourhood safety	↓6
9	Sources of noise, such as busy streets	The residential estate is clean and well-maintained	↑2
10	Social relations and social participation. Social bonds, proximity of friends and family	Social relations and social participation. Social bonds, proximity of friends and family	→
11	The residential estate is clean and well-maintained	Architectural solutions	↑6
12	Basic recreational infrastructure. Benches and rest areas	Traffic routes. Distance between buildings	↓5
13	Age-friendly parking	Sanitation infrastructure	↑9
14	Good/bad neighbourhood	Adequate access to information about public transport (timetables, routes, delays, changes)	↑1
15	Adequate access to information about public transport (timetables, routes, delays, changes)	Route directions, traffic signs, information boards, signposts	↑1
16	Route directions, traffic signs, information boards, signposts	Civil defence infrastructure	↑14
17	Architectural solutions	Age-friendly parking	↓4
18	Warning signs and audible traffic signals (including at pedestrian crossings)	Basic recreational infrastructure. Cycle paths	↑5
19	Traffic routes. Vegetation density	Basic recreational infrastructure. Sports facilities (outdoor gyms, playing fields)	↑6
20	Assistive technologies	Taxi stops	↑6
21	Social relations and social participation. Community or district clubs	Basic recreational infrastructure. Benches and rest areas	↓9
22	Sanitation infrastructure	Basic recreational infrastructure. Picnic areas (barbecue and fire pits)	↑7
23	Basic recreational infrastructure. Cycle paths.	Assistive technologies	↓3
24	Free transport for older citizens	Warning signs and audible traffic signals (including at pedestrian crossings)	↓6
25	Basic recreational infrastructure. Sports facilities (outdoor gyms, playing fields)	Traffic routes. Vegetation density	↓6
26	Taxi stops	Bad/good neighbourhood	↓12
27	Landmarks that facilitate orientation (such as church towers, tall buildings, old trees)	Landmarks that facilitate orientation (such as church towers, tall buildings, old trees)	→
28	Social relations and social participation. Local volunteer services (shopping, cleaning, etc.)	Free transport for older citizens	↓5
29	Basic recreational infrastructure. Picnic areas (barbecue and fire pits)	Social relations and social participation. Local volunteer services (shopping, cleaning, etc.)	↓1
30	Civil defence infrastructure	Social relations and social participation. Community or district clubs	↓9

*I – the first survey was conducted during the third wave of the COVID-19 pandemic in October 2021
**II – the second survey was conducted at the turn of March and April 2022 (two months after the outbreak of the war in Ukraine)
*** – changes in perceived importance: ↑ the importance of the criterion increased, ↓ the importance of the criterion decreased, → the importance of the criterion did not change.
Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

Table 9. Ranks calculated for the analysed factors during the COVID-19 pandemic and after the outbreak of the war in Ukraine, separately for age groups

Cat.	Factor	Total		55–59		60–75		76+	
		Rank I*	Rank II**	Rank I*	Rank II**	Rank I*	Rank II**	Rank I*	Rank II**
1A	Architectural solutions	3	3	3	3	3	4	3	4
1B	Assistive technologies	3	3	3	3	3	3	3	4
1C1	Basic recreational infrastructure. Benches and rest areas	4	3	3	3	4	3	4	3
1C2	Basic recreational infrastructure. Picnic areas (barbecue and fire pits)	2	3	2	3	2	3	2	3
1C3	Basic recreational infrastructure. Cycle paths	3	3	3	3	3	3	2	3
1C4	Basic recreational infrastructure. Sports facilities (outdoor gyms, playing fields)	3	3	3	3	3	3	2	3
1D	Civil defence infrastructure	2	3	1	3	2	3	1	3
1E	Sanitation infrastructure	3	3	3	2	3	4	2	4
2A1	Traffic routes. Distance between buildings	4	3	4	4	4	3	4	3
2A2	Traffic routes. Condition of sidewalks, curbs, and ramps	4	4	4	4	4	4	4	4
2A3	Traffic routes. Vegetation density	3	3	3	2	3	3	3	3
2A4	Traffic routes. Sunlight access in streets and residential estates	4	4	4	4	4	4	4	4
2B1	Adequate access to information about public transport (time tables, routes, delays, changes)	3	3	3	3	3	3	3	3
2B2	Free transport for older citizens	3	2	3	2	3	2	2	3
2B3	Access to public transport stops (bus, tram, metro)	4	4	4	4	4	4	4	4
2B4	Taxi stops	3	3	3	3	3	3	2	4
2C	Age-friendly parking	4	3	4	4	4	3	4	4
2D1	Landmarks that facilitate orientation (such as church towers, tall buildings, old trees)	2	2	3	2	2	3	3	2
2D2	Warning signs and audible traffic signals (including at pedestrian crossings)	3	2	4	3	3	2	2	2
3B	Access to healthcare facilities and pharmacies	3	3	3	3	3	3	3	3
3C	Rapid Police and City Guard response to calls for service	4	4	4	4	4	4	3	4
3D1	Social relations and social participation. Local volunteer services (shopping, cleaning, etc.)	4	4	4	4	4	4	4	4
3D2	Social relations and social participation. Community and district clubs	4	4	4	4	4	4	4	4
3D3	Social relations and social participation. Social bonds, proximity of friends and family	2	2	2	2	2	2	4	2
4A	Cleanliness	2	2	3	2	3	2	2	2
4B	Neighbourhood safety	4	3	3	3	4	3	3	4
4C	Good/bad neighbourhood	3	3	4	3	3	3	4	3
4D	Sources of residential noise, such as busy streets	4	4	4	4	4	4	4	4

*I – the first survey was conducted during the third wave of the COVID-19 pandemic in October 2021
**II – the second survey was conducted at the turn of March and April 2022 (two months after the outbreak of the war in Ukraine).
Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

The young-old (60–75) attached greater importance to picnic areas (+51%) and civil defence infrastructure (+36%). The significance of perceptions of the neighbourhood (-19%), neighbourhood safety (-12%), and rapid Police and City Guard response to calls for service (-12%) decreased in the second survey. No significant differences were observed in the importance of residential cleanliness, social bonds, and independent living in the place of residence (0% each).

In turn, people aged 76+ were significantly more likely to recognize the importance of civil defence infrastructure (+79%), picnic areas (+30%), and sanitation infrastructure (+19%). The greatest decrease was noted in the perceived importance of the distance

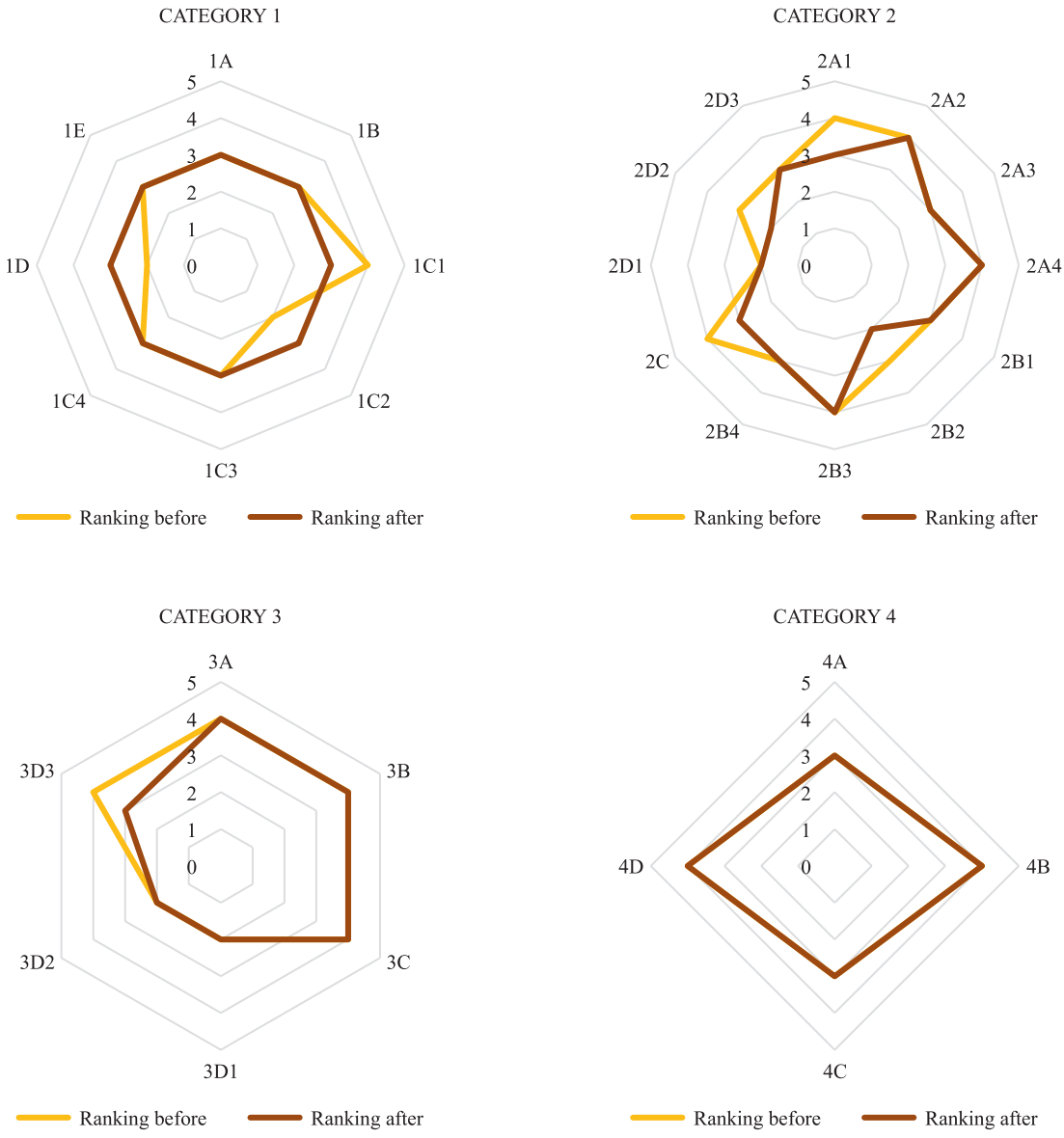

Fig. 8. Ranking of the analysed factors before and after the outbreak of the COVID-19 pandemic and the war in Ukraine

Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

between buildings (-24%), perceptions of the neighbourhood (-23%), and the presence of benches and rest areas (-19%). The importance of public transport stops (0%) did not change, whereas only a minor decrease was observed as regarding the importance of public transport and transport information (-1%), as well as route directions, traffic signs, information boards, and signposts (-1%).

The analysed factors were ranked based on cumulative frequency series and median values – before and after the outbreak of the COVID-19 pandemic and the war in Ukraine, respectively. Ranks were calculated for the entire population sample and each age group (Table 9). Factors which perceived importance increased in the second survey are marked in green, and factors which importance decreased in the second survey are marked in red. A similar comparison was conducted for male and female participants, as well as older citizens residing in apartments and single-family houses, but significant differences were not found between these groups.

The analysed factors in each of the four groups of infrastructure components that contribute to older people's sense of security in the place of residence were ranked based on their perceived importance in the survey (Fig. 8). Category 1 factors (Technical protective infrastructure, infrastructure without architectural barriers, and safe shelters) and Category 2 factors (Safe transport solutions) are ranked in Figure 9. Category 3 factors (Social support and welfare) and Category 4 factors (Perceptions of the neighbourhood) are ranked in Figure 10.

The data presented in the figures point to the highest increase in the ranking of safe transport

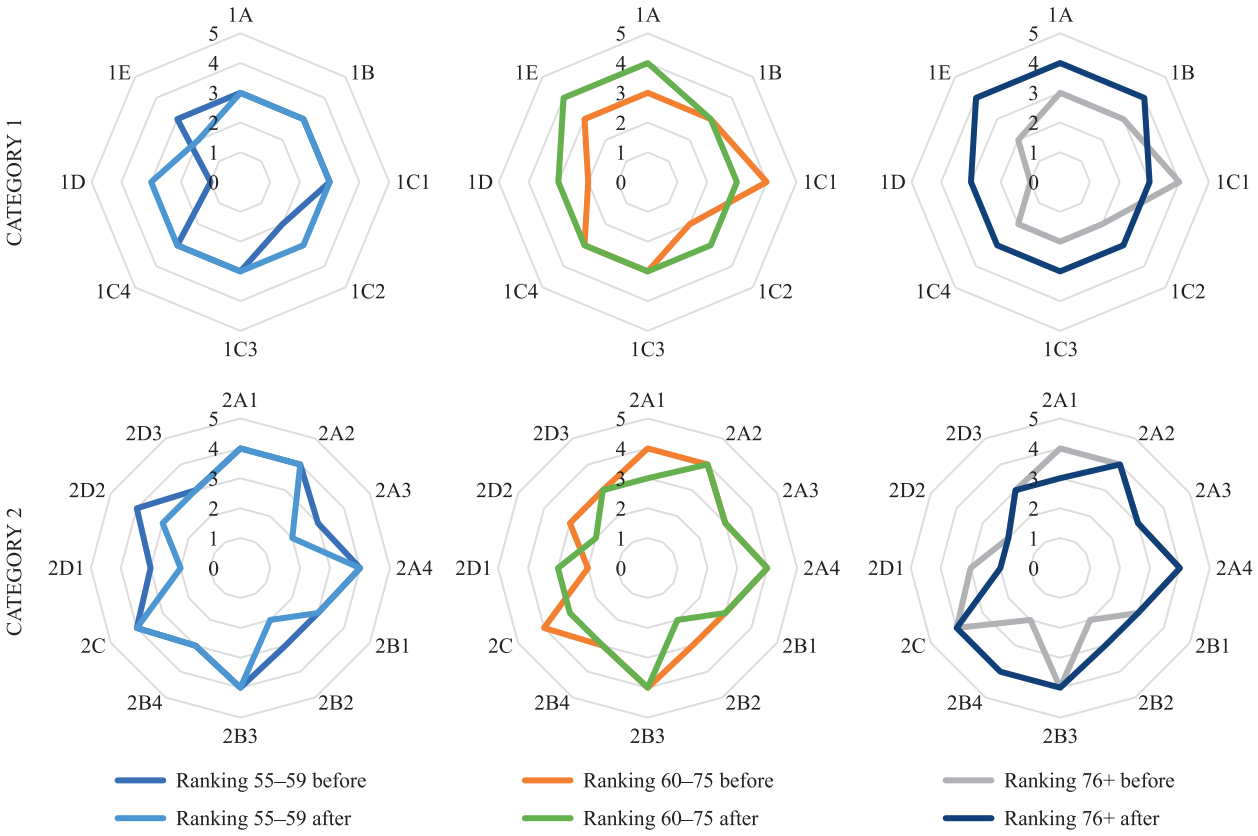

Fig. 9. Ranking of category 1 and category 2 factors before and after the outbreak of the COVID-19 pandemic and the war in Ukraine, in different age groups

Source: own elaboration.

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

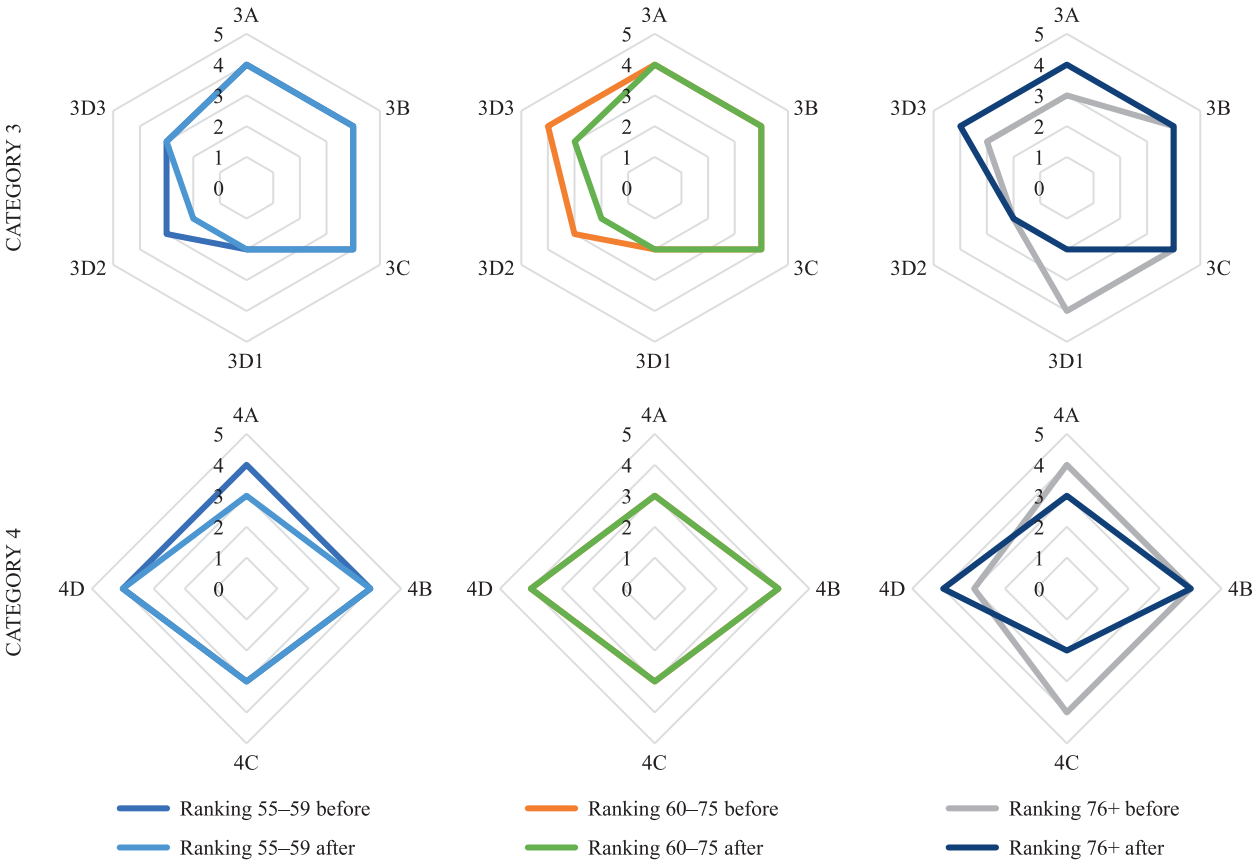

Fig. 10. Ranking of category 3 and category 4 factors before and after the outbreak of the COVID-19 pandemic and the war in Ukraine, in different age groups

Source: own elaboration.

solutions (category 2), followed by social infrastructure (category 3). A minor decrease was observed in the importance of technical protective infrastructure, infrastructure without architectural barriers, and safe shelters (category 1). No significant changes were noted in the ranking of category 4 factors (perceptions of the neighbourhood). Certain differences in the perceived importance of the analysed factors were observed between age groups. The opinions voiced by the oldest group differed from those expressed by the remaining respondents (greatest differences in the perceived importance of the analysed factors before and after the outbreak of the COVID-19 pandemic and the war in Ukraine).

CONCLUSIONS

The results of the study were used to develop a list of factors which contribute to older people's sense of security in public open spaces in residential estates. The list is innovative and universal, and it was compiled based on a review of domestic and international literature. The identified factors can be applied in all countries to expand the scope of research conducted at the national, regional, and local level. These factors were classified into four categories. Older persons participated in two questionnaire surveys, and their responses were used to classify the perceived importance of the analysed factors in different age groups. Most differences were associated with the participants' age, which confirms the research

✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

hypothesis. These findings can be attributed to health factors in age groups and potential generational differences. No significant differences were observed between respondents residing in different cities, between genders, or between participants living in different types of housing. The results were used to determine the influence of two different threats on the perceived importance of infrastructure components that increase safety in residential estates. During the COVID-19 pandemic, the respondents attached the greatest importance to category 4 factors (perceptions of the neighbourhood, cleanliness and sanitation) and category 3 factors (social support and welfare). After the outbreak of the war in Ukraine, the participants attached equal importance to category 4 factors, whereas category 1 factors (technical protective infrastructure, infrastructure without architectural barriers, and safe shelters) emerged as the second most important category.

The results of the study indicate that older people's sense of security in public open spaces in residential estates should be identified in the context of various threats. The opinions and perceptions of older adults should be analysed in various age groups.

A considerable limitation in carrying out such surveys is the lifestyle of older citizens. It is much easier to reach those who prefer an active lifestyle with surveys than those who are less active (homemakers). Therefore, preference surveys should be extended to include a larger random sample of people with low activity levels in order to validate the results obtained.

The major limitation during these studies proved to be the availability to older people during the pandemic period. Therefore, studies performed during a time of threat (e.g. pandemic and armed conflict) should be validated by repeating them during a quieter period without the direct influence of these threatening factors (stabilisation period). Perhaps then the hierarchy of factors will change due to re-evaluation. However, given that emerging threats are pulsating phenomena, the results of the research should be taken into account and hooked into the time of threats as important influences (biases) on the results obtained. In peacetime we do not need shelters, but this does not mean that they are unnecessary elements of infrastructure. In view of this, all preferences and needs that may be affected by any hazards should still be taken into account even despite their current existence, in the event that these hazards emerge or return.

The functional and landscape components of residential estates that enhance older people's sense of security should also be studied in the international context. Such attempts will be made in successive stages of research.

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✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

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✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

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✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

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✉marta.czaplicka@uwm.edu.pl, ✉agnieszka.dawidowicz@uwm.edu.pl, ✉gosiadudzi@uwm.edu.pl, ✉adam.senetra@uwm.edu.pl

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RESTRICTIONS ON THE USE OF AGRICULTURAL LAND IN UKRAINE FOR THE PROTECTION OF WATER RESOURCES

Yosyp Dorosh[1]✉, Roman Derkulskyi[2]✉, Andriy Dorosh[3]✉, Alina Kabuzan[4]✉

[1] ORCID: 0000-0002-1764-6188
[2] ORCID: 0000-0002-7244-3906
[3] ORCID: 0000-0002-2234-124X
[4] ORCID: 0009-0003-0189-0893
[1,2,3,4] Land Management Institute of National Academy of Agrarian Sciences of Ukraine
Vasylkivska Street, 37, 03022, Kyiv, **Ukraine**

ABSTRACT

Motives: The value of water resources has increased in the 21st century due to global climate change, population growth, and the demand for water in agriculture, industry, and other sectors of the economy. However, increasing demand leads to a deterioration in the quality of water, including drinking water, and it affects the environmental sustainability of water resources and coastal lands. Agriculture plays a major role in water pollution in Ukraine and in other European countries. Therefore, it is important to address the topic of restrictions on the use of agricultural land to reduce the polluting effect.
Aim: The main aim of the study was to examine regulations on the use of agricultural land in Ukraine for the protection of water resources, and the process of imposing water protection restrictions on the use of agricultural land, taking into account the requirements of the Sustainable Development Goals and the prospects for Ukraine's accession to the European Union.
Results: The theoretical principles for establishing the boundaries of water protection zones and coastal protection belts around water bodies were analyzed. The legal framework regulating restrictions on the use of agricultural land in Ukraine was examined, with particular emphasis on the establishment of water protection zones. It was found that the provisions of the Land and Water Codes of Ukraine regulate the size of water protection zones and coastal protection belts. Water bodies are regime-forming objects, and they are systematized according to the requirements for establishing the boundaries of coastal protection belts. The indicators measuring the access to drinking water, as part of the implementation of the Sustainable Development Goals in Ukraine, were analyzed. The study revealed that in Ukraine, regardless of the current legislative regulations relating to the restrictions on the use of agricultural land, which provide for the protection of water bodies from pollution and clogging and the preservation of water resources, there is a need to establish the boundaries of water protection zones and coastal protection belts.

Keywords: water bodies, water protection zones, land management, coastal protection belts, water fund, land management projects, Nitrates Directive, Nitrate Vulnerable Zones (NVZs)

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

INTRODUCTION

Anthropogenic activity in one way or another affects the surrounding natural environment and its components: water resources, atmospheric air, animal and plant life, and land resources. As a result of the land reform in Ukraine, land, in addition to the previously performed functions (natural resource, basis of production and living, means of production), became an object of real estate and investment, a market resource. As the basis of the ecosystem, a tool and object of production, an object of property rights, it is the basis of sustainable development, a condition for social progress and public welfare (Novakovska, 2018). That is why, in the interest of ensuring public welfare, it is necessary to regulate the issue of protection and rational use of natural resources, in particular, land resources and water resources, at the legislative level.

Before the full-scale invasion of the Russian Federation, Ukraine ranked 3rd in the world in terms of the area of agricultural arable land per inhabitant, and with 8.7% of the world's chernozem area on its territory, Ukraine can meet the food needs of at least 150–180 million people, i.e. to provide the own population with food products and to organize the export of part of the food, the need for which is constantly growing in the world. It is indisputable that the realization of the specified goal is impossible without frugal, rational and ecologically safe use and all kinds of protection of the unique land and resource potential of the country (Nedashkivska & Dobryak, 2014).

For the sake of rational and ecologically safe use of agricultural and other lands around water bodies in Ukraine, restrictions on the use of land plots are established. The Law of Ukraine "On the State Land Cadastre" defines the term regime-forming object, "an object of natural or artificial origin (a water object, an object of main pipelines, an energy object, an object of cultural heritage, a military object , another object defined by law), under which and/or around which, in connection with its natural or acquired properties, according to the law, land use restrictions are established" (Law of Ukraine "On the State Land Cadastre", 2011).

In Ukraine, water protection zones are established in order to create a favorable regime for water bodies, prevent their pollution, clogging and depletion, destruction aquatic plants and animals, as well as reduce flow fluctuations along rivers, seas and around lakes, reservoirs and other bodies of water.

In order to protect surface water bodies from pollution and clogging and preserve their water capacity along streams, rivers, around lakes and seas, reservoirs and other bodies of water within water protection zones, land plots are allocated for coastal protection belts based on land management projects.

That is, in Ukraine there is a certain legislative and regulatory regulation of the use of agricultural lands and not only those adjacent to water bodies in the format of establishing restrictions, which provide for a regime of regulated economic activity on the territory of water protection zones and a stricter regime of limited economic activity within the boundaries of coastal protection belts, which are defined as nature conservation areas. However, these regulations do not fully fulfill the functions that rely on them, and therefore the main purpose of establishing regulations is not achieved.

Certain reasons for which there are problems with the formation of water protection zones and coastal protection belts, compliance with restrictions on the use of agricultural land for the protection of water resources require research, wider disclosure and the search for solutions, especially in the context of adapting Ukrainian legislation and policies to similar ones in the European Union.

The relevance of the issue disclosed in this article is also correlated with the Sustainable Development Goals of Ukraine for the period up to 2030, which are adapted taking into account the specifics of Ukraine's development and set forth in the National Report "Sustainable Development Goals: Ukraine", which are based on the resolutions of the General Assembly of the Organization United Nations of September 25, 2015 No. 70/1 global goals for sustainable development until 2030. In particular, in the context of this

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

publication, the achievement of the following goals should be highlighted:

- overcoming hunger, achieving food security, improving nutrition and promoting the sustainable development of agriculture;
- ensuring availability and sustainable management of water resources and sanitation;
- taking urgent measures to combat climate change and its consequences;
- preservation and rational use of oceans, seas and marine resources in the interests of sustainable development;
- protection and restoration of terrestrial ecosystems and promotion of their rational use, rational forest use, combating desertification, stopping and reversing (reversal) the process of land degradation and stopping the process of biodiversity loss.

The goals of sustainable development of Ukraine for the period until 2030 are guidelines for the development of projects of forecasting and program documents, projects of normative legal acts with the aim of ensuring the balance of economic, social and ecological dimensions of sustainable development of Ukraine.

LITERATURE REVIEW

Research conducted by such European scientists as: Susanne Wuijts, Jacqueline Claessens, Luke Farrow, Donnacha G. Doody, Susanne Klages, Chris Christophoridis, Rozalija Cvejić, Matjaž Glavan, Ingrid Nesheim, Froukje Platjouw, Isobel Wright, Jenny Rowbottom, Morten Graversgaard, Cors van den Brink, Inês Leitão, António Ferreira, Sandra Boekhold shows that the complexity and inconsistency of the European legislation created to protect drinking water resources from agricultural pollution is most clearly manifested at the local level, where cross-sectoral measures need to be taken and the consequences controlled. At this local level, they tend to hinder efforts to achieve water quality goals rather than facilitate them. The upcoming revision of the EU Water Framework Directive (WFD) should strengthen the links between the different directives and how they can be applied at the local level (Wuijts et al., 2021).

The analysis by H. M. Flávio, P. Ferreira, N. Formigo, J. C. Svendsen shows significant progress in efforts to link agriculture and water restoration, but it also demonstrates the urgent need for more and more detailed restoration projects. The first cycle of the EU WFD ended in 2015 and, according to the authors, did not achieve the goal of good ecological status in many European water bodies (Flávio et al., 2017).

The publication of M. K. Cherkashyna is devoted to the consideration of the main issues of the water policy of the European Union regarding water protection and rational water use (Cherkashyna, 2017).

At the basic, review level, T. O. Basiuk, I. A. Boiko, A. G. Borovytska, I. V. Hopchak, M. Mikhalieva, P. Stoliarchuk considered the experience of the European Union in the field of protection and rational use of water resources, but this issue was not comprehensively analyzed by Ukrainian scientists. Issues related to the regulation of regime-forming objects, land protection, rational use of the water fund, and the establishment of coastal protection belts in Ukraine are covered in the works of Yu. Yaremko and N. Dudyak (Yaremko & Dudyak, 2020), T. Nedashkivska and D. Dobryak, V. Peresoliak and S. Malakhova and other scientists.

T. Nedashkivska and D. Dobryak, draw attention to the need to substantiate (economic, ecological and legal) mechanisms for establishing protective, security and sanitary zones and belts around regime-forming objects and determining the extent of damages caused by them, as well as their compensation (Nedashkivska & Dobryak, 2014).

I. Pokydko and A. Martyn highlight issues related to the formation of water protection restrictions in land use through the reform of the already existing organizational and legal system of regulation of coastal land use in Ukraine. They point out that it is worth referring to foreign experience in the issue of forming water protection restrictions in land use (Pokydko & Martyn, 2012).

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

V. Peresolyak, S. Malakhova point out that it is necessary to regulate the issue of construction of coastal protective belts, because excessive development near water bodies in turn leads to a negative impact on the ecosystem as a whole (Peresolyak & Malakhova, 2013).

A study (Wilkinson, 1985) noted that often imposed restrictions lead to a significant decrease in the market value of the object to which such restrictions are applied. This is especially evident in relation to limiting the use of land for agricultural purposes. At the same time, another problem is noted regarding the existing legislation of many developing countries, which does not provide for compensation to land owners whose land is subject to restrictions (Wilkinson, 1985).

MATERIALS AND METHODS

Given the relevance of the issue of restrictions on the use of agricultural land in Ukraine within water protection zones and coastal protection belts, the materials of our study include practical examples of violations of the size of coastal protection zones, as well as their use regimes. Special emphasis is given to the issue of implementation in Ukraine of European policies regarding the protection of water bodies. The analysis of the materials of the Methodology for determining zones vulnerable to (accumulation) of nitrates provides for the implementation of some provisions regarding the definition of Nitrate Vulnerable Zones (NVZs) in the process of developing land management projects that define water protection zones and coastal protection belts.

In the process of scientific research, generally accepted methods of scientific research were used: monographic, statistical, analytical, comparative, and abstract-logical methods.

The works of scientists who studied the formation and establishment of water protection zones and coastal protective belts and restrictions on the use of agricultural land, which are established for the protection of water resources, were analyzed using the monographic method.

The statistical evaluation method was used in the evaluation of the data of the monitoring report "Sustainable Development Goals – Ukraine" regarding the safety of drinking water according to microbiological indicators (by % of non-standard samples) and the construction of a graph.

The comparison method was used when comparing the principles of land management for the territories adjacent to water bodies in Ukraine, the relevant legal framework and European policies, such as: Water Framework Directive (2000/60/EC), Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources 91/676/EEC, Directive on the quality of water intended for human consumption (2020/2184), Floods Directive (2007/60/EC).

Summarizing the results, conclusions were made using the abstract-logical method regarding the shortcomings in the observance of restrictions on the use of agricultural land in Ukraine for the purpose of protecting water resources, regarding the determination of the boundaries of water protection zones and coastal protection belts. Regarding the improvement of land management measures around water bodies, in particular regarding the implementation of the provisions of the Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources 91/676/EEC.

RESULTS

Protection of water resources and ensuring water quality are important problems in Ukraine. First of all, it provides for the protection of water ecosystems from pollution and lowering the water level in rivers, lakes and other water bodies. According to the national atlas, 63,119 rivers and streams with a total length of over 206,000 km flow through the territory of Ukraine. About 60,000 of them (93%) are very small (less than 10 km long). Their total length is 112 thousand km; there are 3,219 small rivers with a length of more than 10 km, and their total length is about 74 thousand km. There are 81 medium

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

rivers with a total length of 15,488 km within Ukraine (Sustainable Development Goals, 2021).

Large rivers include the Danube, Tisza, Dnipro, Pripyat, Desna, Dniester, Siverskyi Donets, Southern Bug, and Western Bug. The largest number of rivers belongs to the basins of the Dnipro – 27.7, the Danube – 26.3, the Dniester – 23.7, and the Southern Bug – 9.3% (of the entire number of rivers in Ukraine) (Sustainable Development Goals, 2021).

It is also important to note that such large cross-border rivers as Tisza, Danube, Dniester, Prut, Uzh, Western Bug, Syan and other smaller rivers flow through the territory of Ukraine and European countries. In this regard, the protection of water resources and restrictions on the use of agricultural land in Ukraine and in neighboring countries should be harmonized and agreed, which can be ensured by the implementation of EU policies, rules and EU directives.

Ukraine has a significant amount of water resources, but their pollution and overexploitation can lead to serious problems with water supply and water quality. Ensuring water quality includes monitoring the quality of drinking water, water for industry, population and other purposes. Water pollution can occur naturally, but in most cases it is a consequence of human activity. Insufficient control over pollution can lead to a threat to people's health and to a decrease in the economic potential of regions.

The water strategy of Ukraine for the period until 2025, which was developed by the Institute of Water Problems and Reclamation of the National Academy of Agrarian Sciences of Ukraine, notes the significant negative impact on water bodies, which is exerted by dispersed (diffuse) runoff from agricultural and residential (urbanized) territories, as well as from areas occupied by industrial waste, landfills. There is also a constant danger of cross-border pollution of the river flow. These factors led to the fact that a large part of water bodies is characterized by a high degree of pollution and low water quality. The most tense situation has developed in the basins of the Siverskyi Donets, Ingul, Ingulets, and Priazovia rivers (Hadzalo et al., 2015).

A separate threat is the conduct of military (combat) operations in the territories of territorial communities located in the south and east of Ukraine and subject to both landmines and the catastrophic consequences of hostilities, one of which was the destruction of the Kakhovka Reservoir dam. In addition to human casualties and economic losses, ecological damage and pollution of the waters of the Dnipro River and the Black Sea, which are unprecedented for Europe.

As in pre-war times, as of now and in the period of post-war reconstruction, water resources protection is one of the important components of ensuring water quality in Ukraine. Usually, sources of pollution of water resources include:
– substances used in agriculture;
– waste oil products from water transport;
– wastewater from industrial and other enterprises.

One of the main results of the protection of water bodies should be the improvement of the quality of drinking water, so according to the monitoring report "Goals of sustainable development – Ukraine", the safety of drinking water according to microbiological indicators (in % of non-standard samples) has been slowly but gradually increasing since 2015 of this indicator and as of 2021 was 5.1% for urban areas of residence (orange line), 11.9% for rural areas (green line), by type of water supply: centralized – 7.6% (purple line), decentralized – 22.6% (brown line), which is shown in Chart 1.

Agriculture is one of the key sources of water pollution, which necessitates the establishment of water protection zones with a regime of regulated economic activity and coastal protective belts with a regime of limited economic activity with special conditions for the use of agricultural land.

In Ukraine, there is a regime of regulated economic activity within water protection zones, and the following actions are prohibited:
1. Use of persistent and potent pesticides.
2. Placement of cemeteries, cattle burial grounds, landfills and filtration fields.
3. Discharge of untreated sewage into reservoirs, quarries, streams, etc.

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

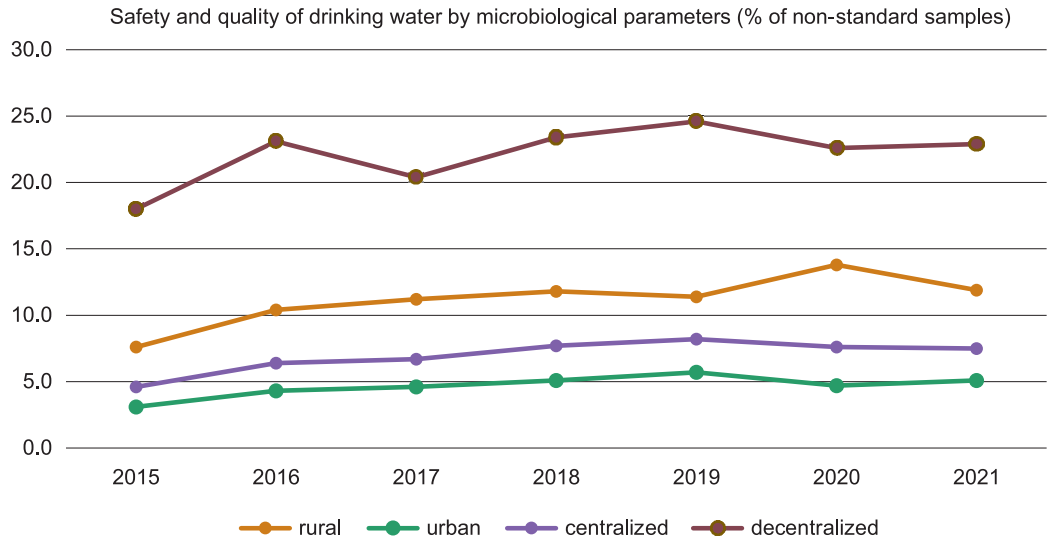

Chart 1. Safety of drinking water in Ukraine according to microbiological indicators (by % of non-standard samples)

Source: own preparation based on data from Sustainable Development Goals. Monitoring Report (2021).

In some cases, when the impact of the planned activity on the environment has been assessed and approved, sand and gravel mining is allowed within the water protection zone, except for the lands of the water fund, on land in floodplains and in the riverbeds, subject to approval by the relevant state authorities. Water protection zones of marine water areas, bays and estuaries in Ukraine usually coincide with the coastal protective belt and have a width of at least 2 km from the edge of the water.

The boundaries of water protection zones are established in accordance with land management projects, which provide for the organization and establishment of boundaries of water fund territories and water protection zones, as well as restrictions on the use of lands and their regime-forming objects. Also, the boundaries of water protection zones can be determined by comprehensive plans for the spatial development of the territories of territorial communities, or by general plans of settlements. The boundaries of water protection zones are established taking into account several factors. First of all, the topography of the area, the level of flooding and submergence, the intensity of coastal erosion and the presence of engineering coastal protection structures are taken into account. The purpose of the lands included in the water protection zones is also taken into account.

The water protection zone has internal and external boundaries. The inner boundary coincides with the minimum water level in the water body. The outer boundary is usually attached to the existing contours of agricultural land, roads, forest belts, floodplain borders, supraflood terraces, slope edges, gullies and ravines. It is determined by the line furthest from the water body, which takes into account flooding at the maximum flood water level, coastal erosion, temporary and permanent flooding of land, erosion activity, coastal slopes and heavily eroded land.

The outer boundary of the water protection zone on the lands of rural settlements, lands of agricultural purpose, forest fund, on the territories of water management, forest management and fishery enterprises, as well as on the lands of other owners and users is determined taking into account:

– zones of sanitary protection of sources of drinking water supply;
– calculation zone of coastal processing;
– forest plantations, which to the greatest extent contribute to the protection of waters with an outer boundary of at least 1,000 meters from the boundary water level cut;

landukrainenaas@gmail.com, romderk@ukr.net, doroshandriy1@gmail.com, alina.zuzko@gmail.com

– of all land set aside on existing reclamation systems, but at least 200 meters from the edge of canals or dams.

For mountain and foothill rivers, the outer boundary of the water protection zone is determined taking into account geomorphological and hydrological conditions, as well as the risk of mudslides and landslides.

Within the water protection zones, land plots are allocated for coastal protection belts with a stricter regime of limited economic activity. Land plots under coastal protection belts are allocated for the purpose of protecting surface water bodies, such as rivers, seas, lakes, reservoirs and other bodies of water, from pollution, clogging and preserving their water quality. These protective belts are located along the shores and create a barrier that prevents harmful substances from entering water bodies, ensuring the preservation of the natural environment and its ecological balance. Coastal protective belts, which are a nature protection area, where there is a regime of limited economic activity, which is prohibited:

1. Use of land for plowing (with the exception of soil preparation for liming and afforestation), as well as horticulture and gardening.
2. Storage and use of pesticides and fertilizers (including nitrates).
3. Arrangement of summer camps for cattle.
4. Construction of any structures (except hydraulic, navigation, hydrometric, linear, engineering and fortification structures, fences, border signs, border crossings and communications), including recreation centers, cottages, garages and parking lots.
5. Washing and maintenance of vehicles and equipment.
6. Creation of landfills, manure storages, landfills, liquid and solid waste storage facilities, cemeteries, cattle burial grounds, filtration fields and other similar facilities.
7. Burning of dry vegetation or its remains in violation of the procedure established by the central executive body responsible for the environmental protection policy.

Objects located in coastal protection zones can be exploited, provided that the regime of limited economic activity is observed. Structures that are not subject to operation or do not meet the established management regimes must be removed from the coastal protective belts. Reconstruction, restoration and overhaul of existing objects (buildings) are allowed in the coastal protection belts.

Table 1. Dimensions of coastal protection belts in Ukraine

Regime-forming water objects	Requirements for establishing the border of coastal protection belts
Rivers, reservoirs and islands	– for small rivers, streams and streams, as well as ponds with an area of less than 3 hectares – 25 meters f or medium-sized rivers, reservoirs on them and ponds with an area of more than 3 hectares – 50 meters – for large rivers, reservoirs on them and lakes – 100 meters
Seas, around sea bays, estuaries	a coastal protective belt with a width of at least 2 kilometers from the edge of the water

Source: own preparation based on Water Code of Ukraine and Land Code of Ukraine.

In Ukraine, not only the observance of usage regimes, but also the establishment of boundaries of water protection zones and coastal protective belts in the area remains a problematic issue. Both on agricultural lands and on lands of other categories, landowners and land users often do not observe the boundaries of water protection zones and coastal protection belts in the area, arguing that the relevant land management projects for the purpose of establishing the boundaries of water protection zones and coastal protection belts do not developed and not approved (Fig. 1–3).

Thus, the current Procedure for determining the size and boundaries of water protection zones and the regime of conducting economic activities in them, approved by Resolution No. 486 of the Cabinet of Ministers of Ukraine dated May 8, 1996, provides that the size and boundaries of water protection zones are determined by the project on the basis of regulatory and technical documentation, which

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

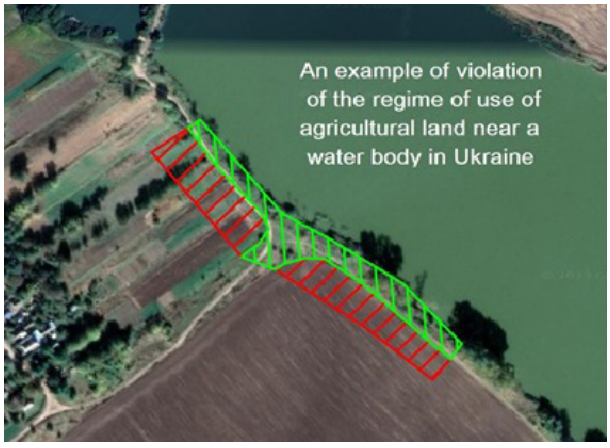

Fig. 1. An example of violation of the mode of use and dimensions of the coastal protective belt in Kyiv region, Ukraine
Source: own preparation based on various materials (2022).

Fig. 2. An example of violation of the regime of use and dimensions of the coastal protective belt in the Cherkasy region, Ukraine
Source: own preparation based on various materials (2022).

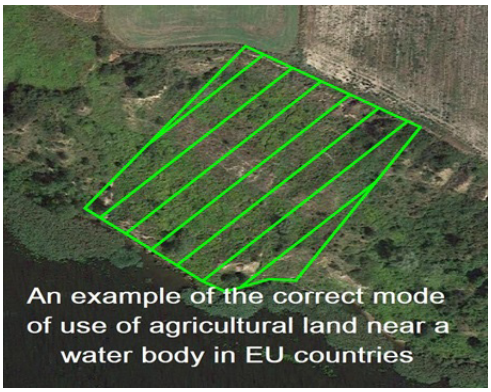

Fig. 3. An example of the complied requirements for the size of the coastal protection belt
Source: own preparation based on various materials (2022).

is coordinated with relevant bodies, land owners, land users and approved by relevant local bodies of state executive power.

It is important to note that the Supreme Court of Ukraine has established a legal position, which is that the absence of such a project and the uncertainty of the boundaries of the coastal protective belt in the area by the relevant state authorities cannot be considered as the absence of the coastal protective belt itself. The actual size and boundaries of the coastal protective belt are determined in accordance with the law, and the land management project that establishes the coastal protective belt is only a document containing graphic materials and information about the calculated area in the sizes and limits defined by the law (the Supreme Court of Ukraine, 2018). However, it should be noted that these provisions still do not remove the issue of the necessity and feasibility of developing relevant land management projects.

Restrictions on the use of agricultural land in Ukraine for the purpose of protecting water resources are important to consider in the context of the political and institutional rapprochement of Ukraine and the EU, because on June 23, 2022, the European Council decided to grant Ukraine the status of a candidate for the EU. Thus, Ukraine should take on the obligations envisaged by the prospect of EU membership, first of all, align the legislation with the EU regulatory framework (acquis) – a set of general EU rights and obligations. This also applies to issues of water protection and land use regulation.

The European policy of relations in the water sector is regulated by a number of directives, among which are the following: Water Framework Directive (2000/60/EC), Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC), Directive on the quality of water intended for human consumption (2020/2184), Floods Directive (2007/60/ EC), as well as a number of other directives (Osadcha et al., 2013).

Since the storage and use of pesticides and fertilizers is prohibited within the coastal protection zones, as nature conservation areas, where there is a regime of limited economic activity according to the Water Code of Ukraine, it is important to note

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

the implementation of Directive No. 91/676/EU on the protection of waters from pollution, caused by nitrates from rural and agricultural sources, the purpose of which is:

1. Reduction of water pollution caused or caused by nitrates from agricultural sources.
2. Prevention of such pollution in the future.

Directive No. 91/676/EC establishes requirements for:

1. Adoption of national legislation and determination of the authorized body (bodies).
2. Definition of nitrate vulnerable zones (NVZs): all known land parcels in their territories from which there is a runoff of nitrates to waters affected by pollution and waters that may be affected by pollution. With the notification of the Commission about such initial determination (Article 3).
3. Introduction of action programs for NVZs (Article 5).
4. Introduction of programs for monitoring the concentration of nitrates in fresh waters (Article 6).

In Ukraine, the aforementioned directive is expected to be implemented through the adoption of a package of documents, which includes the Methodology for determining NVZs and establishing codes of good agricultural practices and measures, which would allow balancing agricultural and economic needs with the need to ensure the good condition of water and water ecosystems.

The methodology for determining "vulnerable zones" to nitrate pollution will allow monitoring and identifying areas where there is already an excess of the safe level of nitrates (over 50 ml/l). In such areas, action plans should be applied to reduce the risks and manifestations of pollution. Codes of good agricultural practices and measures will contain measures and restrictions for the use of fertilizers, their storage, pre-treatment, crop rotation and agricultural practices that prevent leaching of nutrients from the soil (for example, diversification of agricultural crops grown on the same field, use of seedless methods agriculture or cover crops).

The implementation of the provisions of Directive No. 91/676/EC on the protection of waters from pollution caused by nitrates from agricultural sources into Ukrainian legislation is a component of the Association Agreement between Ukraine and the EU, and the development of relevant documents is stipulated in Appendix XXX to Chapter 6 "Environment" Agreement on association, with the definition of specific tasks and schedules, as well as written in the Plan of measures for the implementation of the Agreement. In different years, several EU projects for technical support of Ukraine were involved in the development of the Methodology and the Code, and in the end, the relevant documents were developed through the joint efforts of relevant ministries, institutions and experts.

Currently, the documents are undergoing the procedure of coordination with the relevant bodies of the central government and are published for public discussion on the website of the Ministry of Environmental Protection and Natural Resources. After their agreement and adoption, the following steps in the practical implementation of the provisions of the Nitrate Directive will become possible: a list of zones vulnerable to nitrate pollution will be formed, where systematic measures will be taken to reduce and prevent this problem, and mechanisms for economic stimulation of economic entities will be determined regarding compliance with the best agricultural practices (Ihnatenko, 2021).

In conclusion, it should be noted that according to the analytical report of the European Commission, which assessed Ukraine's ability to assume the obligations envisaged by the prospect of membership in the European Union, published as of February 2, 2023, it was ascertained that there is a certain level of training in water management. Ukraine updated the Water Code and established areas of river basins. Ukraine joined the Water Convention and ratified the Water Protocol. In addition, Ukraine has developed the State Program for the Construction and Reconstruction of Drinking Water Supply Infrastructure for 2022–2026, but it still needs improvement to bring it in line with the latest EU standards. Alignment with the Urban Wastewater Treatment and Bathing Water Directives and the revised Drinking Water Directive is still needed.

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

From an enforcement perspective, clean water services are in place, but drinking water and wastewater responsibilities need to be clarified.

In the aforementioned analytical report of the European Commission, it was also noted that the general principles of marine water protection are reflected in Ukrainian legislation. Monitoring of sea waters, including protected areas, is planned. The Marine Environmental Strategy was approved in 2021 with the aim of achieving and maintaining good environmental status in accordance with the Marine Strategy Framework Directive. Measures have been taken to comply with Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources. Nitrate-vulnerable zones still need to be defined (European Commission, 2023).

On April 15, 2021, the Ministry of Environmental Protection and Natural Resources of Ukraine approved the Methodology for determining zones vulnerable to (accumulation of) nitrates. This technique is an element of the implementation of Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources and the Association Agreement with the EU.

Every year, a process of eutrophication is observed in the reservoirs of Ukraine, the cause of which is the entry into the water of an excessive amount of nitrogen and phosphorus compounds, primarily nitrates and phosphates. This deteriorates water quality and threatens to turn water bodies into swamps altogether. After all, the high content of nitrates causes the growth of blue-green algae and the reproduction of bacteria that absorb oxygen in the water, and leads to the death of aquatic inhabitants. Nitrate contamination of groundwater and water in wells is especially dangerous. After all, almost 75% of the rural population in Ukraine use water from underground sources. Consumption of nitrate-contaminated drinking water harms the life and health of the population. As mentioned earlier, one of the main polluters of reservoirs and groundwater in Ukraine is the agricultural sector, which has problems with irrational and uncontrolled use of mineral and organic fertilizers, as well as improper management practices with livestock waste and other waste. The data of the state record of water use indicate that last year 45 thousand tons of nitrates got into reservoirs (Luhyn community, 2021). In connection with this, it is necessary to introduce restrictions on the use of agricultural lands for the protection of water resources.

Currently, it is difficult to determine and control the impact of agriculture on open water bodies and groundwater. Polluting substances originating from agricultural lands, places where animals are kept and grazed, directly fall into water bodies, but the places of pollution are not clearly defined and their influence extends over large areas. As part of the implementation of Directive No. 91/676/EC on the protection of waters against pollution caused by nitrates from agricultural sources, "vulnerable zones" that are constantly exposed to nitrate pollution should be established in Ukraine in order to take measures to prevent and reduce such pollution. Based on the determination of such vulnerable zones, the rules for maintaining soil fertility and preventing nutrient losses due to soil leaching into water bodies can be applied. These zones and measures to reduce and prevent pollution will become parts of river basin management plans, which are strategic documents for achieving a "good" state of water resources (Luhyn community, 2021).

The methodology for determining zones vulnerable to (accumulation) of nitrates establishes the criteria and procedure for determining zones vulnerable to (accumulation) of nitrates of agricultural origin, and is aimed at reducing water pollution by biogenic elements and preventing the occurrence of eutrophication in accordance with the provisions of Annex I to the Council Directive 91/676/EEC of December 12, 1991 on the protection of waters against pollution caused by nitrates from agricultural sources, as amended by Regulation (EC) No. 1882/200. The mentioned technique contains the following sections:

1. General provisions.
2. Determination of zones vulnerable to (accumulation of) nitrates in surface waters.

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

3. Determination of zones vulnerable to (accumulation) of nitrates in groundwater.

According to the methodology, a zone is a limited part of land that has uniform characteristics regarding water pollution with nitrate compounds. A zone is considered vulnerable to (accumulation of) nitrates if: in surface and/or underground waters used for drinking water supply, or intended as sources of drinking water supply:

– an excess of nitrate (NO_3^-) content of more than 50 mg/dm^{-3} (11.3 mg N dm^{-3}) was recorded;
– in the future, if appropriate measures to prevent water pollution are not taken, the nitrate content (NO_3^-) may exceed 50 mg/dm^{-3} (11.3 mg N dm^{-3}).

Taking into account the biogeochemical instability of nitrogen compounds in water, the total content of inorganic nitrogen compounds (inorganic N) = ($NH_4^+ + NO_2^- + NO_3^-$) is considered for the definition of zones vulnerable to (accumulation) of nitrates. The inorganic N criterion>11.3 mg N dm^{-3} is used for rivers with a Strahler coefficient <5 and groundwater.

It should be noted that according to the mentioned methodology, based on the water regime of soils and their filtration coefficients (Fig. 4), as well as the nitrogen balance in soils, calculated for the purposes of the Nitrate Directive and at a level not exceeding the administrative district (Fig. 5), determine the potential conditions for the leaching of nitrogen compounds from the catchment area of water bodies.

Based on the above information, 3 types of nitrate vulnerable zones (NVZs) are distinguished:

1. Zones of high risk of water pollution, where a positive balance of nitrogen in the soil is observed with the washing and periodic washing-water regime of the soils.
2. Zones of potential water pollution, where a deficient nitrogen balance in the soil is observed with the washing and periodic washing water regime of the soils.
3. Zones of short-term pollution, where there is a positive balance of nitrogen in the soil with non-washable water regime of the soil.

Determination of zones vulnerable to (accumulation) of nitrates is carried out on the basis of water monitoring data, which can be supplemented by modeling results.

It is also important to introduce the European Union Directive 2007/60/EU "Assessment and management of flood risks", which declares the latest strategic approaches to increasing the level of hydro-ecological safety of river basins, which provide for the transition from the "paradigm of protection" to risk management and ensure coordination, pooling of efforts and material resources

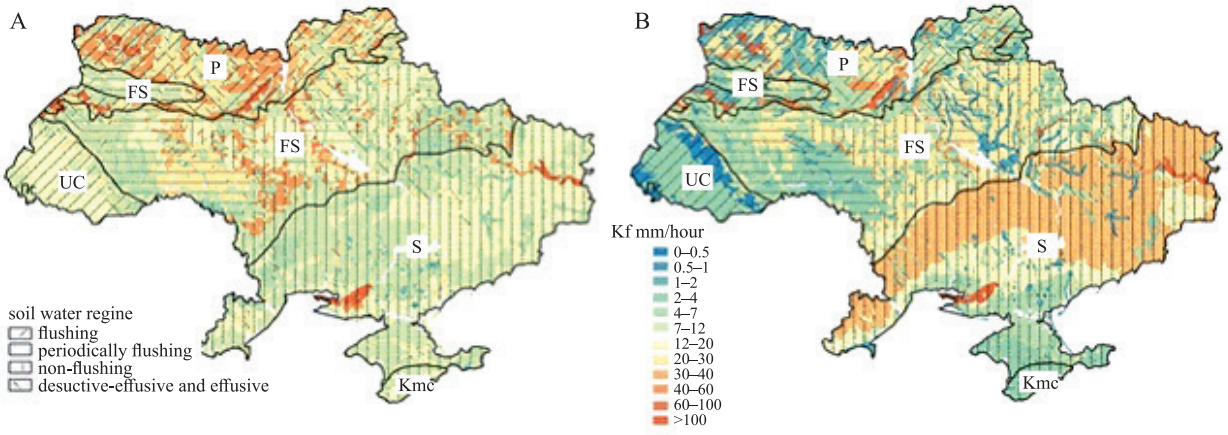

Fig. 4. Soil water regime (hatching) and filtration coefficients of A – top layer (A0, A1) and B – bottom layer (A2, B, C) of soils of Ukraine according to agro-soil zoning zones of Ukraine (P – Southwestern part of mixed forest zone, Ukrainian Polissya (P), FS – forest-steppe zone, S – steppe zone, UC – Ukrainian Carpathians, Kmc – Crimean mountainous country)
Source: data from the Methodology for determining zones vulnerable to (accumulation of) nitrates.

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

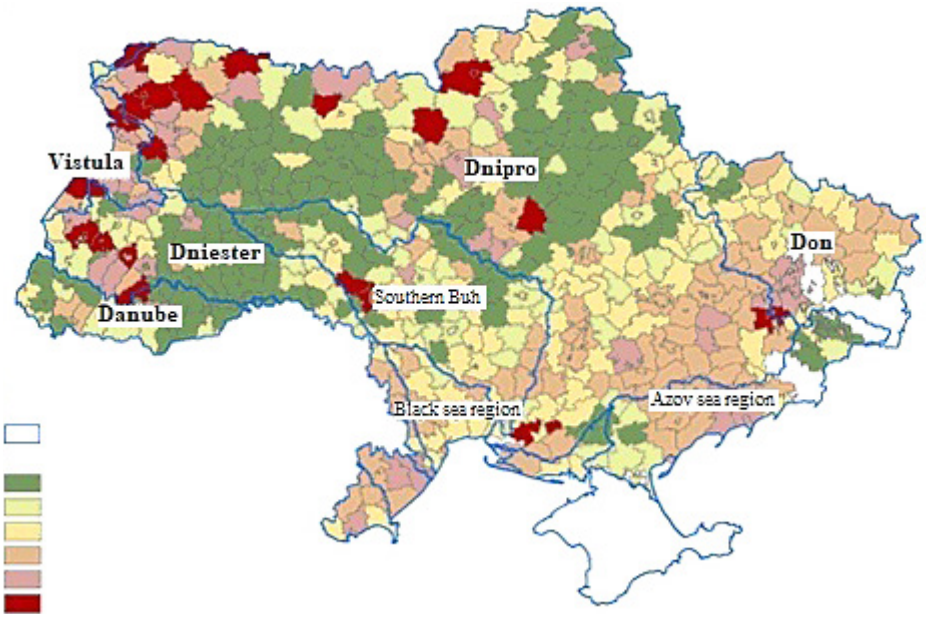

Fig. 5. Nitrogen balance in soils at the level of individual administrative districts of Ukraine as of 2018

Source: data from the Methodology for determining zones vulnerable to (accumulation of) nitrates.

of all interested parties of society, local, regional and state authorities. The strategy for managing risks from the harmful effects of water should provide for the integration of the organization of land use and water resources management in river basins with a complex of nature protection, anti-flood and other measures and is aimed at the simultaneous preservation of river ecosystems and related biodiversity, ensuring normal living conditions and management in the conditions of manifestations of harmful effects of water, lowering the level of vulnerability of territories, as well as increasing the efficiency of the use of river floodplains (Hadzalo et al., 2015).

CONCLUSIONS

The problem of drinking water quality in Ukraine and the world is socially significant. In Ukraine, there are a number of legal acts regulating the protection of water resources and ensuring water quality. Among them are the Water Code of Ukraine, the Land Code of Ukraine, the Resolution of the Cabinet of Ministers of Ukraine "On Approval of the Procedure for Determining the Size and Boundaries of Water Protection Zones and the Mode of Conducting Economic Activities in Them", Law of Ukraine "On Environmental Protection". At the same time, Ukraine, having signed the Association Agreement with the EU, undertook to implement a number of Directives regulating the use and protection of water resources.

The procedure for determining the size and boundaries of water protection zones and the mode of conducting economic activities in them, which is in force in Ukraine, defines that the boundaries of water protection zones are established taking into account: the topography of the area, inundation, the intensity of coastal erosion, the construction of engineering protection of the shore, purpose of the lands included in the water protection zone. On the territory of water protection zones, the use of persistent and potent pesticides is prohibited and other prohibitions apply. Within the boundaries of water protection zones, land plots are allocated for coastal protection belts.

✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

However, the specified procedure was approved in 1996 and did not take into account the need to implement EU Directives, including Directive No. 91/676/EC on the protection of waters from pollution caused by nitrates from agricultural sources. Since there is a regime of limited economic activity and the storage and use of pesticides and fertilizers are prohibited within the coastal protection zones as nature protection areas, it is important to conclude that the establishment of water protection zones and the allocation of land plots for coastal protection zones should take into account the zones vulnerable to (accumulation) of nitrates of agricultural origin, determined according to the relevant Methodology. From the point of view of land management, this will be the practical implementation of Directive No. 91/676/EC.

An important problem that needs to be solved is the actual establishment of water protection zones and coastal protective belts. Including, but not limited to, financing the development of relevant documentation on land management with an indication of the boundaries of coastal protection belts, beach zones and marking by executive authorities and local self-government bodies on the territory of such objects with informational signs, which in practice does not happen often.

Information about the boundaries of coastal protection belts, beach zones must be entered into the State Land Cadastre as information about land use restrictions. It is important to note that the absence of documentation on land management and the failure of the appropriate state authorities to determine the border of the coastal protective belt in the area cannot be interpreted as the absence of the coastal protective belt itself and the corresponding restrictions on the use of agricultural land.

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✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

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✉landukrainenaas@gmail.com, ✉romderk@ukr.net, ✉doroshandriy1@gmail.com, ✉alina.zuzko@gmail.com

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THE APPLICATION OF GEOPLANNER IN THE MANAGEMENT OF LOCAL DEVELOPMENT

Jan K. Kazak[1]✉, Małgorzata Świąder[2]✉, Gustavo Arciniegas[3]✉, Rengin Aslanoğlu[4]✉, Dirk Wascher[5]✉, Grzegorz Chrobak[6]✉

[1] ORCID: 0000-0002-1864-9954
[2] ORCID: 0000-0003-3398-4985
[3] ORCID: 0000-0002-9211-5467
[4] ORCID: 0000-0002-8002-5069
[5] ORCID: 0000-0003-1611-3475
[6] ORCID: 0000-0002-1313-947X
[1,2,4,6] Wrocław University of Environmental and Life Sciences
Norwida Street, 25, 50-537 Wrocław, **Poland**
[3,5] Susmetro
Fabriekstraat, 24, 5038 EN Tilburg, **The Netherlands**

ABSTRACT

Motives: Local development can be supported by GIS-based tools and many solutions are being developed. They can be helpful in supporting more sustainable decision-making processes in public administration and can be used by stakeholders taking part in shaping common space. However, many of these tools are not used by practitioners in their daily activities. Therefore, the added value of this research is to examine how local development might benefit from further implementation of GIS solutions.
Aim: The aim of this study was to verify whether a model designed in ArcGIS GeoPlanner is considered a useful tool by local stakeholders (representatives of public authorities and NGOs), and which issues in local development could be potential areas of application of similar models.
Results: The model was tested during a workshop focused on transforming the local food system of Wrocław, Poland. Most participants declared that they rarely use GIS-based tools (less than once a month) or that they do not use them at all; however, they were willing to incorporate these tools into their activities if they meet their needs. An ex-post evaluation revealed that the use of GeoPlanner can help strengthen a knowledge-based approach during social participation. Participants were eager to use different functionalities of GeoPlanner to modify land use structure guided by a real-time verification of indicator-based results. Finally, a too detailed model can also be perceived as not helpful in regional planning. The user-friendly interface of GeoPlanner helped users develop a shared understanding of urban systems and design action plans, and contributed to capacity building by local stakeholders and raising their awareness.

Keywords: ArcGIS, what-if scenarios, decision support system, food system, urban farming, land footprint

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

INTRODUCTION

Local development planning has gained importance in the modern world as communities explore strategies for building resilient and sustainable economies (Forys & Cymerman, 2019; Furmankiewicz et al., 2021). It has become an essential instrument for protecting and promoting the distinctive cultural, social, and economic qualities of various regions and communities impacted by the advent of globalization. Local development planning can help improve community well-being by concentrating on local assets, abilities, and resources (Bazan-Krzywoszańska et al., 2017; Chodkowska-Miszczuk & Szymańska, 2014). Additionally, local development planning can aid in addressing a number of urgent global issues such as socioeconomic injustice, climate change, and the deterioration of democratic institutions (Kazak et al., 2023). Local communities can cooperate to create more just and sustainable societies by promoting a sense of local ownership and control over economic development and enhance social participation in decision making processes (Kołat et al., 2022; Kryk, 2019; Przybyła & Kulczyk-Dynowska, 2018; Przywojska & Podgórniak-Krzykacz, 2022).

By offering insightful information on regional spatial patterns and relationships, geographic information system (GIS) tools can be very helpful in assisting local development initiatives (Bazan-Krzywoszańska et al., 2019; Bieda et al., 2020; Kulesza & Florek-Paszkowski, 2018; Michalik & Zwirowicz-Rutkowska, 2023). Geographical data, including land use, population demographics, transportation networks, and natural resources, may be mapped and analyzed using GIS technology, which can help guide decisions about economic development, infrastructure design, and resource management (Coetzee et al., 2017; Giang & Vinh, 2014; Ilyushina et al., 2018; Jawecki et al., 2019; Kaczmarek et al., 2022). Local governments and development organizations can better understand the regional economy and spot opportunities for investment and expansion by combining GIS data with other sources of information, such as commercial and social data (Iwaniak et al., 2016, 2017; Jędruch et al., 2020; Kazak et al., 2018). Additionally, by facilitating the display and exchange of data with stakeholders, fostering collaboration and informed decision-making, GIS systems can promote community engagement and participation (García Castro et al., 2020).

Despite their universal character, GIS-based tools are less frequently employed in practice for a variety of reasons. First, the development and upkeep of GIS systems may be time- and resource-consuming and requiring specific technical know-how. In case of using commercial software it could also be a significant financial commitment. It may be an obstacle especially for smaller organisations. Secondly, GIS data gathering, conversion and maintenance frequently require a lot of work and time, particularly in case of more popular big data and dynamic (real-time) datasets. Additionally, problems with compatibility across various GIS applications and data formats might make it difficult to smoothly incorporate GIS systems into current workflows and systems. Finally, a barrier to the widespread implementation of GIS technology is decision-makers' and stakeholders' lack of knowledge and comprehension of its potential advantages. All these elements lead to the situation where although many tools and systems are being developed, they are not commonly used by local stakeholders (Uran & Janssen, 2003). Therefore, the research question in this research was whether a model designed in the web-based ArcGIS GeoPlanner planning tool can be considered by practitioners as useful tools and which issues in local development are considered by them as potential fields of application. The aim of the research was to verify this aspect.

MATERIALS AND METHODS

In order to verify the possibility of the application of GIS tools in local development, a model built in ArcGIS® GeoPlanner℠ (Version: 3.7 Build: 72) has been prepared. The application of the model was tested during a workshop organized within the framework of the FoodSHIFT 2030 project (Horizon 2020, Grant Agreement #862716: Food System Hubs

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

Innovating towards Fast Transition by 2030) which was held in May 2023 in Wrocław (Poland). The main goal of the FoodSHIFT2030 project is to develop more sustainable food-systems within 9 European city-regions (Athens, GR; Avignon, FR; Barcelona, ES; Bari, IT; Berlin, DE; Brasov, RO; Copenhagen, DK; Oostende, BE; Wrocław, PL). Therefore, for this reason, analyses were conducted for the status quo as well as for alternative food systems scenarios. Typically the FAL (FoodSHIFT Accelerator Lab) is responsible to host such workshops. FALs comprise of: (1) Lab leader – usually a Small Medium Enterprise (SME) or a Non-Governmental Organization (NGO); (2) Lab host – usually a municipality; (3) Lab assistant – university or research unit. Therefore, this workshop presented a realistic and practical perspective on the organization of a FAL activity. The workshop was attended by a total of nine participants, including representatives from municipal and regional authorities, as well as non-governmental organizations (NGOs). The small size of the workshop group was due to the nature of teamwork and the aim to ensure that participants were able to actively participate at each stage of the tasks. Participants took part in ex-ante and ex-post evaluations.

The model includes non-spatial and spatial data. Non-spatial data covered two types of data from Statistics Poland. Variables taken into account included population, and average consumption of selected foodstuffs (divided into 39 categories) per capita in households), recommended diet based on the EAT-Lancet dietary advice (Hirvonen et al., 2020), and the local land footprint needed to provide one kilo or liter of given type food (Poore & Nemecek, 2018). Spatial data included the national register of borders (General Office Geodesy and Cartography), European land cover and agricultural land based on Corine Land Cover 2018 (Copernicus Land Monitoring Service, 2023), Natura 2000 protected habitats, crop yield forecasting (Joint Research Centre), complexes of agricultural suitability of soils on arable land (IUNG), and topographic data in vector representation tiled from satellite imagery maps (European Environment Agency, 2019). The model incorporated participants' evaluations and assumptions to calculate the suitability and the impacts of land use changes proposed during the workshop (i.e., community gardens, urban farms, agro-parks) on food production and demand of citizens.

RESULTS

Ex-ante evaluation

Before starting the workshop participants filled out an ex-ante evaluation form. There were 3 representatives from the City Hall, 2 from the Marshal's Office (regional authorities), and 4 from NGOs (including EcoDevelopment Foundation; Community Garden 'Motyka i Słońce' in Warsaw; and the Krzyżowa Foundation for Mutual Understanding in Europe). As participants did not represent specialized GIS units in their organizations, but they specialized rather in local and regional development or food-related topics, they stated that they rarely use GIS solutions (less than once per month) or do not use such tools at all. However, 8 out of 9 participants expressed their willingness to start using them if they would be helpful in their work. Only one person reported being familiar with GIS-based scenario tools like GeoPlanner. When asked about their expectations from the workshop, participants indicated knowledge about the basic functionality of GIS (3 participants), functionality associated with selecting suitable locations (2 participants), topics related to food system – not associated with GIS (3 participants), and one person did not specify any concrete expectations.

Geodesign Workshop

First, the workshop participants were introduced to the Metropolitan Foodscape Planner (MFP) method (Arciniegas et al., 2022), which allows the comparison of actually available agricultural-productive land with the area footprint estimated to meet the food habits of residents. The data and assumptions that were used to calculate the footprint were discussed, as well as the four scenarios that were prepared using the GeoPlanner solution (Fig. 1).

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

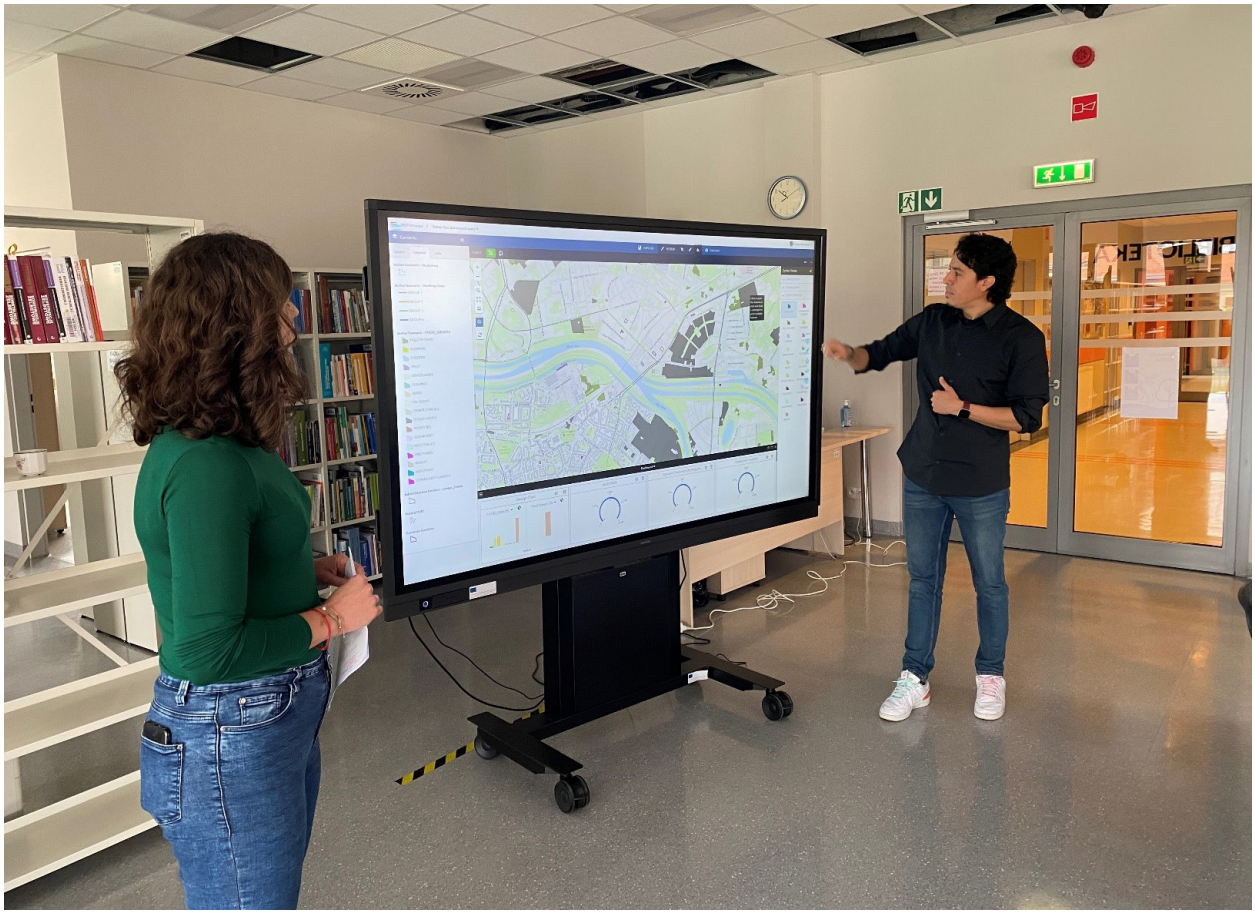

Fig. 1. Presentation of functionalities of the model
Source: own picture.

Four scenarios were prepared for the workshop:
- Scenario 1: land footprint for current eating habits of officially registered residents of Wrocław,
- Scenario 2: land footprint for current eating habits of estimated number of residents of Wrocław city (those not registered as well as those registered) estimated by the Municipal Water Supply and Sewerage Company in Wrocław,
- Scenario 3: land footprint with dietary change to EAT-Lancet for officially registered residents of Wrocław,
- Scenario 4: land footprint with dietary change to EAT-Lancet for estimated number of residents of Wrocław.

The results of the MFP analysis (Table 1) for the urban core of Wroclaw showed that, in the case of the first scenario (status quo), 46,000 ha of land are required to satisfy plant-based food needs and 182,000 ha are required for meat-based needs. In case of the second scenario, it was 61,000 ha for plant-based, and 241,000 ha for animal-based food production. For both, first and second scenarios including current eating habits, the annual land footprint per capita was quantified as 0.357 ha. However, in case of third and fourth scenario, the area needed to satisfy plant-based needs was quantified as 66 thousand ha and 88 thousand ha, and for meat-based as 180 thousand ha and 239 ha. The change to this diet would involve a land footprint of 0.385 ha per capita. The difference between the land footprint for current food habits and EAT-Lancet can be seen in a 54% increase in the consumption of flour products, a 20% decrease in the

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

Table 1. Results obtained using MFP tool

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Land required to satisfy plant-based needs [ha]	46,000	61,000	66,000	88,000
Land required to satisfy meat-based needs [ha]	182,000	241,000	180,000	239,000
Land footprint per capita [ha]	0.357	0.357	0.385	0.385

Source: own preparation.

consumption of potatoes, a 36% decrease in the consumption of meat, eggs, and butter, a 154% increase in the consumption of vegetable fats, a 519% increase in fruit consumption.

Moreover, an additional category in EAT-Lancet is appearing – unrecorded in the Polish diet due to its marginal share – legumes. During the workshop it was pointed out that although the land footprint for current habits is lower than for EAT-Lancet (7.36% lower), this does not mean that these habits are healthy. EAT-Lancet assumes that the diet is healthy, nutritious, affordable, and environmentally friendly. This is evidenced, for example, by more than 5 times too low consumption of fruits regarding current eating habits.

Fig. 2. Modification of the model by participants during workshop
Source: own picture.

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

In the next step, participants worked on agricultural land use change. This step showed how land use change can affect the convergence to the area (land footprint) needed to meet the food needs of residents. Workshop participants were able to, on the one hand, change land use to groups of crops identified in the MFP model (e.g. fruit, grasslands, oil seeds, potatoes, vegetables), and on the other hand, plan land use changes for agricultural cooperative solutions (ie. community gardens, urban farms, agro-parks). Wanting to see how changes in land use would affect the fulfilment of current eating habits, they worked mainly on the second scenario. Participants began working jointly on paper versions to draw a set of preliminary concepts for land use change. In the second stage, they made changes using an interactive map table (that is an 86-inch touch screen) (Fig. 2). The participants were divided into two groups, the first working in the urban area of the city of Wrocław, and the second on the metropolitan area, covering both the city together with suburban areas.

The approaches used by the participants differed from each other (Fig. 3). Participants in the urban group focused primarily on land changes in the context of creating new community gardens and agro-parks. Participants in the metropolitan group, on the other hand, paid attention to the accuracy of data from the European Commission's Joint research Centre. The high level of generalization of the data resulted in smaller patches representing a different type of crop (e.g., vineyards) being aggregated to the larger dominant ones in the neighborhood (e.g., wheat).

An important observation is that all participants were eager to use the reference layers (presented as web-based feature layers) and the base maps (topographic, aerial photography, OpenStreetMap) that had been prepared for them. They paid attention to such aspects as the quality of soils, the suitability of soils for growing specific types of crops, and whether there were any protected areas, such as Natura2000, in the areas of possible change. What is more, the workshop participants also used their knowledge of current land use or took into account potential spatial problems that could be unfavorable for locating a particular solution like a community garden or agro-park (e.g., significant proximity

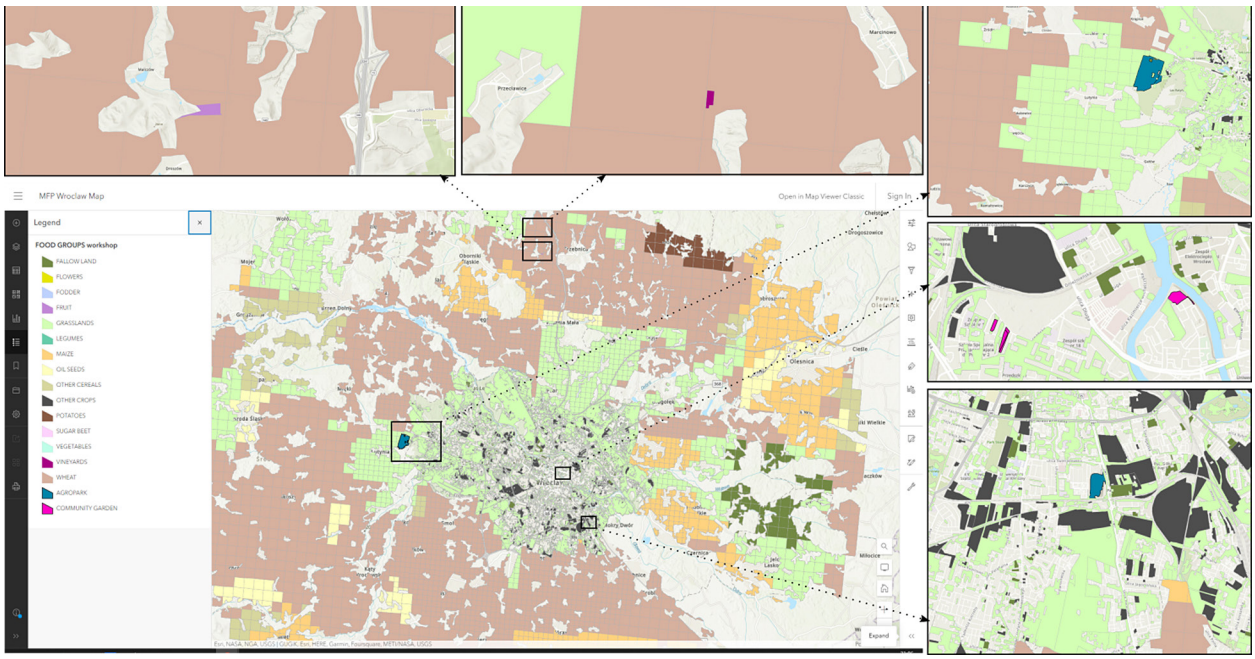

Fig. 3. Some changes made by participants on model during the workshop
Source: own picture.

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

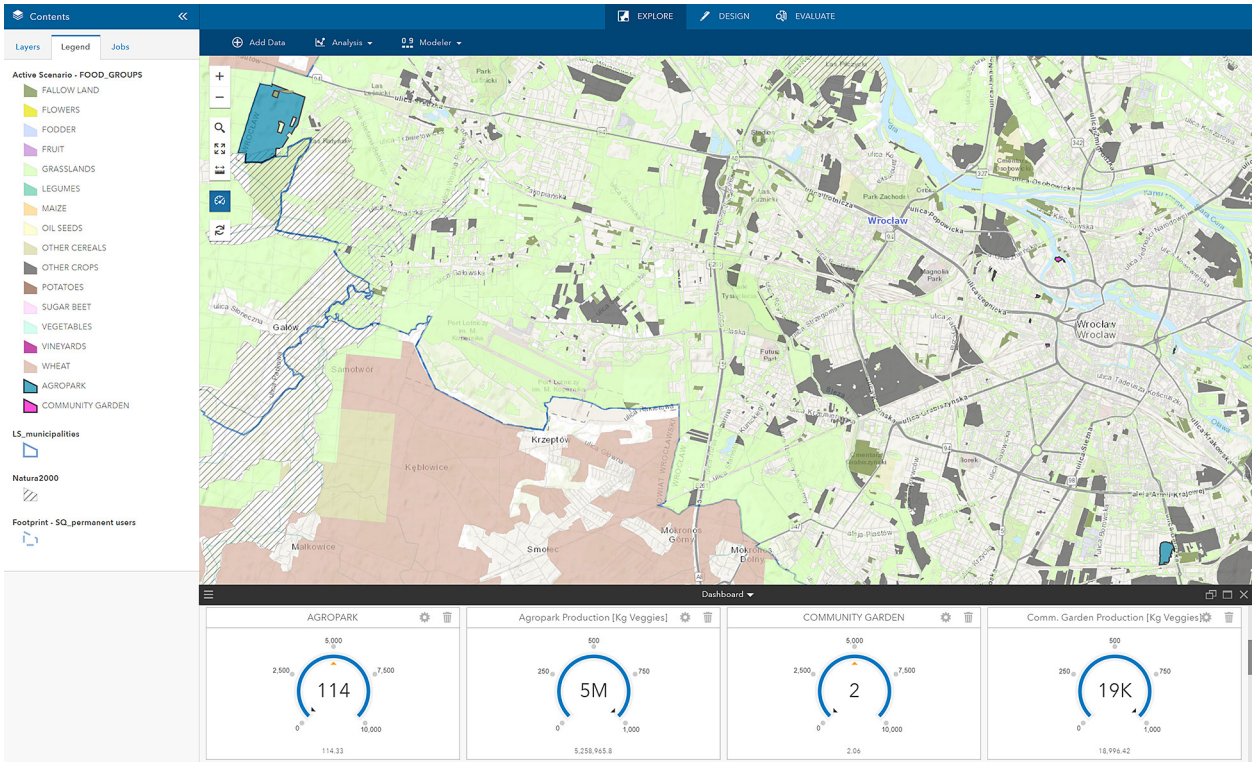

Fig. 4. Screenshot of the model in GeoPlanner. Charts at the bottom show hectares per land use and food production in kg
Source: own picture.

to roads). In addition to unsuitable spatial factors (proximity to roads, proximity to protected areas), participants also took into account existing social problems. In this case, they relied on their knowledge of the incidence of vandalism in similar areas, around which gardens or agro-parks could potentially be located (Fig. 4).

The advantage of working with the combination of the GeoPlanner solution and an interactive MapTable simplify the use of a designed system. Users do not need to be experts in GIS to make land use changes. Moreover, several attempts to change land use (including splitting a polygon if needed) make participants courageous in changing current land use. Participants working in the administrative sector concluded during the workshop that the model that was presented could be used to work with residents as a decision-support tool for food system development.

Ex-post evaluation

Some aspects of ex-post evaluation appeared already during the workshop as participants shared their comments while working on the study analysis. First of all they mentioned that having all data collected in one place gave them more holistic understanding of the study area. Participants referred especially to the data on soil quality and the network of facilities associated with local food system. Secondly, participants did not limit their actions to basic functions like land use modifications of specific polygons, but also they took an advantage of more advanced changes like changing geometry of polygons. By such changes they influenced not only categories but also topological structure of land uses. Participants highlighted that the outcomes of indicator calculations used during the workshop would be helpful for

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

discussing the alternatives with other partners and thus to the decision making processes. They also liked the fact that once they have an idea for alternative scenario, they can verify its impact on targets instantly. Using current approaches it is more common that decision makers suggest scenarios of actions, then these scenarios are analyzed by analysts separately, and results are sent back to decision makers with a degree of delay.

After finishing the workshop participant were asked to answer two ex-post questions. All of attendees stated that workshop met their expectations. 7 out of 9 of them said that they would be interested to use such solution in their work. Most common tasks that they mentioned for potential utilization of the model were land use and food system planning. One person wrote that she/he could see a potential to use the approach in co-creation activities with local communities. One participant representing an NGO highlighted that such a tool would not be helpful for current tasks but could be useful for planning new activities using such systems. A person from another NGO noted that using such model could be helpful in increasing credibility of arguments used during discussions. Those participants who did not anticipate any applicability of the model in their work were representing regional authorities. When it comes to features of the model that would make people less interested in using the tool, 2 participants highlighted technical barriers associated with understanding the GIS environment. Finally, participants were asked for their feedback concerning the workshop itself, in order to improve promotion of GIS solutions. The only response collected here was a suggestion to divide the workshop into shorter tasks in order to go through the model step by step. There were no other suggestions.

CONCLUSIONS

Based on the user feedback, these stakeholders of local development management and planning expressed their intentions to incorporate GIS-based solutions in their regular activity. However, solutions should address their tasks, therefore, the promotion of GIS tools should not be based on what software developers want to show but on the needs of potential users, reflecting the most common problem defined two decades ago by Uran and Janssen (2003). Participants were clearly able to see the potential for using GIS-models more widely in land use and food system planning which overlapped with the topic of the workshop. None of them referred to a different field of application which raises the question as to whether they were able to link the available functionalities for food system planning with other domains. Nevertheless, it is worth highlighting the opinion of one participant that knowing about available functionalities could boost future actions and plans by planning new more ambitious tasks at a higher level than existing ones.

Secondly, the use of models similar to the one designed in GeoPlanner for this workshop could be helpful during the process of public participation. Rather than relying on subjective points of view and ideas, a model can help to evaluate different scenarios and compare them based on quantitative indicators. As a result, it is possible to increase the role of knowledge-based discussion and to refer to an impact supported by defensible evidence more than relying on opinions and feeling. That could help in minimizing social conflicts that can appear during social participation processes, that commonly appear during management of common goods (Furmankiewicz et al., 2019).

Finally, the results from the workshop shows that representatives of a city hall and NGOs are willing to introduce a GIS-based solution like GeoPlanner in their work, while representatives of regional authorities are less interested in that. This statement can be biased by a small sample and repetition of the workshop with employees of different units from regional authorities could change the situation, however, the underlying question may be whether the model fits regional needs. The level of precision of data (sizes of analyzed individual objects) could be high enough to carry out the task at a local/municipal level but to carry out regional tasks it might be necessary to generalize and simplify datasets and models. This

✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

limitation has also been observed while implementing other decision support systems like CommunityViz (Aggett & McColl, 2006; García Castro et al., 2020).

The main limitation of the obtained results may be the GIS experience or exposure of participants who took part in the workshop. Our findings do not refer to general understanding of GeoPlanner models worldwide, as representatives of public authorities and NGOs may differ in their background and IT skills. In order to state a more universal opinion on it similar studies should be carried out in other places, preferably including different socio-cultural context, as it may refer not only to level of knowledge but also to willingness to explore new approaches enhancing public stakeholder participation in decision making processes.

Based on the workshop we can define four main ways how GeoPlanner could possibly support local development management:

1. Shared Understanding: By working together with GeoPlanner, participants can develop a shared understanding of urban system and its challenges. The visual and interactive nature of GeoPlanner can help communicate complex issues more effectively than text or tables alone.
2. Action Plan: Based on their analysis, participants could develop an action plan with specific steps to improve an existing system. This plan could include both short-term actions and longer-term strategies.
3. Capacity Building: Participants could gain new skills in GIS and spatial analysis, which they could apply in their work. The workshop could also increase participants' understanding of local system and its complexity.
4. Awareness Raising: The workshop could raise awareness about the importance of a sustainable and equitable a system among participants and their organizations. This could lead to increased support for policies and programs that improve a system (here the example was the planning of food systems).

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✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

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✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

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✉jan.kazak@upwr.edu.pl, ✉malgorzata.swiader@upwr.edu.pl, ✉gustavo@susmetro.eu, ✉rengin.aslanoglu@upwr.edu.pl, ✉dirk@susmetro.eu, ✉grzegorz.chrobak@upwr.edu.pl

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AN EVALUATION FRAMEWORK OF THE CURRENT CADASTRAL SYSTEM IN UKRAINE – A CASE STUDY

Andriy Popov[1]✉, Pavlo Kolodiy[2]✉, Yurii Zadorogniy[3]✉

[1] ORCID: 0000-0001-7292-8818
[2] ORCID: 0000-0001-9847-9520
[3] ORCID: 0000-0003-3499-7753
[1,3] Mykolayiv National Agrarian University
General Karpenko Street, 73, 54000, Mykolayiv, **Ukraine**
[2] Lviv National Environmental University
Volodymyr the Great Street, 1, 80381, Dublyany, **Ukraine**

ABSTRACT

Motives: Land is the most vital resource that meets basic human needs. There are several mechanisms for achieving the goals of sustainable administration and management of land resources, and the cadastral system is the key mechanism. In most developing countries, the procedures for monitoring the performance of cadastral systems are inadequate or non-existent. Ukraine is not an exception in this respect, and this issue is largely disregarded in the domestic literature.
Aim: The objective of the study was to establish an evaluation framework that relies on globally recognized best practices and their corresponding indicators. The main aim of the framework is to measure and assess the effectiveness of Ukraine's cadastral system.
Results: The evaluation methodology consisted of four stages: an analysis of evaluation indicators, identification of international best practices, identification of performance gaps in the cadastral system, and the development of a summary profile based on a SWOT analysis. The cadastral system was evaluated based on indicators within five domains: political, management, operational levels, external factors, and the review process.

Keywords: cadastral system, land cadastre, property registration, evaluation indicators, evaluation framework

INTRODUCTION

Land plays a pivotal role as a valuable resource and a major contributor to wealth on a global scale. Land as the primary resource and production tool is even more significant for agriculture (Burns, 2007; De Soto, 2000; Diiesperov, 2010; Stupen et al., 2016). The availability of cadastral data is crucial for effective land resource management, highlighting the vital role played by both the cadastre and the registration of legal rights on the land. Together, they contribute significantly to the progress and prosperity of society. Land data is subject to continual change and dynamism because of evolving attitudes towards land, specifically in terms

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

of land tenure. This is primarily driven by the growing flexibility and complexity of contemporary land ownership and land use practices.

However, as studies (Dale & McLaughlin, 1998) show, traditional cadastres (cadastral systems) are usually quite slow in their nature to respond to the ever-changing needs of society. Moreover, the information incorporated into the cadastre must be consistently updated due to the inevitable aging of cadastre databases resulting from changes occurring on the ground (Bielska et al., 2020; Buśko et al., 2022; Gürsoy Sürmeneli & Alkan, 2021; Klimach et al., 2020; Szafranska et al., 2020). This requires constant expenditures to maintain the functioning of the cadastral system (Busko & Apollo, 2023; Roić et al., 2021).

The issue of a comprehensive evaluation of the effectiveness of current systems of administering and managing the state land cadastre and registering land rights (cadastral system) in promoting the development of the land market and ensuring conditions for sustainable development of the country has become relevant in Ukraine because the interaction between individuals and land has grown increasingly dynamic.

In Ukraine, the cadastral system follows a dual agency model, with different institutions overseeing land cadastre and legal registry activities. The State Service for Geodesy, Cartography, and Cadastre (StateGeoCadastre) and its local offices, subordinated to the Ministry of Agrarian Policy and Food, is chargeable for governing the State Land Cadastre. This includes tasks such as spatial registration of land plots, development of the national geospatial infrastructure, creation of index cadastral maps, and mapping activities. On the other hand, the Department of Notary and State Registration under the Ministry of Justice handles legal matters related to land registration. The State Land Cadastre (SLC) is specifically focused on land plots. Its primary purpose is to record and register the spatial attributes of each land plot, including boundary coordinates, landmarks, and land characteristics such as area and land types. This information is associated with a unique cadastral number assigned to each plot. The Department of Notary and State Registration is responsible for managing and regularly updating the State Register of Property Rights to Immovable Property, which pertains to the registration of property rights. This property register performs duties for officially recording ownership titles (once the land plot is registered in the State Land Cadastre) and various legal rights and interests on the land. These may include mortgages, restrictions, and responsibilities, among others (Popov, 2019). These two registers serve different purposes but are interconnected and accessible to the public.

LITERATURE REVIEW

A wide range of Ukrainian scientists is engaged in solving issues related to the management and formation of the cadastral system. Boklah (2014), Dombrovska and Tyshkovets (2019), Kuryltsiv (2012) and Perovych (2013) argue that the cadastral system is a basis for facilitating land administration. Bordiuzha (2013), Boiko et al. (2016), Kovalyshyn (2017), Martyn (2011, 2017), Tykhenko (2016), Tretiak (2012) and Tsytsyura (2016) are focused on the current situation, advantages, disadvantages and possible improvements of cadastral system functioning. Panas (2008), Perovych and Ludchak (2015), Stupen (2016) and Taratula (2017) devoted to research on foreign experience in the development of cadastral systems and their comparative analysis. Shchepak (2017) and Yasinetska et al. (2018) have addressed geoinformation technology for the cadastral system. To date, the systematic performance evaluation measures for the cadastral system remain out of focus in Ukraine. The key obstacle to creating a successful cadastral system is the lack of standardised frameworks for evaluating the effectiveness of the performance of undertaking institutions, according to Gebrewold (2016). In the Ukrainian context, there are thirteen different cadastres for natural resources, including two types of land cadastre (urban and rural), along with a unified State Register of Property Rights to Immovable Property (Popov, 2019). In such complexity cadastral system, there is a lack of a nationwide accepted methodology to effectively measure and evaluate the performance of the cadastral system.

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

Hence, the research objective is to find an evaluation framework that draws upon international best practices and their corresponding indicators. This framework will enable the comprehensive measurement and evaluation of the overall performance of Ukraine's cadastral system. Aligned with this objective, the research sought to address the following question: Which indicators can be used for measuring and evaluating the performance of Ukraine's cadastral system? Therefore, the research contribution is formulating a unified methodology for the many-sided evaluation of the cadastral system. Additionally, it seeks to assess the performance of Ukraine's cadastral system, providing policymakers, practitioners, and stakeholders with insights into the advancements made by cadastral system projects in reaching their desired goals. This paper mainly focuses on cadastral system evaluation because different evaluation indicators can enhance the monitoring of land administration and land management, thus reinforcing governance in this domain.

The paper is organized into four main sections. The first section provides an overview of the data collection and analysis process. The following section digs into the theoretical knowledge and background related to cadastral systems evaluation. This is followed by the results section that presents and discusses the evaluation frameworks utilized for assessing the cadastral system in Ukraine, along with the corresponding evaluation outcomes. Finally, the paper concludes by providing an answer to the research question. While this paper focuses on the specific experiences of Ukraine, it can also serve as a valuable resource for other countries developing their cadastral systems.

MATERIALS AND METHODS

For this research, a comprehensive approach was employed, incorporating a desk review of international literature, a case study, and an analysis of Ukrainian documents related to the functioning of the cadastral system. The desk review primarily aims to explore and examine the available literature concerning evaluation indicators and international best practices related to cadastral systems. The desk review was conducted to identify methodologies for measuring and evaluating the performance of the cadastral system in Ukraine. The desk review relied on secondary data sources, including journals, monographs, books, and conference proceedings, as the foundation for gathering information. Through the literature review, seven frameworks and models that are suitable and relevant for evaluating cadastral systems were identified. These represent the Cadastral template (Steudler et al., 2003), the Land Administration Evaluation Framework (Steudler, 2004), the EFQM Excellence Model (EFQM, 2012), Cadastre 2014 (Steudler, 2014) and 2034 (ICSM, 2014), the Land Administration Evaluation systems (Shibeshi et al., 2015), the Land Governance Assessment Framework (Gebrewold, 2016) and the 2030 Agenda for SDG (UN, 2015). The reason for selecting these frameworks and models is their flexible, comprehensive, reliable, and attainable nature. Steudler et al. (2004), Yilmaz et al. (2015), and Mitchell et al. (2017) have developed an evaluation framework for cadastral systems that encompasses five levels: policy level, management level, operational level, external factors, and review process. These levels are further subdivided into evaluation aspects. Best practices and corresponding indicators are developed for each evaluation aspect. This paper develops an evaluation framework for the Ukrainian cadastral system based on the above literature.

The evaluation framework developed for the Ukrainian cadastral system was applied using a case study methodology. This enabled the assessment of the system's performance. The evaluation of the different aspects is primarily rooted in the authors' extensive experience of at least sixteen years in conducting research and instructing students and practitioners in cadastre and cadastral surveying.

The third research method employed was document analysis, which involves a qualitative approach wherein documents are examined to derive meaningful insights and understanding. The basic policy (legal) documents that were analysed included

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

the Law "On State Land Cadastre" no. 3613-VI (dealing with the land cadastre administrating and managing), the Resolution of the Cabinet of Ministers "On the Procedure for Carrying On of the State Land Cadastre" no. 1051 (dealing with spatial registration procedure of land plots) and no. 1438 (dealing with the realisation of the pilot project on land registration by private land surveyors), the Law "On State Registration of Real Estate Rights and Their Burdens" no. 1952-IV (dealing with the registration procedure of interests to land plots). In addition, the legislation on the cadastral system, official documentation of the StateGeoCadastre and cadastral data from the Public Cadastral Map of Ukraine were analysed. All the information, discussions, and conclusions presented in this study apply to the cadastral system in Ukraine, except for the temporarily occupied territory of the Autonomous Republic of Crimea and some areas of Donetsk and Luhansk oblasts, up until the Russian invasion of Ukraine on February 24, 2022. It should be noted that during the ongoing conflict in Ukraine, the cadastral system operates under significant restrictions and limitations.

Theoretical Background and an Evaluation Framework

In this paper, the term "cadastral system" refers to a formal subsystem within land administration. It includes the organizational system, involving various professional actors from both public and private sectors responsible for the protection of property rights. It also contains procedures, regulations, and different registers, all working in tandem to ensure the accuracy and currency of land information and its associated attributes. In short, the cadastral system of Ukraine contains two registers: SLC and Property Register (the State Register of Property Rights to Immovable Property). SLC is responsible for land plot registration (landmarks boundaries coordinates, land use, land value, land types, soils, etc.) by using unique cadastral numbers. Property Register dealing with registration of ownership and other interest to land. The integrated view of cadastre and registration systems implies the entirety of the cadastral system, including its structure, processes, and functions. The cadastral system is centralised in the meaning of land registering and recording within the single digital public cadastral map. At the same time, the financial and technical responsibilities lie on separated institutions and ministries. The Ministry of Agrarian Policy and Food, specifically the StateGeoCadastre (a national authority) and its local offices, is responsible for managing the activities of the SLC. The Ministry of Justice, specifically the Department of Notary and State Registration, is responsible for property registration. Often this leads to discrepancy in the methodology of the cadastral system functioning.

The term "land administration system" encompasses a broader scope, which includes land use planning, valuation, taxation, and other related aspects (Bennett et al., 2012; Bogaerts & Zevenbergen, 2001; Enemark et. al., 2010; van der Molen, 2002; Williamson, 2001). Dale and McLaughlin (1988) illustrated the classical concept of land administration systems, highlighting their alignment with land policy and land tenure arrangements.

Evaluation refers to the systematic gathering and analysis of data to assess the strengths and weaknesses of programs, policies, projects, and organizations, to enhance their effectiveness (Baird, 1998). Evaluation refers to the systematic gathering and analysis of data to assess the strengths and weaknesses of programs, policies, projects, and organizations. Its purpose is to enhance their effectiveness and performance (Baird, 1998). The evaluation process can mitigate subjectivity and establish an objective foundation for investigating success and experiences by incorporating best practices and their corresponding indicators. This approach facilitates performance improvement for any given object(s) or process(es). Best practices serve as the primary objectives or desired outcomes of a well-functioning system while indicators serve as the means to measure the level of success in achieving these best practices. Furthermore, best practices and indicators serve as benchmarks for evaluation and are essential components of the evaluation system (UN-Habitat, 2003).

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

The framework offers an evaluation technique that assists in identifying indicators for cadastral systems that can be enhanced according to international standards (Chekole et al., 2020; EFQM, 2012; Gebrewold, 2016; ICSM, 2014; Steudler et al., 2003; Yilmaz et al., 2015). An indicator is a distinct, measurable, and observable characteristic employed to designate changes or the degree of progress made by a system in attaining a particular result. Recent studies in land management have shown an increased interest in developing evaluation frameworks to assess land administration systems. As an example, the International Federation of Surveyors (FIG, 1995) put forward a series of criteria designed to evaluate the success and effectiveness of a land administration systems. Steudler (2004) introduced a land administration evaluation framework including three organizational levels (operational, management, policy), the review process and external factors. The organizational pyramids are used to adapt and develop such evaluation frameworks and define evaluation indicators. Chimhamhiwa et al. (2009) formulated a conceptual model to measure the comprehensive performance of land administration systems by focusing on cross-organizational business processes. Bandeira et al. (2010) introduced a comparative methodology for assessing national land administration systems and applied it to evaluate the systems of Honduras and Peru as specific cases. The "Land Governance Assessment Framework" (Gebrewold, 2016) is another example of an evaluation framework. This tool is designed to evaluate the state of land governance within a specific country.

Kaufmann (2000) proposed viewing the cadastre as an "accounting system" for land issues that facilitates sustainable development. Like an accounting system in a business or organization, the cadastral system must adhere to specific rules and principles. The principles governing the cadastral system are rooted in tradition and primarily aimed at ensuring the supply of accurate and organized information regarding individual land plots. These principles serve various purposes, such as land valuation and taxation, land-use planning, land markets, and legal, regulatory, and fiscal aspects of land administration. Therefore, the cadastral system can be regarded as an integral component of the operational level within land administration. Zhang and Tang (2017) proposed to use the multi-criteria analysis tools to evaluate the performance of the cadastral system at the operational level and systematically present an evaluation methodology (Mitchell et al., 2017; Steudler, 2004; Steudler & Williamson, 2002; Yilmaz et al., 2015) that relied on the three levels (policy, management and operational), external factors and the review process.

It is noteworthy that Rajabifard et al. (2007) created the cadastral template. Nevertheless, the template primarily serves as a standardized form that cadastral institutions complete by showcasing the emerging trends in comparative studies in cadastre, ultimately aiming to facilitate benchmarking. As of March 2022, the cadastral template, available at http://cadastraltemplate.org, comprises the culmination of 39 country templates that rely on six statistical indicators and two descriptive indicators. The reports from EuroGeographics, as outlined by Haldrup and Stubkjær (2013), provide an overview of the implementation of various performance indicators at a national level. These indicators encompass aspects such as the number of transactions, hours per unit of production, personnel productivity, and production backlogs. Nevertheless, certain studies are more comprehensively structured and incorporate quantitative data, as noticed by Haldrup and Stubkjær (2013).

In this paper, the authors examine peer-reviewed written works on evaluation frameworks and existing models for assessing land administration systems to develop a methodology and framework that can effectively evaluate and measure the performance of the Ukrainian cadastral system. The evaluation framework includes various aspects and indicators specifically designed for the Ukrainian cadastral system, as presented in Table 1.

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

Table 1. A framework for evaluating the cadastral system in Ukraine

Evaluation Area	Evaluation Indicators	International Best Practice
	Land policy aspects and objectives (5–20 years)	
1	2	
Policy Level Stakeholders: Parliament, Government Tasks: definition of the objectives, legal framework, long-term financial aspects, economic-social-environmental aspects (equitable, sustainable)	• The presence of a governmental policy regarding the cadastral system • The cadastral policy supports: agenda 2030 for SDG; digital cadastral data lodgement portal; developing 3D digital cadastral system; digital data sharing; making and maintenance of a cadastral single map • Policy objectives are SMART identified (list of objectives and tasks)	• The aspects of the cadastral policy are incorporated within the land policy, which includes relevant laws and regulations adapted to the specific circumstances • Policy objectives are specific, measurable, achievable, realistic, timely and continuously acknowledged • Cadastral policy supports and contributes to the achievement of SDGs • Cadastral policy supports developing digital cadastral data lodgement portal • Cadastral policy guides developing 3D digital cadastral system • Cadastral policy supports digital data composing and sharing • Cadastral single map making and updating guides by policy
	Historical, legal, social, cultural background	
	• The land administration system supports the cadastral system • Society benefits from and acknowledges the cadastral policy • Transparent data access and information about the land resources, land use and land situation • Good governance and civic participation	• The historical background is recognized and acknowledged by the government and society • Administrative and political structures are suited to circumstances • Society recognizes the importance and advantages of implementing the cadastral policy • Cadastral system facilitates transparent and effective access to land-related data and information • Cadastral system is supported by strategic and political decisions • Civic participation is ensured
	Land tenure and legal aspects	
	• Land tenure aspects (recognition of informal tenure, qualified (limited) titles and flexible cadastral boundaries; humankind to land relationships is dynamic; role of the cadastral system in supporting the land management, natural resources, land market, etc.) • Legal aspects (institutions with clear responsibilities, protection ownership rights, existence of legal basis, system uniformity, etc.)	• Legal recognition of all the details and standard procedures • The government recognizes the relationship between humankind and land and ensures its suitability for circumstances • The legal framework is well-suited to the cadastral system (e.g., by protecting ownership rights, recognition of informal tenure, qualified [limited] titles and flexible cadastral boundaries, legal reforms are on-going) • Cadastral system institutions have clear responsibilities and easy procedures • Cadastral system is well-adapted for circumstances
	Financial and economic aspects	
	• Aspects related to the land market (efficient functioning of land and property market, number of land sales, value of property market, total value of mortgages, etc.)	• The policy of the cadastral system promotes a well--functional land market and aligns with the circumstances • Funding supports an efficient establishment of the cadastral system • Reasonable direct revenue from the cadastral operations

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

cont. Table 1

1	2	
	• Aspects related to funding (system of funding, involvement of institutions at different administrative levels) • Direct revenue (commercialisation of registration, land taxes, stamp duties, fees) • Cost recovery policy (operations)	• Cadastral agencies directly derive benefits that align with the circumstances • A clear policy for the cadastral system self-financing and ensuring cost recovery
	Environmental sustainability aspects	
	• Cadastral policy ensures the sustainability of the environment • Defined environmental duties	• Cadastral system includes duties such as monitoring land and natural resources, zoning restrictions, environmental protection, etc. • Cadastral system supports environmental sustainability issues
Management Level Stakeholders: administrations responsible for the operation of the cadastral components Tasks: definition of strategic targets, set-up of institutional and organisational structures	Strategic aspects (1–5 years)	
	• Strategic aspects and targets • Stakeholder-focused strategy	• Strategies clearly defined, published and shared • Cadastral agencies fulfil their mission and vision by formulating a strategy centred around stakeholders' needs and interests • Objectives, plans, and activities are formulated and actuated to execute the strategy
	Institutional and organisational aspects	
	• System characteristics (cadastral departments, agencies, centralized vs. decentralized) • How cadastral agencies are organized themselves (legal, organizational, technical links between agencies/ institutions) • Private sector involvement • Land disputes arrangements • Reform activities	• The organization of the cadastral system is beneficial and well-defined • Institutional aspects are suited to circumstances • Involved institutions have well-defined roles and demonstrate effective collaboration and communication among themselves • Organizational aspects are structured to ensure appropriate levels of authority and jurisdiction • State-private partnership with well-determined limits • Hierarchical dispute resolution mechanisms • Reform projects are implemented with coordination and a clear understanding of the context
	Human resources and personnel aspect	
	• Number of staff • Salaries	• Adequate number of personnel in relation to a tasks • Salaries are suited to the circumstances
	Cadastral principles	
	• Comprehensive legal status of land (the inclusion of all public responsibilities and restrictions, private rights) • Role of the cadastral system within the land administration system • Availability and suitability of cadastral data for the overall purpose • Cadastral survey data serves as the basis for land information systems • Processes related to cadastral transactions	• Cadastral system supports sustainable development • The cadastral system provides a comprehensive overview of the legal status of the land • There is a single, fully developed and reliable cadastral system that is efficient, effective, and trustworthy • The cadastral surveying data undergo continuous updates to ensure standardization and suitability for a wide range of purposes • Cadastral data standards (data model, accuracy, etc.) are clearly defined and suitable for various applications • Cadastral transactions are efficient and secure

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

cont. Table 1

1	2	
Operational Level Stakeholders: cadastral operational units (short-term implications) Tasks: to provide products, services, and interfaces (between units and the user) in an efficient, reliable, secure and complete manner	Definition of users, services and products	
	• List of clients (users), services and products	• The cadastral operators possess knowledge about the clients, their desired services and products, and the feasibility of delivering those services and products
	Aspects affecting the users	
	• Data reliability (numbers of errors, title and boundary disputes) • Data security (duplicate storage of records, prevention unauthorised access) • Information accuracy on land and property registration • Efficiency of transactions (time and money wise) • Transparency, clarity and simplicity of the system • Efficient and effective access to cadastral data	• Low number of disputes and errors • Updating process is dependable, and there is a backup procedure in place • Cadastral system provides accurate registration. Adequate cadastral records • Transactions performed in a reasonable short time and at a reasonable cost • Cadastral system is transparent, clear and simple • Accessibility to cadastral information is open, transparent and simple as possible
	Aspects affecting the services and products	
	• Aspects of spatial data infrastructure (digital data modelling techniques and data format) • Aspects of information technology (information technology, web-enabled solutions) • Data integration and technical standards • Mapping standards • Complete coverage • Completeness of the cadastral records	• Digital format of cadastral data and interoperable data sharing • Level of computerization of the cadastral system is suited for the country's capabilities • Cadastral system is used unique plot identifiers, linkage of data, adopted and customised international technical standards • Mapping data and cadastral surveying are coordinated and connected to a unique geodetic reference framework • Coverage of the cadastral system is 100% • Record of each land plot and property complete by itself
External Factors Stakeholders: academia, industry, etc. Tasks: capacity building, technological supply, human resources	Capacity building, education	
	• A number of universities proposed education in the cadastral field • Number of students • Number of workshops proposed for continuing education • Number of institutions and research projects related to the functioning of the cadastral system	• Continuing education regularly • Appropriate numbers of universities and students to the total population • The researchers are involved in the optimisation of the cadastral system • Good cooperation between state, academic, and private sectors
	Technological supply	
	• Existence of local industry • Initiation, adoption, maintenance, and development of suitable technology	• The technological provision is cost-effective and suitable, suited to the specific circumstances • New technologies are evaluated continuingly
	Professional association aspects	
	• Support of the profession by the associations • Associations provide ethical and professional guidelines	• The professional association plays an active role • The profession is organized according to circumstances

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

cont. Table 1

1	2	
Review Process	Review process	
Stakeholder: cannot exactly be defined (e.g. independent land review panel) Tasks: to review objectives and strategies, monitor user satisfaction, manage visions and reforms	• Review process is defined and regular • Performance and reliability of the system (number of errors, time to deliver, turnover) • Objectives and strategies of the cadastral system are satisfied and reviewed	• Review process is conducted periodically and according to clear guidelines • Cadastral system provides timely and accurate results, with minimal errors • Strategic targets and objectives are adapted or achieved • System is effective and efficient
	User satisfaction	
	• Reviewing and assessing the level of satisfaction among the system's clients (landowners, government agencies, etc.)	• User satisfaction review is done regularly • Users of the cadastral system are satisfied • Appropriate, fast and reliable service to users
	Visions and reforms	
	• Reforms and visions are managed	• Reforms and visions are closely monitored and recognized

Source: own preparation based on Chekole et al., 2020; Steudler, 2004; Yilmaz et al., 2015.

RESULTS

Policy level

Land policy aspects and objectives: One of the criteria for evaluating the cadastral system is the presence of well-defined policy objectives for administering and managing the SLC and Property Register. The current legislative support for the activity of the cadastral system in Ukraine not only regulates its legal framework but also identifies it's administering and managing procedure. The goal of the SLC's functioning is to provide information to government authorities, local self-governance bodies, legal entities, and individuals during land tenure regulations, land-use planning, land management, arrangement of rational use and land protection, land valuation and taxation, as well as establishing and managing urban cadasters and cadasters for other natural resources. According to the KMU (2015), the StateGeoCadastre is the primary authority within the executive branch and tackles responsibility for administrating and controlling the SLC and the performance of more than seventy different tasks. The StateGeoCadastre's main objective is to implement the state's policies concerning topographical, geodetic, and cartographic activities, as well as land tenure regulations, land-use planning, and state supervision in industrial agriculture to ensure adherence to land legislation. Territorial bodies of the StateGeoCadastre on the local (community) level and private businesses or persons, who are licensed (certified) by the StateGeoCadastre, are recorded spatial information about land plots into the SLC. The establishment of the electronic (digital) format of the cadastral and land-use planning documentation expanded the purpose of spatial data in land information systems. In terms of e-government, the cadastral system in Ukraine is an integral component of the national geospatial data infrastructure. This infrastructure includes identification systems for registration objects and subjects and geographic information that serves complex purposes, as outlined in VRU (2020).

The registration of property rights is done by state registration entities that have received accreditation from the Ministry of Justice. The main objective of the Property Register is to guarantee the state's objectivity, reliability and fullness of information regarding registered property rights and any other interests in land. The organisational structure of the cadastral system in Ukraine is illustrated in Fig. 1.

The matters related to cadastre are clearly stated and referenced in the Ukrainian legislation, specifically in the Land Code, Civil Code and

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

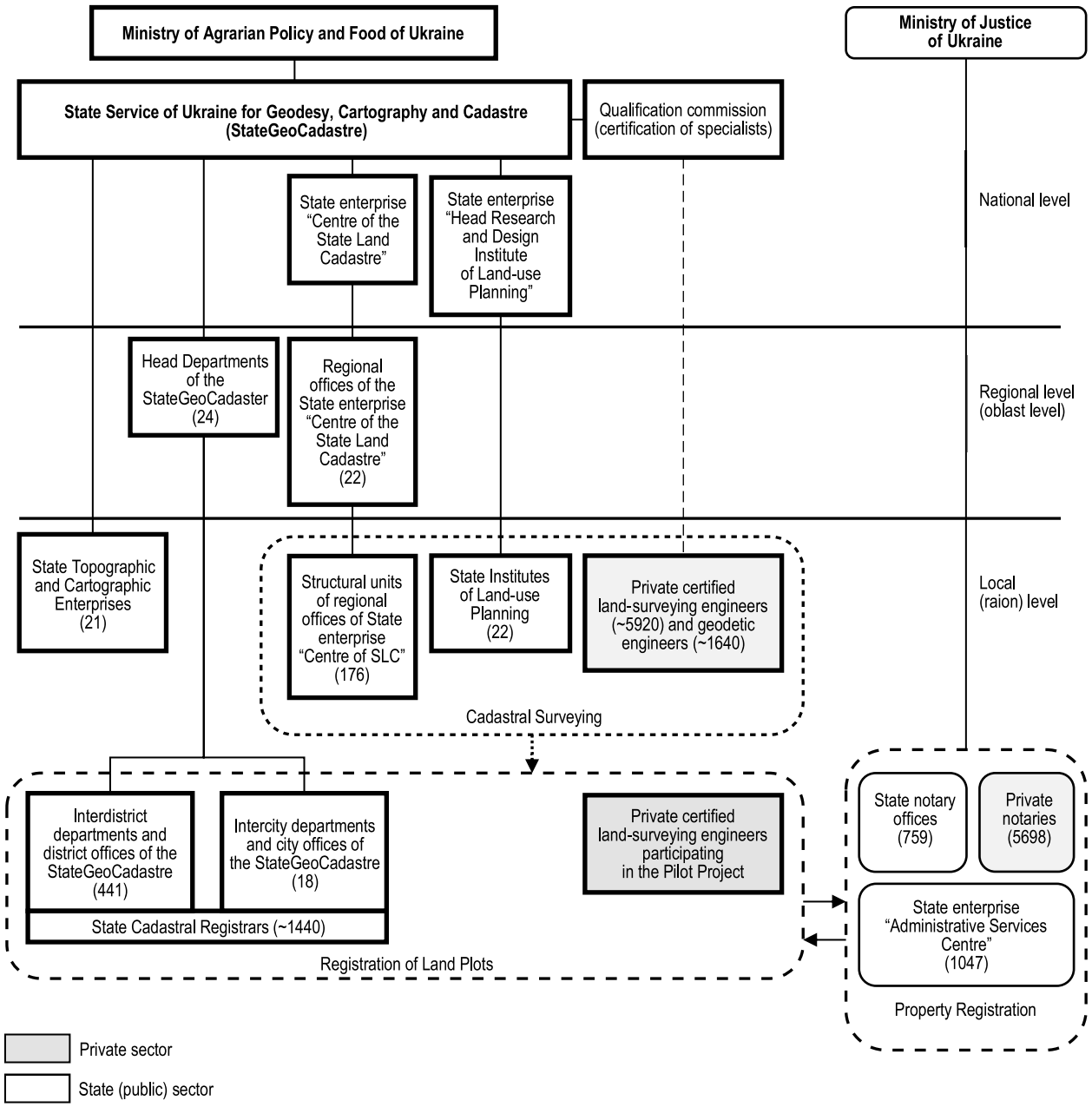

Fig. 1. The organisational structure of the cadastral system in Ukraine
Source: prepared by the authors.

Cadastre Law, along with relevant regulations and decrees. Nevertheless, there is no coherent state policy (program, concept) regarding the development of the SLC and Property Register, and accordingly, there is no vision of what the cadastral system should be in the future 10–20 years. Evidence from international best practices demonstrates that the introduction of an efficient and effective cadastral system necessitates robust and affirmative political support and decision-making. The political institutions within

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

a country must showcase their determination and dedication to accomplishing predefined objectives.

Performance gap: 1) There is no concise state policy regarding the future evolution of the cadastral system; 2) The specific vision and goals of the cadastral system are not defined in a SMART manner; 3) The exact contribution of the cadastral system in facilitating the land market remains unclear; 4) No specific policy exists to guide the advancement of the cadastral system in supporting and facilitating the attainment of the Sustainable Development Goals.

Historical, political, and social context: Society has a strong understanding and awareness of the historical context of cadastral surveying, land cadastre, land registration, and property register. The social acceptance of these concepts is also high. Overall, the cadastral system adequately addresses the current land tenure challenges and societal needs. However, the land administration structures lack proper alignment and suitability with the political and administrative frameworks. It negatively affects the quality of development and the implementation of management decisions. The territorial bodies of the StateGeoCadastre gravitate towards a strong vertically integrated management system, which does not correspond to the decentralization course declared by the political leadership of Ukraine. As part of the implementation of the policy of openness, de-shadowing, prevention and counteraction of corruption in the field of land issues, electronic (online) services were introduced for the prompt receipt of the most requested certificates and documents from the SLC and Property Register (e.g., an extract from the State Land Cadastre about a land plot, an extract from technical documentation about the normative monetary valuation of the land plot).

Performance gap: 1) There is a dispersion of existing land and property data and information between different agencies; 2) Public access to the information of the SLC and the Property Register is limited; 3) The political and administrative system does not correspond to modern transformational processes; 4) There is a bureaucratic model of the apparatus of StateGeoCadastre.

Land tenure and legal aspects: The legal framework governing land tenure arrangements, the functioning of the SLC, and the Property Register is intricate, fragmented, and prone to conflicts. In recent times, there has been an enhancement in the level of legal certainty. However, there is still a place for improvement in terms of effectively implementing laws and legal regulations. Every year the number of norms and restrictions of public law increases, which can significantly limit the use of own land plots (real property). The land legislation recognises the concept of acquisitive prescription (adverse possession), which, as best practice shows, is one of the prerequisites for the effectiveness of the cadastral system.

Performance gap: 1) Integration of public law regulations and encumbrances into the SLC and Property Register is incomplete, varied, and consequently lacks transparency for the land market; 2) Land legislation does not recognise "general" boundaries of land plots; 3) There are cases of ignoring the legislation norms by the state bodies responsible for the SLC functioning.

Financial and economic aspects: The StateGeoCadastre is the fifth-largest state civil agency in the country, which is represented at the level of each oblast, district (raion) and/or city. In 2019, the maintenance of the StateGeoCadastre cost the taxpayers of Ukraine 1.9 billion UAH of budget funds (about 71.2 million USD), of which 1.44 billion UAH are earmarked for management and administration (VRU, 2021). The State Budget of Ukraine bears the cost of supporting the administration and functioning of the SLC, and the list of paid and free services is clearly regulated by legislation. For example, registration of land plots in the SLC and making changes to them are performed free of charge. An administrative fee is charged for correcting technical errors in the SLC data and getting information from SLC. However, the executive power bodies and local self-government bodies are used the cadastral data free of charge. State registration of land ownership is paid, in contrast to the free land registration in the SLC.

The agricultural land market in Ukraine officially began on July 1, 2021. Despite the ongoing war, the land market sector in Ukraine remains remarkably

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

active. Since the implementation of the land market, there have been 153,659 land transactions covering a total agricultural land area of 344,061 hectares (SGC, 2023). It is worth mentioning that over one-third of these transactions occurred during the full-scale war. As of April 2023, the average agricultural land price per hectare is UAH 39,000 or EUR 973. Since the beginning of 2023, the price of agricultural (farming) land has increased by an average of 20%. Nevertheless, the service fees acquired from land transactions are not allocated towards supporting the functioning of the cadastral system.

Performance gap: 1) The StateGeoCadastre and its regional offices are required to compete for funding from the State Budget of Ukraine to support the development of the SLC; 2) The Ukrainian cadastral system is not a profitable venture for the government; 3) SLC does not operate on the principle of self-sufficiency; 4) There are fundamentally different approaches to the payment of fees for land plots registration in the SLC and property rights in the Property Register; 5) The cadastral system has to struggle to get budget from the State Budget of Ukraine.

Environmental sustainability aspects: The cadastral system does not support environmental protection due to the lack of relevant indicators in the system.

Performance gap: 1) The Ukrainian legislation does not provide the recording (registering) environmental data into the SLC and Property Register; 2) Restrictions on land use are only partially and in a descriptive form integrated into the cadastral system; 3) The responsibilities are not included in the cadastral system, having the effect of a certain non-transparency.

Management Level

Strategic aspects: The key responsibilities of the management level involve establishing strategic objectives by Government stakeholders with medium-term impacts of approximately 1–5 years. Despite this, the principles outlined by the FIG (1995), UNECE (1996, 2005a, 2005b), Kaufmann and Steudler (1998), Steudler et al. (2014), and Williamson et al. (2010) regarding the establishment of a strategic Land Administration System have not yet been embraced by the Ukrainian government. Similarly, the ISO 19152:2012 Geographic Information – Land Administration-Domain Model (LADM), designed to enhance interoperability among cadastres across different nations, has not been a focal point on the government's agenda over the last five years. Hence, there is a lack of utilization of a Unified Modelling Language to describe, visualize, and document the processes within the land administration system. It is important to highlight that as of 2021, the establishment of the National Geospatial Data Infrastructure commenced, following the guidelines of the ISO 19101:2002 standard and incorporating national standards from the ISO 19100 series. The diagram in Fig. 2 illustrates the logical framework of the existing land administration system.

The Order of the StateGeoCadastre No. 343 of December 16, 2019, adopted an action plan for implementing the Strategic Action Plan "Cadastre 2.0 Transparency. Accessibility. Innovation" until 2021. That included tasks such as complete digitisation of cadastral processes and elimination of personal contact with officials, public control, reduction and simplification of cadastral procedures, creation of Service Control Departments, total disclosure of information about the land and property objects, deregulation and transfer of some powers to the local level. However, the Strategic Action Plan is still not publicly available. Few statistics are available. It is impossible to assess the implementation success of the aforesaid measures.

Performance gap: 1) The responsible agency for reviewing and controlling the implementation of the Strategic Action Plan was not identified; 2) Digitalisation and integration of geospatial data into digital registries are too slow; 3) In some cases, legislative norms are ignored to implement specific settings of the Strategic Action Plan; 4) The Strategic Action Plan for SLC is not transparent; 5) There is a lack of a strategy for the future adoption of the ISO 19152:2012 Geographic Information – Land Administration-Domain Model.

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

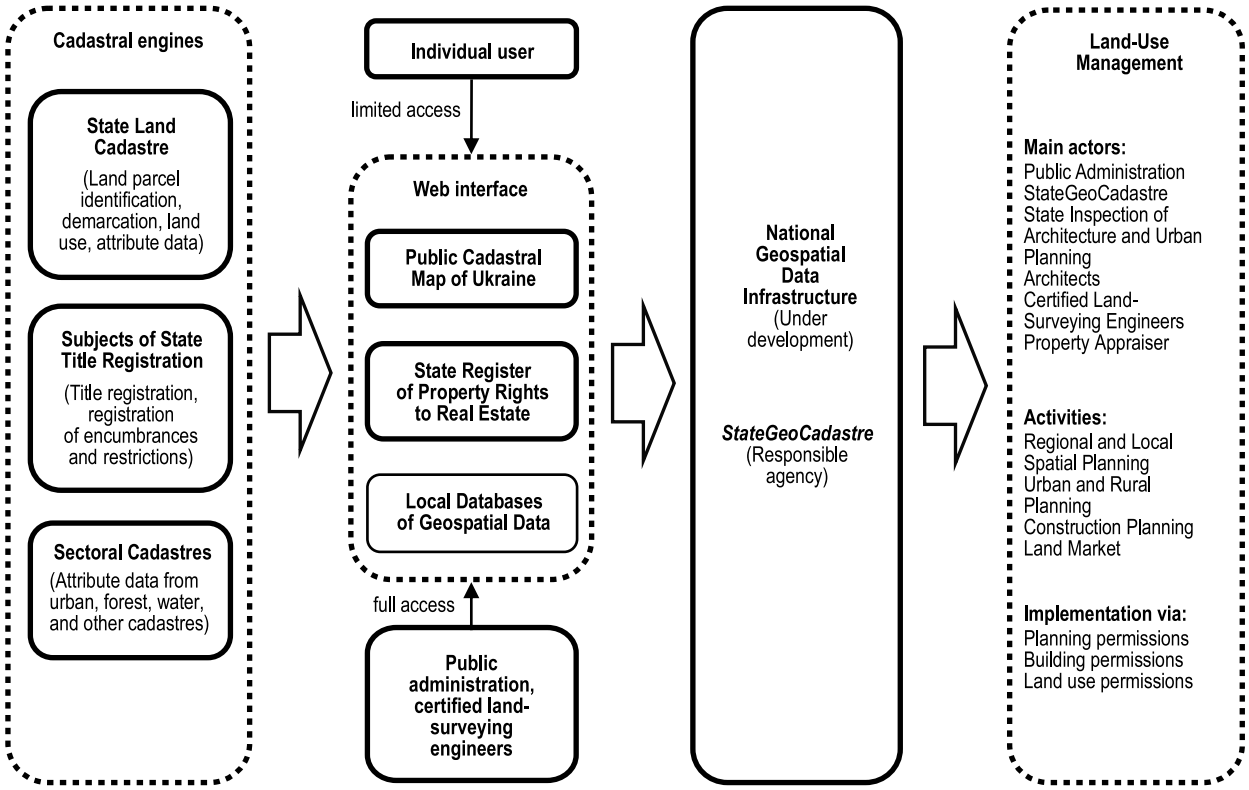

Fig. 2. The simplified land administration system in Ukraine
Source: prepared by the authors.

Institutional and organizational aspects: Today, land tenure arrangements and the SLC functioning are considered one of the most corrupt spheres of state administration for the last decades. In addition, the system of bodies of the StateGeoCadastre is treated as an attractive organisational and managerial tool for generating various methods and mechanisms of receiving corruption income (VRU, 2021). The StateGeoCadastre is characterised by solid centralised management vertical by subordinating 47 state land-use planning, topographic and cartographic enterprises with their structural subdivisions at the national, regional (oblast), and local (raion) levels (Fig. 1). The StateGeoCadastre has a departmental monopoly on services for state registration of newly created land plots (initial land plot registration) and other services. State property and other rights registration are carried out via local administrative service centres or notaries (Fig. 1). The central database for information about land plots is the State Land Cadastre, which is accessible online through the Public Cadastral Map of Ukraine. Additionally, details concerning title, encumbrances and restrictions related to land plots are maintained in the Property Register.

In recent years, the engagement of the private sector has demonstrated significant benefits for the evolution of the cadastral system. Private certified land-surveying engineers and geodetic engineers have effectively adjusted technologies and processes, introducing modern capabilities, methods, and applications that have helped enhance cadastral activities. Well-defined and sustainable partnership rules strengthen the innovation potential of state-private cooperation, resulting in overall benefits for the entire cadastral system.

Performance gap: 1) The StateGeoCadastre is constantly at the stage of reorganisation; 2) There is still

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

little desire of the StateGeoCadastre bodies to cooperate with the private sector; 3) The StateGeoCadastre holds a monopoly over services related to access to land information, initial registration of land plots, training and accreditation of land-surveying engineers and geodetic engineers, and the approval of professional qualification commission compositions; 4) Excessive technical and qualification requirements, established by StateGeoCadastre acts, complicate the integration of cadastral documentation in administrative service centres.

Human Resources and personnel aspect: The staff of the StateGeoCadastre and its territorial bodies is about 10,000 people, of whom 1,436 are state cadastral registrars. In 2020, the maximum number of employees of the State Geo Cadastre system was going to be reduced by 57% – to 4,317 full-time employees (Epravda, 2020). However, it was not possible to get updated information. As of 2022, 5,698 private notaries and about 4,000 state registrars, notaries and registrars in local self-government bodies perform property registration.

The salaries in the state sector are suitable and comparable to those in the private sector. However, it is not uncommon for the private sector to unofficially pay a portion of the salary "under the table" or through informal means.

Performance gap: 1) By increasing the number of registration offices (Administrative Services Centres), the number of state cadastral registrars remains unchanged or even decreases, which slows down the process of serving citizens; 2) There are high qualification requirements for officials of local self-government bodies and Administrative Services Centres to provide access to work with the SLC information.

Cadastral principles: The SLC serves as the foundation for maintaining the twelve cadastres in Ukraine. The SLC is based on six objects: land plots; land use restrictions; reclamation networks; constituent parts of reclamation networks; land within the territory of administrative-territorial units and territorial communities; land within the state border of Ukraine. During the registration in the SLC, the first object (land plots) is assigned unique cadastral numbers and other – registration numbers. Land plots and property registration are public registries where the documentation related to land interests is maintained. There is one unique assigned property title to each land plot in Property Register after registering the physical land plot in the SLC. The cadastral system is plot-based but overlaps with five other SLC objects.

SLC is considered an entrance to property registration because holds the basic data from the input documents of the property registration. Land plots are registered in the SLC register and on the cadastral index map. State registration of land plots and property rights is mandatory during the formation of the new land plot (property) or land (property) transactions. However, land and property registration is carried out sporadically on a voluntary approach.

The cadastral plan of a land plot is compiled in digital and paper formats at a scale that ensures an accurate representation of information, and the area is recorded in the SLC with precision to four significant digits after the decimal point (KMU, 2012). The area of the land plot is indicated up to 1 square meter, considering the maximum scale error of the plan in cases where the coordinates of the boundary reference point are determined with an accuracy of up to 0.01 meters. The root-mean-square error of determining the coordinates of cadastral boundary points relative to the nearest points of the state geodetic network, densification geodetic networks, and urban geodetic networks should not exceed: in Kyiv, Sevastopol, and cities of regional subordination – 0.1 meters; in other cities and towns – 0.2 meters; in villages – 0.3 meters; outside settlements – 0.5 meters (KMU, 2019). The maximum discrepancies should not exceed double the values of permissible root-mean-square errors, and their number should not exceed 10% of the total number of control measurements.

The legal timeline for land plots and property registration is not more than one month without cadastral surveying. However, in real life, registration can take several months because of tenure

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

uncertainties (e.g., data discrepancy between SLC and Property Register, double land registration, land plots overlapping, etc.). Few statistics are available on land disputes. It is known about the technical errors in the SLC data. A commonly encountered issue is overlapping land plots and discrepancies between the boundaries (shape and size) stated in the legal document and the actual boundaries of the land plot (Popov et al., 2019).

In theory, the land plots should cover the entire territory without any gaps or overlaps. Roads, shelterbelts, forests, rivers, and lakes are designated as single land plots with assigned landowners or land users. As of March 2023, about 72% of the country's territory (43.6 ml hectares) is registered in the SLC (SGC, 2023) and covered by digital cadastral maps of land parcels. No administrative-territorial units have a fully completed (digital) cadastral map at 100%. Officially marked administrative boundaries of 21,702 settlements are registered in the SLC, which is 76.7% of the 28,299 settlements in Ukraine (SGC, 2020) (excluding the Autonomous Republic of Crimea and the temporarily occupied territories of the Donetsk and Luhansk regions). The Public Cadastral Map of Ukraine, accessible to the public online, presents little information regarding registered land plots and SLC objects. Cadastral maps and data are maintained both in physical paper format and digitally within the State Fund of Land-use Planning Documentation. Additionally, they are securely stored on the servers of the StateGeoCadastre, ensuring accessibility and preservation for efficient land management.

The cadastral system does not provide a comprehensive representation of the legal status of the land (property) since it does not incorporate information regarding zoning or other public rights limitations and restrictions. Legal data is stored in Property Register. Consequently, this situation has resulted in a growing lack of transparency within the land market, particularly in the agricultural land sector. The Public Cadastral Map of Ukraine has errors of both technical (overlapping of land plots and their location) and legal nature. The digital format of cadastral data makes it possible to structure it into layers developing their usability, adaptability, and flexibility.

Performance gap: 1) The cadastral system is dual. There are two different registers; 2) SLC does not register (contain) information about real property objects (buildings); 3) The software which would allow keeping the SCL completely accordingly to the cadastral legislation was not developed yet; 4) The information of the SLC and Property Register is not entirety publicly available; 5) There is no legal procedure for assigning registration numbers to SLC objects and the cadastral number assigned to land plots does not follow the current legislation; 6) The cadastral system does not include public law responsibilities and restrictions; 7) Information about the property rights to land plots registered before 2013 was not fully transferred (integrated) from SLC to Property Register; 8) A complete and comprehensive cadastral index map is currently unavailable; 9) Cadastral surveys can use at least five different coordinate systems: UCS-2000, CS-42, CS-63, local coordinate systems, and nominal coordinate systems; 10) There are cases of noncompliance between the boundaries of land plots specified in the legal document and physically fixed boundaries; 11) Legislatively fixed principles of SLC functioning are mostly declarative; 12) There are no clear standards for the preparation of cadastral documentation.

Operational Level

Definition of users, services, and products: The overall focus of the cadastral system is to offer user services, and significant efforts have been dedicated to its improvement over the past three years. The responsibility to provide cadastral surveying has predominantly been entrusted to the private sector, while the local level StateGeoCadastre authorities handle land plot registration and oversee their immediate supervisory duties.

Creating a properly operational (agricultural) land market holds significant importance in the present time. However, the existing cadastral system is not focused on the market of real property and land plots. Both the StateGeoCadastre and the Department of Notary and State Registration recognize the importance of prioritizing the welfare of citizens,

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

certified land surveyors, and notaries as the primary beneficiaries. Nevertheless, prioritizing the clear definition of users, services, and products was not a top concern.

Performance gap: There is no unified, comprehensive, and user-friendly service available.

Aspects affecting the users (clients): Data security is effectively managed through regulations and stringent checks on data backup procedures. The ongoing updating of cadastral databases is carried out through clearly defined notification procedures implemented by the central database. Despite the StateGeoCadastre's monopoly and the centralized model of collecting cadastral information, accessing data is challenging, particularly when the extensive data coverage is required for large areas.

The registration procedure for land plots and property is quite simple, clear, and understandable. However, leasing hundreds or even thousands of land plots entail significant financial expenses (around 11.20 USD/ha) and time investment (three months or longer) for registering lease rights (Popov et al., 2019).

The reliability of the cadastral system for land market operations is relatively low. There is a significant occurrence of title (property) and boundary disputes, with the number of land disputes being exponentially higher compared to disputes in other industries, with a ratio of ten thousand to one. Namely, for every ten thousand land disputes there is one dispute in other sectors of the economy taken all together (Havrylenko, 2019). In 2017, the courts registered 1.905 administrative land disputes, 10.621 civil land disputes and 5.379 economic land disputes (SY, 2018). As practice shows, one of the most widespread land disputes is disputes over the shared boundary of neighbouring land plots (overlapping of land plot boundaries). A common problem is the double registration of land lease contracts, which often is used to grab other people's property. On average, there are 35 errors in the SLC database per thousand registered landowners and land users in cities; in rural areas – 15 errors (SY, 2018).

The Public Cadastral Map of Ukraine is constantly being improved, which allows better access to various data. The system offers straightforward access to information, although it may not be comprehensive. Internet-based solutions are increasingly employed to enhance user access and improve overall usability. Therefore, the number of electronic cadastral services provided by the StateGeoCadastre and Department of Notary and State Registration is gradually increasing.

Performance gap: 1) Certain cadastral information is enclosed and scattered among different agencies and databases; 2) Cadastral databases are incomplete; 3) The occurrence of errors, as well as the frequency of title and boundary disputes, is significantly high; 4) Registration of lease rights for agricultural enterprises is time-consuming.

Aspects affecting the services and products: The integration of data and information within the cadastral system domain is good. There are unique land plots (cadastral numbers) and SLC objects (register numbers) identifiers. Consequently, all plot-related information can be associated with the specific land plot by ensuring a robust linkage. The completeness of the land records is commendable, as all data is consistently and comprehensively gathered.

Cadastral data is presented in digital form using XML technology, which ensures shared data exchange. The use of XML format (exchange file) made it possible to improve the quality of the cadastral documents, such as completeness, ease of use and functional convenience. Modern information and communication technology are increasingly integrated into the cadastral system.

Cadastral surveying and data mapping are harmonized and interconnected with the Unified State Geodetic Reference Coordinate System UCS-2000. The data coverage in cadastral mapping is limited due to the sporadic approach taken towards the registration of land plots and properties. The last update of orthophoto plans was in 2007–2011. Spatial data infrastructure aspects were not given significant priority during the past ten years of the cadastral system's operation. The Ukrainian government formulated spatial data infrastructure legislation in 2020, which came into force in 2021.

Performance gap: 1) The cadastral system is incomplete with 71% coverage of the country territory;

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

2) The record of each individual land plot is incomplete by itself; 3) The Public Cadastral Map of Ukraine is not displayed all cadastral data; 4) Orthophoto plans are not updated.

External Factors

External factors exert influence on all three organizational levels (Steudler et al., 2004). These external factors should encompass various functional areas such as research and education institutions, innovative technology, or industries involved in the operations of the cadastral system directly or indirectly. The cadastral system operates within an ideological context that includes these external sectors, as outlined by Steudler (2004).

Capacity building, and education: Numerous workshops and seminars are currently being arranged to provide ongoing training and education for cadastral specialists in both the public and private sectors. The educational capacity in the speciality 193 "Geodesy and land-use planning" is deemed sufficient, with fifty-one universities providing programs related to land surveying, mapping, cadastre, and land-use planning. However, there has been a steady decrease in the number of students pursuing this field.

Performance gap: The partnership between the state and private cadastral activities and academia is not close.

Technological supply: Geodetic equipment is almost not produced in Ukraine. Nevertheless, the private sector exhibits considerable strength in providing the local market with geodetic tools and GIS products required for the cadastral surveying and cadastral system.

Professional association aspects: Multiple professional associations, including the "Association of Land-use Planning Specialists of Ukraine", "Land Association of Ukraine", "All-Ukrainian Union of Certified Land-Surveying Engineers", "Ukrainian Society of Geodesy and Cartography", "All-Ukrainian Union of Certified Geodetic Engineers", and "Union of Surveyors and Cartographers", actively advocate (lobbying) for the progress and promotion of professional interests. The interactions between the state and these professional associations are accomplished and appropriate. There are specific requirements in place that limit membership in professional associations.

Review Process Aspects

It is crucial for any system that it is regularly being reviewed and adjusted if necessary. Following international best practices, it is recommended to establish an independent commission, either temporary or permanent (governmental, parliamentary, or public), to assess the state of the cadastral system. This commission would be responsible for overseeing and supervising the entire cadastral system.

Review Process: Within the framework of the "Supporting Reforms in Agriculture and Land Relations in Ukraine" project, supported by the World Bank, a monitoring initiative was conducted to assess land tenure issues in Ukraine from 2013 to 2017. The monitoring process used 65 indicators aligned with the practices of developed countries and the recommendations of the World Bank (SY, 2018). The analysis of the functioning of the SLC and Property Register was a part of the monitoring. The results of monitoring are publicly available in the form of yearbooks. However, after the completion of such a project, monitoring or other comprehensive analysis of land tenure issues was not carried out at the national level.

It should be noted that the analysis based on World Bank indicators had a statistical nature regarding land transactions, completeness of official registration, normative monetary valuation of land plots, the number of registrars, and land disputes. Conducting such an analysis is essential for upholding the principles of transparency and accountability in the cadastral system. However, the evaluation framework proposed in the article is primarily focused on establishing qualitative indicators of the cadastral system rather than quantitative ones. Through the integration of both quantitative and qualitative indicators, various stakeholders can achieve a well-rounded understanding of how the cadastral system's performance. This comprehensive assessment helps identify areas that require improvement, showcases successful practices,

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

Table 2. The SWOT evaluation matrix of the cadastral system in Ukraine

Strengths	Weaknesses
• The sole national agency entrusted with the responsibility for the national infrastructure of geospatial data • Central databases of SLC and Property Register are accessible via the Internet • A unified and standardized data format for defining and exchanging digital information • The registration procedure of land and property and functions of system users are clearly defined • A relatively swift and cost-effective process for registering land plots and properties • A land transaction registration process that is relatively fast and cost-effective • Concept of one-stop-shopping • Active involvement of the private sector • Good collaboration between the private and public sectors • There is professional associations • Implementation of pilot projects by the StateGeoCadastre	• No clear state policy regarding the future development of the cadastral system • No regular and comprehensive review panel (monitoring) of the "Cadastre 2.0" strategy • No systematic procedure for regular monitoring and evaluation to assess the effectiveness of the cadastral system • Need to enhance and strengthen the regulatory standards for cadastral documentation • Registration of land plots and property and other rights is carried out by two different agencies • Cadastral surveying is conducted on many local coordinate systems • No comprehensive and complete cadastral map thus far • Weak collaboration between the academic, private, public, and sectors • Competition between different interest groups (land-surveying engineers and geodetic engineers, cadastral and property registrars) rather than cooperation • The territorial bodies of the StateGeoCadastre have monopoly access to cadastre information yet • Limited integration between SLC and Property databases • Double registration of lease rights for one land plot • Technical errors in SLC database • Most of the SLC objects that should be contained in the SLC database are missing • There are signs of bureaucracy • The legislation on the cadastral system is, in most cases, not in line with new technology • The slow development of the cadastral system due to systems problems and resource issues • No regular customer satisfaction surveys
Opportunities	**Threats**
• Development of a clear state policy regarding the cadastral system strategy • Strengthen political and legal support • Engagement of the private sector can be expanded to foster a mutually beneficial partnership between the state and private sectors • The establishment of a national geospatial data infrastructure has the potential to improve the acquisition and distribution of cadastral data for promoting good governance • It is a good time to initiate the establishment of a unified electronic 3D Property Cadastre • Decentralisation of management and regulatory powers • A more resolute dedication to good governance and adherence to the rule of law • Rapid infrastructure and technological development • Recognizing the significance of the cadastral system in socio-economic progress for allocating the necessary resources to cadastral agencies to ensure their technological advancement • Improving the security and guarantee of land rights • Increasing user (customer) support • Involvement of community and civic organizations	• Losing political support • Incapacity to unite divergent interest groups • Cost of data acquisition, implementation, and integration of new technology • Continued tensions between StateGeoCadastre, Department of Notary and State Registration and private sector • Lack of funding • Dependency on imported technologies

Source: prepared by the authors.

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

and guides strategic decision-making. Ultimately, this approach ensures that the cadastral system not only meets technical requirements but also aligns with user expectations and contributes to achieving sustainable development principles.

Performance gap: 1) A regular and comprehensive review process for evaluating the performance and advancement of the cadastral system, along with the status of its objectives and strategy, is absent; 2) There is no land accounting in the country.

User satisfaction: StateGeoCadastre and the Department of Notary and State Registration appeared to be taking a market-oriented approach focusing on identifying and satisfying consumer needs and desires. The cadastral system has the ability to swiftly and flexibly adapt to necessary changes. However, this stands in contrast to the conventional approach to public administration, which tends to be slow. Currently, there is no monitoring of user satisfaction with the cadastral system. Nonetheless, the majority of users appear to be content with the services offered.

Performance gap: 1) There is no regular monitoring of the satisfaction of cadastral system users; 2) Users can be served more efficiently in the Internet age; 3) The costs associated with land transactions and cadastral surveying are frequently perceived as being high.

Visions and reforms: Employees of the StateGeoCadastre and Department of Notary and State Registration are generally open and willing to receive new knowledge and adopt new visions from other countries. The participation of the private sector in the cadastral system presents a continuous challenge to exploring new concepts and envisions for its development, which ultimately benefits the entire system.

Performance gap: The visions and requirements for reform are not closely observed and recognized.

SWOT ANALYSIS

The SWOT analysis is a strategic planning technique employed to assess an organization's strengths, weaknesses, opportunities, and threats, as outlined by Hill and Westbrook (1997). According to Gürel and Tat (2017), these factors represent the most influential parameters in determining the future prospects of the cadastral system. Identifying strengths and weaknesses gives valuable advice on improvement for the cadastral system, and threats and opportunities will hint at possible development concerning long-term strategies and plans. Using the SWOT matrix (Table 2) to analyse the present state of Ukraine's existing cadastral system will aid in the development of strategic planning.

CONCLUSIONS

The purpose of this research was to create an evaluation framework that utilizes international best practices, publications from International Scientific Indexing journals, and cadastral models to measure and evaluate the performance of the cadastral system in Ukraine. Building upon previous findings, a comprehensive collection of evaluation indicators has been identified to measure the extent to which best practices align with the criteria across various evaluation areas and aspects of the cadastral system. Consequently, a comprehensive evaluation framework has been formulated, encompassing best practices and their corresponding evaluation indicators for all eighteen aspects within the five designated evaluation areas (refer to Table 1). The significant contribution of this paper is to raise awareness regarding the importance of establishing a nationally recognized methodology for conducting regular performance evaluations of a country's cadastral system. The significance of the evaluation framework presented in this paper is further reinforced by the fact that it is the inaugural framework of its kind in the Ukrainian cadastral field.

The paper highlights the importance of connecting the evaluation of the Ukrainian cadastral system to broader economic and social concerns. The evaluation framework should consider a comprehensive range of factors, including political, institutional, legal, economic, environmental, social, and technical aspects, alongside the influence of partnerships between state and private sectors. Implementing such an evaluation framework will establish a foundation

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

for a more comprehensive and standardized approach. The analysis of strengths, weaknesses, opportunities, and threats of the cadastral system (as depicted in Table 2) is explored in the context of strategic planning development. The suggested evaluation framework has the potential to serve as a robust tool for strategic sustainability planning and management drawing upon the analysis of the current situation. The results of this research will allow decision-makers at various levels of policymaking to effectively monitor, evaluate, and review the cadastral system performance's strengths and weaknesses in response to changes in technology, organisational capacity, and access to geospatial information. Therefore, drawing from the achieved results, the researchers propose the following recommendations:

1. The presence of a comprehensive cadastral policy is crucial for the successful implementation of the cadastral system in Ukraine. At the heart of this policy should lie political willingness and commitment, addressing institutional and legal matters, as well as sustainability considerations including economic, social, and environmental aspects, along with technical standards. The next stage has tended to be the integration of this policy into legislative programmes.
2. Given the lack of a clear vision for the future evolution of the cadastral system, the implementation of the ISO 19152 – Land Administration Domain Model is being suggested as an alternative approach. It will be crucial for a cadastral system's development as it provides a standardized framework for consistent data representation, enhancing interoperability and facilitating efficient data exchange among diverse land information systems. By aligning with LADM, Ukraine can establish a robust foundation for modernized and integrated land administration practices, supporting accurate land management, transactions, and decision-making.
3. In order to choose the most suitable cadastral system for Ukraine, the involvement of policy and decision-makers, academia, and professionals through state-private partnerships is crucial. Their support plays a vital role in developing sound cadastral policies and establishing an appropriate cadastral system, as well as a comprehensive land administration system overall.
4. The private sector's involvement in the cadastral system is already evident. However, the private sector can further contribute to the implementation of the cadastral system policy, despite the government's ultimate responsibility for it. Hence, it is crucial to ensure the sustainability of the cadastral system through effective state-private partnerships and collaboration with end customers.
5. Cadastral institutions and organizations, both individually and as part of the overall cadastral system, should implement a regular review process to evaluate and monitor the performance of their operations. This includes assessing their organizational excellence and finding ways to measure it effectively. Moreover, organizations involved in cadastral system implementations should prioritize customer satisfaction surveys as a means to gauge their accomplishments.
6. The institutions and organizations responsible for the implementation of the cadastral system should adopt the suggested evaluation framework as a standard reference point. It is recommended to conduct regular review processes and issue annual reports to assess their progress. The application of the proposed evaluation framework will bring meaningful transformations in various economic and social aspects supporting the country's sustainable development goals.

Unfortunately, land continues to be a key factor in conflicts and wars. The presence of a robust cadastral system, along with its evaluation framework, can contribute to post-war and post-conflict mitigation. Future research could focus on examining the policies and strategies employed by the cadastral system to address the diverse objectives and requirements found in various environments and contexts, such as urban and rural areas.

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✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

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Note: the results of this study were presented in another form, such as a poster at a conference.

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✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

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✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

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Abbreviations

EFQM – European Foundation Quality Management
KMU – Kabinet Ministriv Ukrainy
SDG – Sustainable Development Goals
SGC – StateGeoCadastre
SY – Statistical Yearbook
VRU – Verkhovna Rada Ukrainy

✉popov@mnau.edu.ua, ✉pavlokolodiy@gmail.com, ✉tankist815@gmail.com

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SMALL-SCALE RETENTION AS AN ELEMENT OF THE ECO-CITY CONCEPT IN THE CONTEXT OF STRATEGIC PLANNING DOCUMENTS IN POLAND

Krzysztof Rogatka[1]✉, Anna Brzezicka-Rawa[2]✉, Aleksandra Lewandowska-Czuła[3]✉, Aleksandra Kustra-Rogatka[4]✉, Marcin Leźnicki[5]✉

[1] ORCID: 0000-0001-5500-4197
[2] ORCID: 0000-0003-3865-9823
[3] ORCID: 0000-0002-1694-5151
[4] ORCID: 0000-0002-1153-8717
[5] ORCID: 0000-0002-0855-146X
[1,2,3,4,5] Nicolaus Copernicus University in Toruń
Gagarina Street, 11, 87-100 Toruń, **Poland**

ABSTRACT

Contemporary cities should be developed based on concepts grounded in ecology and sustainable development. The eco-city is one of such concepts which emphasises the role of hydrological resources, especially small-scale retention, in environmentally- and user-friendly spatial development. Pro-environmental concepts are manifested mainly as provisions reflecting the above principles in the strategic documents of cities. The aim of this article was to verify the hypothesis postulating that in "Studies of the Conditions and Directions of Spatial Development" (SCaDSD) [in Polish: "Studia uwarunkowań i kierunków zagospodarowania przestrzennego" – SUiKZP], which are the fundamental strategic documents for Polish cities, the approach to small-scale retention is diverse and often insufficient from the "eco-city" perspective. To achieve the research goal, SCaDSDs were analysed in a comparative study (7,061 data records for spatial planning and small-scale retention were analysed). The study demonstrated that in SCaDSDs, small-scale retention solutions are diversified both quantitatively and qualitatively, which may hinder the implementation of the eco-city concept in terms of small-scale retention. SCaDSDs focus primarily on the protective and cleansing roles of retention, including protection against flood risk and access to clean water which is a basic human need. SCaDSDs should offer a multi-functional approach to retention and thus fully implement "eco-city" principles. This is a particularly important consideration because the role of strategic planning documents is to provide up-to-date directions for the sustainable development for modern cities.

Keywords: city, spatial planning, environmental management, water, blue infrastructure

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

INTRODUCTION

The urgent need to implement the postulates of sustainable development, including in designing cities, was first addressed by the those who are considered to have sown the germ of the idea – the Greek philosophers (Girard, 2013; Raju & Manasi, 2017). Therefore, when planning a city in antiquity, humans were perceived to be an inseparable part of nature. It was postulated to shape urban space in such a way as to interfere with the natural environment to the least degree possible. Moreover, it was realised that citizen-friendly cities should serve to enhance quality of life (Baran-Zgłobicka, 2017; Leźnicki & Lewandowska, 2016). For this purpose, cities were built to be compact and have a well-planned logistics and transport network, while also being green. However, for them to remain so, it was self-evident that a network of aqueducts, water and sewage systems, and tanks for storing water (in the event of drought, for example) were all necessary. Care was also taken to maintain the city's microclimate, which is crucial for the comfort of inhabitants, while also eliminating urban heat islands. For this purpose, city pools were

Fig. 1. Disappearing water bodies (Pilczycki Park, Wrocław) constituting the city's small-scale retention system

Source: SIP Wrocław (geoportal.wroclaw.pl, 15.12.2022).

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

built – and even fountains – that were integrated into the city landscape and constituted a source of running drinking water, while also cooling the urban space. It seems that the importance of these issues has now waned, and predatory urbanisation is in the ascendant (Noszczyk, 2023; Szymańska, 2007).

Today's dynamic advance of civilisation, which manifests as (among other things) the urbanisation of space, has brought unfavourable changes in the natural environment that are ultimately bringing about irreversible climate changes and radically reducing the quality of life in cities (Giedych, 2018; Noszczyk et al., 2022). One current climate-change-related problem that is affecting urban space (though not only) is the growing lack of access to drinking water and desertification of areas (see Fig. 1).

In cities, this problem manifests as increased temperatures and the formation of urban heat islands, which adversely affect residents' health and quality of life. In Poland, the growing tendency to concrete-over public spaces in cities and along riverbanks and to drain often attractively located wetlands for development has further aggravated the problem of the hydrological deficit. Moreover, such activities have often been carried out in contravention of sustainable development principles. This is why eco-city concepts appeared in the 1970s (to be developed in later years) aimed at implementing pro-ecological solutions in cities (Joss et al., 2013; Rapoport & Vernay 2011; Roseland, 1997; Wong & Yuen 2011).

The subject of analyses in this article is the strategic planning documents of communes in Poland, i.e. "Studies of the Conditions and Directions of Spatial Development" (SCaDSD) [Pol. "Studia uwarunkowań i kierunków zagospodarowania przestrzennego" – SUiKZP]. The SCaDSDs were analysed and assessed in terms of their inclusion of provisions for small-scale retention, which constitute evidence that eco-city principles are being implemented in cities.

It should be noted that, while the Polish spatial planning system does not refer directly to the concept of the eco-city, it does exhibit applications of the idea of sustainable development. Thus, spatial planning, through sustainable development, should be associated with the concept of the eco-city.

METHODOLOGY

Aim of the study

The article aims to verify the hypothesis that "Studies of Conditions and Directions of Spatial Development" of Polish cities take a variety of approaches to the problem of small-scale retention that are in many cases insufficient from the perspective of eco-city principles.

In order to achieve the aim of the study, the authors defined the following research questions:

Q1: Are references to small-scale retention included in all analysed documents?

Q2: What content regarding small-scale retention contained in the SCaDSD enables the implementation of the eco-city assumptions?

Spatial and temporal scope

To achieve the research goal, a comparative study was used that involved analysing SCaDSD records for references to small-scale retention. The analysis concerned SCaDSDs enacted for 16 cities that are capitals and joint capitals of Polish voivodeships (provinces) – i.e. cities that host the headquarters of the voivode, which is a state administration body and the head of the government of the Republic of Poland in the voivodeship. These cities, which are the main socio-economic and administrative centres in Poland, are the main nodes in the country's settlement network, so it is important to understand the provisions of SCaDSDs in these settlement units of key importance to the country's development. The present study involved the analysis of 7,061 data records for spatial planning and retention and covered the years 2000–2020.

Research procedure

The study was conducted in two phases:

Phase I of the research involved analysing the occurrence of entries related to retention in the SCaDSD (the number of instances of the words *retention* within part 1 of the document entitled:

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

"Diagnosis of present state and development conditions" and in part 2: "Directions and principles of development"). In this part of the research, we also analysed the number of references to retention in the SCaDSD in relation to the date of the adoption (or updating) of the document.

Phase II of the research involved analysing SCaDSD records using the proprietary method of determining retention function identified by Mioduszewski (MWFR) (Mioduszewski, 2006). This method was used to find and define small-scale retention functions in the SCaDSD, these being evidence that eco-city principles are being implemented in cities (Mioduszewski, 2006). MWFR was constructed based on a set of rows and columns. The top row shows the functions of small-scale retention in a city, and the left column lists the cities for which SCaDSD records were examined. The table is completed in a binary manner (if a given retention function is present in SCaDSD of a given city: 1, if not: 0).

The study area comprised 16 capital or joint-capital cities of the 16 voivodeships in Poland, each hosting the headquarters of its voivode (see Fig. 2).

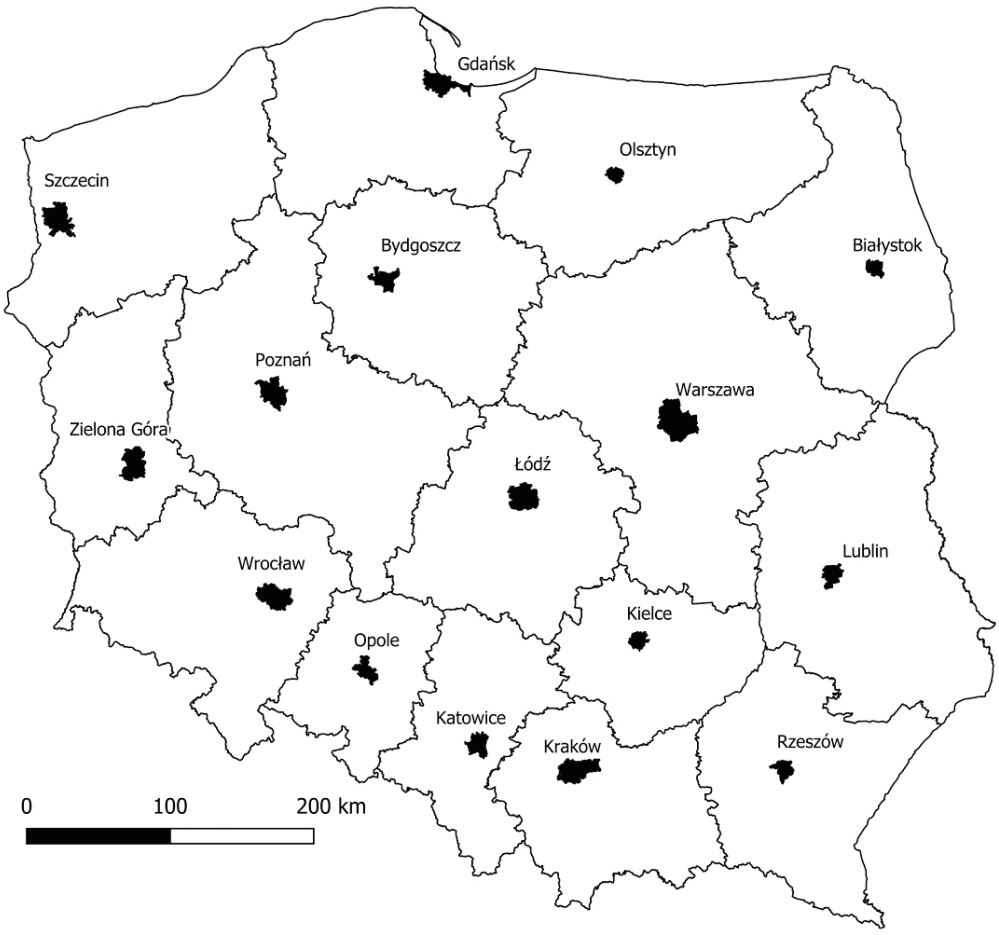

Fig. 2. Spatial scope of the research
Source: author's own work.

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

THEORETICAL BACKGROUND

The eco-city concept and its association with small-scale retention

The term "eco-city" dates back to 1975 and was formulated by R. Register based on a theory of urban ecology that aims to integrate natural and anthropogenic elements in the city (Register, 1987, 1994; Sneddon et al., 2006). The term "eco-city" denotes all the activities of city residents and authorities, in awareness of the growing climate-change-related threats, to shape the urban habitat in to minimally impact the natural environment (Mierzejewska, 2009; Norgaard, 1989). Thus, "eco-city" relates to the idea of activity that is economical, not only in strictly economic terms, but also – importantly – in ecological terms.

Due to the interdisciplinary nature of the eco-city concept, it has several interpretations, but all refer to the following tasks, whose implementation can create a city in line with the "eco" concept:
- changes in land-use priorities aimed at creating small, green, safe, compact, cities with mixed-use housing estates located near to transport nodes;
- changes in transport priorities to favour walking, cycling and public transport, which is associated with eliminating automobile traffic;
- renaturing and revitalising degraded urban environments (water fronts, wet areas and floodlands constituting elements of the city's retention system, etc.);
- construction of socially heterogeneous housing estates (differentiated by age, sex, race, religion, economic status, etc.);
- promoting social equality, especially in terms of, for example, disability;
- **supporting local agriculture, urban horticulture and activities to increase biologically active surface (green and blue infrastructure)**;
- promoting recycling, clean technologies and the protection of resources by reducing pollutant emissions and waste and by opposing excessive consumption of material goods,
- giving preference to ecologically safe economic activity;
- increasing the environmental awareness of inhabitants (Cugurullo, 2015; Mierzejewska, 2010; Roseland, 1997).

Malinga (2013) lists three basic aspects of the eco-city:
- an industrial circular economy based on ecological industry, agriculture and services;
- **building an urban structure that promotes the recycling of water, energy and solid waste**;
- ecological protection, which consists in having ecologically clean buildings that create high-quality urban habitats.

In the context of the subject matter of this article, the three eco-city principles above that are related to water (shown in bold) seem particularly important, i.e. renaturing and revitalisation of degraded urban environments (water fronts, wet areas and floodlands constituting elements of the city's water retention system, etc.); supporting local agriculture, urban horticulture and activities to increase biologically active surface (green and blue infrastructure); and building an urban structure that promotes the recycling of water, energy and solid waste. These specific eco-city tasks relate to the extremely important area of urban small-scale retention, which has a positive effect on the functioning of the entire urban ecosystem. In Poland, since at least the 1960s, the expression "small-scale retention" [Pol. *mała retencja*] has been in use. However, it is not known in other countries. Activities that fall under the banner "increasing natural retention" fall entirely within the definition of small-scale retention. Small-scale retention relates to small water bodies of up to 5 million cubic metres. Above this value, we refer to "large retention" (Wojnowska-Heciak & Janus, 2016).

According to Mioduszewski (2006), small-scale retention can perform many important functions in the city, the most important of which are:
1. improving water relations in urbanised areas, reducing the effects of potential excessive drainage, slowing the outflow of water to rivers;
2. improving water quality – water bodies covered with vegetation act as biofilters purifying water flowing supplied from urbanised areas;

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

3. protecting against erosion by the deposition of solid matter in water bodies (water flow is slowed, and thus has less erosive potential);
4. protecting against floods and droughts – the water bodies of the municipal small-scale retention system surface run-off, thereby flattening out the flood wave, while also supplying rivers during periods of low water;
5. feeding groundwaters – water infiltrating from the water body into the ground feeds aquifers, increasing groundwater resources;
6. meeting water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes;
7. improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area;
8. increasing biodiversity – aquatic vegetation creates habitats for many species of fish, birds and other wild animals and acts as a bank for the gene pool;
9. creating favourable conditions for recreation and tourism – water bodies can be used by fishing enthusiasts and as places for recreation and bathing.

It is therefore important to examine whether the functions of small-scale retention mentioned above are reflected in the provisions of strategic documents shaping cities, such as the SCaDSD.

How the eco-city concept relates to sustainable development and spatial planning?

Implementing sustainable development principles is now a major policy goal in many countries, mainly due to the progressive degradation and shrinking of environmental resources, including water resources in particular (Abrahem et al., 2022; Næss, 2001; Rutherford, 2019).

Mierzejewska (2006, 2010, 2015) distinguishes two groups of models and concepts of the development and shaping of cities in the literature that correspond to sustainable development principles. The first includes models and concepts related primarily to issues of a city's spatial form, namely: the eco-city (ecological city), the compact city, the green city, MILU (Multi-functional and Intensive Land Use), and new urbanism. The discussion here revolves essentially around the importance and methods of creating a compact spatial and functional urban structure that can be considered more sustainable and thus more "eco".

The second group consists of models and concepts that generally relate to issues of quality of life in the city, especially in the context of social justice and sustainable urban economy. Here, we find: the self-reliant city, the eco-innovation city, the community garden, (Kenworthy, 2006; Rutherford, 2019; Sharifi, 2016). The second group certainly includes the concept of the eco-city, which prioritises inhabitants' quality of life and is also related to the spatial form (first group).

It can therefore be concluded that the pursuit of sustainable development reached its culmination in the implementation of the eco-city concept. The concept of the eco-city is therefore very interdisciplinary and diverse due to its connections with various movements, paradigms and ideas that began to emerge in highly developed countries in the late 1960s (Roseland, 1997) (Fig. 3). Moreover, urban development in line with the "eco" concept is particularly popular in Asia (Tianjin, Binhai, Masdar). In Europe, the leaders in implementation are Sweden, Denmark and the United Kingdom (Lia et al., 2019; Song, 2011).

It can therefore be concluded that the overriding goal of the broader shaping of cities in accordance with the eco-city concept is to create a new type of economic, spatial and environmental order, as well as "urban–civic" communities that rise above social divisions and focus on real global threats related to, for example, ecological disasters.

Sustainable development is one of the main principles underlying the Polish spatial planning system (Rogatka et al., 2021, 2023). Sustainable development in spatial planning means designing a space to maintain a balance between all the elements of the environment in which man lives such that rational use of the natural potential can meet the needs of present and future generations (Niewiadomski,

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

Fig. 3. Selected links between the eco-city concept and ecological movements, paradigms and ideas
Source: Author's own work, based on Joss & Molella (2013), Roseland (1997).

2003; Petrişor & Petrişor, 2013). Understanding sustainable development in this way brings it closer to the concept of the eco-city.

It thus seems important to treat sustainable development and spatial planning as complementary processes. Implementing sustainable development in the spatial planning process ensures, among other things: care for the quality of the environment, proper management of resources (including water), rational land management and the undertaking of pro-ecological solutions in line with eco-city principles (in the technical and technological layer); and caring for the proper organisation of public areas, with an emphasis on achieving a high participation of biologically active areas (Kubiak-Wójcicka et al., 2017). Sustainable development emphasises the need to increase the outlays invested in improving environmental quality by: increasing the area of forests; improving water and air purity; increasing water retention in urbanised areas; and collecting, segregating and utilising solid waste. These issues are recorded in the SCaDSD, whose findings are key in planning the development of urban units (Bernat & Górny, 2023; Niewiadomski, 2003; Rogatka & Lewandowska, 2019).

"STUDIES OF THE CONDITIONS AND DIRECTIONS OF SPATIAL PLANNING": IN THE CONTEXT OF LEGAL ACTS AND DOCUMENTS RELATING TO SMALL-SCALE RETENTION IN POLAND

The state of water resources and retention in Poland has many determinants, the most important being physiographic conditions. Due to climate change and strong human impact, water deficits and related drought phenomena have increased in recent years. Poland is sometimes referred to as "the Egypt of Europe", as its average annual rainfall put the country on a par with the driest regions of Europe. Almost 20% of Poland has a yearly rainfall of less than 500 mm and average total precipitation of 600 mm, whereas average precipitation is 700 mm in Germany, 1110 mm in Austria, and 624 mm in Sweden (Wojnowska-Heciak & Janus, 2016). Moreover, over the last 30 years, Poland has experienced two catastrophic floods – in 1997 and 2010 (Kundzewicz & Szwed, 2008). Furthermore, urban floods resulting from heavy rainfall are increasing in frequency in cities (Januchta-Szostak, 2017; Kowalczyk, 2017; Pour et al., 2020). The experience gathered during these events confirmed that small-scale retention facilities can be used as weapons to fight disturbing environmental phenomena.

Legal regulations regarding small-scale retention in Poland are quite scattered and often general in nature. Significant changes were necessitated in the Polish legal system in this regard by the requirement to implement Directive 2000/60/EC of the European Parliament and of the Council of October 23, 2000 establishing a framework for Community action in the field of water policy (the Water Framework Directive) and then by Directive 2007/60/EC of 23 October 2007 on the assessment and management of flood risks (the Floods Directive). Pursuant to the Floods Directive, Poland was also obliged to develop: a preliminary flood risk assessment (PFRA), flood hazard maps and flood risk maps, and flood risk management plans (FRMP) in river basin areas (Bukowski, 2012; Mrozik & Przybyła, 2013).

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

The national-level legal act on small-scale retention is the Act of July 20, 2017. The Water Law (Journal of Laws of 2017, item 1566, as amended) along with executive acts. Apart from transposing the provisions of the WFD, the Act also contains provisions indirectly related to small-scale retention. It indicates, for example, that one objective of water resource management is to ensure adequate quantity and quality of water for the population, protection against floods and droughts, and the provision of water for agriculture (Rakoczy, 2018).

Another document on small-scale retention in Poland is the "Stop Drought programme" authored by the Polish Waters [Państwowe Gospodarstwo Wodne – Wody Polskie]. Its main task is to promote and implement activities related to increasing retention in the countryside, in cities, in forests, in fields and on wastelands.

As part of the project, co-financed by the Operational Programme Infrastructure and Environment 2014–2020 and entitled "Development of plans to counteract the effects of drought in river basin districts", a Drought-Effect Counteraction Plan (DECP) was drafted ["Plan przeciwdziałania skutkom suszy" – PPSS]. It is the first planning document of national importance to deal with the issue of minimising the impacts of drought. It is a planning document that takes a 50-year perspective to the countering of drought impacts. It was developed from the provisions of EU directives and guidelines (the Water Framework Directive) and the provisions of national law (Article 184 of the Water Law Act). The drought countering plan covers a six-year period (2021–27). As its name suggests, the DECP is designed to identify measures that will reduce the negative impacts of drought – be they societal, environmental or economic. The main objective of PPSS is specified by four specific goals:

– effective management of water resources to increase water resources;
– greater retention of waters;
– drought education and coordination of drought-related activities;
– the creation of mechanisms for implementing and financing measures to counteract drought effects.

It is also worth mentioning that there are small-scale retention support programmes in Poland that aim to increase retention, including in urbanised areas (see Table 1).

At the local level, the documents that relate to small-scale retention are Provincial Small-Scale Retention Programmes, municipal small-scale retention programmes and municipal climate-change-adaptation plans. It should be noted that plans and programmes supporting small-scale retention in Poland are often pre-requisites for the obtaining of EU funds. They also play an educational and informational role.

In this context, the SCaDSD, as a document required for each commune and relating absolutely to the entire area of the commune, can have an important organisational function. Because the SCaDSD is oriented to the future and locally focused, its provisions may constitute an important long-term directive for ongoing small-scale retention-related activities by local authorities.

The SCaDSD is one of the local-level tools of spatial policy (Brzezińska-Rawa, 2019; Drzazga, 2018; Nowak, 2017; Rząsa et al., 2021). The SCaDSD consists of two basic parts: part 1 is "Diagnosis of the current state and development conditions", which contains an analysis of the city's existing state of development and current social, economic, environmental and cultural situation; part 2 is "Directions and principles of development". The "Diagnosis of current state and development conditions" constitutes the basis for determining the possible directions of the city's development. The "Directions and Principles of Development" defines primarily the directions of changes in the commune's spatial structure and the future use of areas, along with basic indicators determining investment potential, including the principles of environmental protection.

Niewiadomski (2016) distinguishes three basic functions of the SCaDSD: determining the assumptions of a commune's spatial development policy (including local spatial development rules), coordinating the provisions of local plans and promoting the commune (Izdebski & Zachariasz 2013; Kukulska-Kozieł, 2023; Wierzbowski & Plucińska-Filipowicz, 2016). The role of the study thus amounts to creating

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

Table 1. Selected programmes to support small-scale retention in Poland

Programme name	Coordinating institution	Years of implementation	Programme objectives
The "My water" programme. Co-financing for home retention facility installations	National Fund for Environmental Protection [Pol. NFOŚ] and Provincial Funds for Environmental Protection	2020–24	Co-financing for the construction of domestic ponds and rainwater collectors. The National Fund will allocate PLN 100 million to Polish families for rainwater collectors. The programme covers up to 85% of costs, not exceeding PLN 5,000
Miasto z Klimatem [Town with an Atmosphere] – "green and blue infrastructure"	National Fund for Environmental Protection and Water Management, together with the Ministry of Climate	2019–21	Co-financing of projects to manage rainwater and shape urban greenery. Programme aimed at local government units
Modernisation of farms – irrigated farm area	Agency for Restructuring and Modernisation of Agriculture [ARiMR]	2014–20	A programme of subsidies for farm irrigation, intended for farmers. This enables farm owners to finance, *inter alia*, the construction of wells and water bodies and the purchase of: machinery and equipment for the abstraction, storage, treatment, recovery or distribution of water; irrigation facilities; and irrigation control systems. Financial aid per beneficiary and per farm is up to PLN 100,000
Channel retention – Programme for developing water resources in agricultural areas	Polish Waters [Państwowe Gospodarstwo Wodne – Wody Polskie] together with the Ministry of Infrastructure's Department of Maritime Economy and Inland Navigation	2020–22	The goal is to restore the dual functionality of drainage facilities to provide water retention on agricultural land during periods of drought

Source: author's own work based on https://www.wody.gov.pl/aktualnosci/1054-programy-wspomagajace-mala-retencje.

the commune's spatial policy, though it leaves the regulatory sphere to other tools (in particular, Local Spatial Development Plans).

The SCaDSD has particular potential to support the sustainable management of rainwater and green infrastructure in cities (Feltynowski, 2018; Januchta-Szostak, 2012). This is due to, *inter alia*, the SCaDSD's potential to: exclude from development any green areas of value to the retention and infiltration of rainwater; protect against development any aquatic ecosystems and their buffer zones; ensure spatial connectivity between green and blue infrastructure; designate land for development and/or define the rules for this development (e.g. determine the share of biologically active areas, limit the use of impermeable surfaces and, last but not least, determine the need for water retention) (Kowalewski & Nowak, 2018; Wagner et al., 2014).

RESULTS REGARDING SMALL-SCALE RETENTION IN "STUDIES OF THE CONDITIONS AND DIRECTIONS OF SPATIAL DEVELOPMENT"

Analysis of entries relating to small-scale retention in the SCaDSD and their relationship with the recency of the SCaDSD

When analysing provisions relating to small-scale retention in the SCaDSDs of the selected cities, it should be noted that the number of instances of cognates of the word *retencja* in the discussed strategic documents ranges from 2 (Rzeszów) to 90 (Olsztyn). Thus, there are clearly very large disproportions in this respect. Furthermore, all 16

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

SCaDSD documents contain mentions of retention both in the section "Diagnosis of the state and conditions of development" and "Directions and principles of development". The cities can be divided into three groups by the prominence of the issue of retention in the planning documents. The first group comprises cities for which retention was a minor problem and the term was rarely mentioned. This group consists of: Rzeszów, Szczecin, Zielona Góra, Kielce and Opole. The second group includes cities where the need to increase retention is perceived, but there are no clear actions in this direction (Katowice, Warsaw, Lublin, Poznań, Kraków, Bydgoszcz, Łódź, Wrocław and Gdańsk). The last group refers quite frequently to retention and to measures taken and planned to increase small-scale retention in their cities (Białystok and Olsztyn) (see Table 2).

The SCaDSD for the city of Olsztyn, which contained the most forms of cognates of "retention" (*retencja*, *retencyjność*, *retencyjny*, and their various grammatical forms), was adopted in 2010, and the four SCaDSDs that next-most fully addressed small-scale retention were adopted in 2019 and 2018 (Białystok in 2019 – 63 mentions; Gdańsk 2018 – 43 mentions; Wrocław in 2018 – 41 mentions; and Łódź in 2018 – 40 mentions). The research did not show a relationship between number of references to retention and date of SCaDSD adoption or updating.

Table 2. Dates of adoption (updating) of SCaDSD, and number of instance of retention words (*retencja*, *retencyjność*, *retencyjny*) contained therein

No.	City	Year adopted	Year updated	Number of cognates of "retention"
1.	Szczecin	2008	2012	6
2.	Gdańsk	2018	2019	43
3.	Olsztyn	2010	2013	90
4.	Białystok	2019	–	63
5.	Zielona Góra	2008	2015	8
6.	Poznań	2014	2020	23
7.	Bydgoszcz	2005	2009	37
8.	Łódź	2018	2019	40
9.	Warsaw	2006	2018	20
10.	Lublin	2019	–	21
11.	Wrocław	2018	–	41
12.	Opole	2018	–	9
13.	Katowice	2012	–	16
14.	Kraków	2003	2014	25
15.	Kielce	2000	2014	8
16.	Rzeszów	2018	–	2

Source: Author's own work based on SCaDSD documents.

Analysis of the presence of the small-scale retention function in SCaDSDs

Small-scale retention: analysis by function

Analysis by the method of determining the retention function according to Mioduszewski (MWFR) (Mioduszewski, 2006) distinguished three groups of functions fulfilled by small-scale retention and included in the SCaDSD. The following three groups of functions were distinguished, and they differ in their substance and in the frequencies with which they occur in the 16 examined cities.

Group 1 was of small-scale retention functions that appear with high frequency in the SCaDSDs of the analysed cities. It includes functions that:
- protect against floods and droughts – the water bodies constituting the municipal small-scale retention system store surface run-off, thus attenuating flood waves; the water bodies also supply rivers in low-water periods (this function occurs in 14 of the 16 SCaDSDs);
- improve water conditions in urbanised areas – reduce the effects of potential excessive drainage; slow the outflow of water to rivers: (this function occurs in 12 of the 16 SCaDSDs);
- improve water quality – water bodies covered with vegetation act as biofilters purifying water supplied from urbanised areas: (this function occurs in 10 of the 16 SCaDSDs).

Group 2 was of small-scale retention functions that appear with moderate frequency in the SCaDSDs of the analysed cities. It includes functions that:
- increase biological diversity – aquatic vegetation creates habitats suitable for many species of fish, birds and other wild animals: (this function occurs in 9 of the 16 SCaDSDs);

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

– increase groundwater resources – water infiltrating from water bodies into the ground supplies aquifers, increasing groundwater resources: (this function occurs in 7 of the 16 SCaDSDs);
– create favourable conditions for recreation and tourism – the water bodies can be used by fishing enthusiasts and as places for recreation and bathing: (this function occurs in 7 of the 16 SCaDSDs).

Group 3 was of small-scale retention functions that appear with low frequency in the SCaDSDs of the analysed cities. It includes functions that:
– meet water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes: (this function occurs in 6 of the 16 SCaDSDs);
– improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area: (this function occurs in 6 of the 16 SCaDSDs);
– protecting against erosion by the deposition of solid matter in water bodies – water flow is slowed, and thus has less erosive potential: (this function occurs in 2 of the 16 SCaDSDs).

Looking at the small-scale retention functions in each of the three groups, they can be given names that reflect the type (character) of the functions. Group 1 of small-scale retention functions has a **protective and cleansing** character, consisting in eliminating the effects of excessive drainage, protecting against drought and floods, and improving water quality through mechanical and biological pre-treatment. Group 2 of small-scale retention-functions has a **storage and recreational** character, as it helps increase biodiversity, stores the gene pool and increases groundwater resources. This small-scale retention function also creates favourable conditions for recreation and relaxation. Group 3 of small-scale retention-functions is **economic and aesthetic** – small-scale retention water can be used in caring for green areas, while the hydrological elements and their aquatic plant habitats aesthetically improve the urban landscape (see Table 3).

Table 3. Small-scale retention functions according to Mioduszewski in the SCaDSDs of cities in Poland

No.	City	A.	B.	C.	D.	E.	F.	G.	H.	I.	Total
1.	Szczecin	1	0	0	1	1	0	0	1	0	4
2.	Gdańsk	1	1	0	1	0	0	1	0	1	5
3.	Olsztyn	0	0	0	1	0	1	0	0	0	2
4.	Białystok	0	1	0	1	1	0	0	1	1	5
5.	Zielona Góra	1	1	1	1	0	1	0	1	0	6
6.	Poznań	1	1	0	1	1	1	0	1	0	6
7.	Bydgoszcz	1	1	0	1	0	1	1	1		6
8.	Łódź	1	1	0	1	1	0	1	1	1	7
9.	Warsaw	1	0	0	0	1	0	0	0	0	2
10.	Lublin	1	1	0	1	0	1	1	1	1	7
11.	Wrocław	1	1	0	1	1	1	1	1	1	8
12.	Opole	1	0	0	1	0	0	0	0	0	2
13.	Katowice	0	0	0	1	0	0	0	0	0	1
14.	Kraków	0	1	1	1	1	0	0	0	0	4
15.	Kielce	1	1	0	1	0	0	1	1	1	6
16.	Rzeszów	1	0	0	0	0	0	0	0	1	2
Total	–	12	10	2	14	7	6	6	9	7	–

Explanations:
A. improve water conditions in urbanised areas – reduce the effects of potential excessive drainage; slow the outflow of water to rivers;
B. improving water quality – water bodies covered with vegetation act as biofilters purifying water flowing supplied from urbanised areas;
C. protecting against erosion by the deposition of solid matters in water bodies: (water flow is slowed, and thus has less erosive potential);
D. protecting against floods and droughts – the water bodies of the municipal small-scale retention system surface run-off, thereby flattening out the flood wave, while also supplying rivers periods of low water;
E. feeding groundwaters – water infiltrating from the water body into the ground feeds aquifers, increasing groundwater resources;
F. meeting water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes;
G. improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area;
H. increasing biodiversity – the aquatic vegetation creates habitats for many species of fish, birds and other wild animals and acts as a bank for the gene pool;
I. creating favourable conditions for recreation and tourism – water bodies can be used by fishing enthusiasts and as places for recreation and bathing.

Source: Author's own work based on SCaDSD documents.

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

Small-scale retention: analysis by city

An analysis was also made of the extent to which the SCaDSD of each city refers the individual small-scale retention functions.

Group 1 consists of cities that contain **the greatest number** of the various small-scale retention functions in their SCaDSD. These studies included 6–8 functions out of a possible 9. They are: Wrocław – 8 functions, and Łódź and Lublin – 7 functions each. Poznań, Bydgoszcz, Zielona Góra and Kielce each have 6 small-scale retention functions in their SCaDSD;

Group 2 comprises cities whose number of various small-scale retention functions mentioned in their SCaDSD should be assessed as **moderate**. These studies include 5 functions (Gdańsk and Białystok) or 4 (Kraków and Szczecin) of a possible 9;

Group 3 consists of cities whose SCaDSDs include **the smallest number** of small-scale retention functions. Most of these cities' SCaDSDs refer to 2 small-scale retention functions (Olsztyn, Rzeszów, Warsaw, Opole), while Katowice's refers to only one (of a possible 9). This is the flood-and-drought-protection function, which is also the small-scale retention function that appears most frequently in the documents.

Interestingly, there is no direct link between frequency of references to retention and number of retention functions referred to in the SCaDSDs. For example, Olsztyn's SCaDSD contains the largest number of references to retention (90) but refers to only 2 functions, while those SCaDSDs that refer least frequently to retention (Zielona Góra – 8 mentions; Kielce – 8 mentions) are in the group of cities that refer to the most retention functions (6 functions).

On the basis of Table 4, we sought to identify factors that would explain the adopted solutions. The first factor to be considered was the city's precise location within Poland. Frequency and scope of references to various retention functions were not found to correlate with northern/southern or eastern/western location. The next factor to be considered was city location on a watercourse at risk of flooding. All the cities are situated on rivers. The three largest rivers in Poland (the Vistula, Odra and Warta) run through Szczecin, Gdańsk, Poznań, Bydgoszcz, Zielona Góra, Warsaw, Wrocław, Opole and Kraków. The remaining cities, i.e. Łódź, Białystok, Olsztyn, Lublin, Katowice, Kielce and Rzeszów, are situated on smaller rivers (some even on several) that in all cases except Katowice flow through the city centre. It is no surprise, therefore, that flood protection is the most frequently mentioned small-scale retention function in the SCaDSD. The greatest number of retention functions was referred to in Wrocław. This is due to the great flood that hit the city in 1997. The fewest small-scale retention functions were referred to in Katowice. It is worth noting, however, that the greatest number of mentions of retention is made in Olsztyn's SCaDSD, i.e. the capital of the Warmia-Masuria Voivodeship. Masuria and Warmia, i.e. the geographical region within which this voivodeship lies, is referred to as "the land of a thousand lakes", and, in this part of the country, water resource management is a key issue shaping local policy and spatial management.

Several SCaDSDs attend to retention functions other than those listed in Table 3. Of those unlisted functions, the most frequently mentioned small-scale retention function was to increase biologically active surface (Kraków, Katowice, Warsaw). Small-scale retention water bodies were mentioned as part of creating green belts (Białystok). Wrocław's study indicated the need to create small-scale retention features such as rain gardens or green walls. In turn, Opole's study indicated that small-scale retention performs an ecological and preventive function. The Łódź study argued that small-scale retention contributes to mitigating climate change.

In conclusion, the analysis of the frequency of references to the small-scale retention function in individual SCaDSDs identified no pattern or specific underlying causes explaining the adopted solutions. Probably the reason for this state of affairs is insufficient awareness of local authorities in some areas of the country as to the need for water retention. This is due to the historical conviction dating back to the communist era that a common good (in this case, water) is actually nobody's good, and that accordingly, you do not need to take care of it. Some

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

local authorities have not learned from the floods in other parts of the country. Moreover, they seem oblivious to the already obvious climate change. Furthermore, in Poland there is still a lingering desire for gigantomania, which results in gigantic projects (in terms of money, space and time) being undertaken, relegating the smaller ones to the background. The applicable legal regulations do not force local authorities to take due care of local legislation in the field of small-scale retention. This state of affairs must change quickly.

DISCUSSION

The works of the natural philosophers Thales of Miletus and Aristotle include many mentions of the role and importance of water (Clark, 1944; Cohen et al., 2016; Legutko, 2017; Lloyd et al., 2012; Overman, 1977). Regarding the importance of water, in Thales of Miletus, water appears as a source of life and growth (Reale, 1994, pp. 75–102; Santol et al., 2009). In this sense, water thereby constitutes the environment for all life, an environment without which it could not exist in so many forms (Reale, 1994, p. 172). With regard to the role of water, Thales of Miletus (O'Grady, 2002) and, even more clearly, Aristotle indicate the universal participation of water in preserving and maintaining all life (Kosso & Scott, 2009). Water thus has properties that ensure or condition the stability of the earth and the survival of life on earth.

Therefore, rational water management – which consists in part in planning and creating small-scale retention, which in turn begin in strategic documents and properly conducted urban and spatial policy – is extraordinarily important. This article draws many valuable conclusions on the issue.

Answering the first research question (Q1), it should be stated that all 16 analysed SCaDSD documents contain references to small-scale retention, both in the part concerning "Diagnosis of the state and conditions of development" and in the part called "Directions and principles of development". It is worth noting that the first part of the SCaDSD, which is an analysis of current conditions, requirements for flood protection should be included. Meanwhile, the second part of the SCaDSD, which defines directions of spatial development, need to define, among other things, flood hazard areas. Analysis of the small-scale retention provisions in SCaDSDs in cities nonetheless reveals very large disproportions in this respect. There is no direct relationship between the number of mentions of retention and the SCaDSD's date of adoption or updating. There is therefore no indication that the newer the SCaDSD, the more references to retention there will be: quite the contrary, in fact. This subject has been addressed in strategic documents such as SCaDSDs for many years. Furthermore, the frequency and scope of references to various retention functions were not found to correlate with the geographical location of the analysed cities. Another factor to be considered was whether a city was located on a watercourse at risk of flooding. The analysed cities are situated on rivers that in all cases except Katowice flow through the city centre. It is no surprise, therefore, that protection and cleansing constituted the most frequently mentioned group of small-scale retention functions in the SCaDSDs. It consists in protecting against drought and floods and in improving water quality through mechanical and biological pre-treatment. Another group of functions indicated in SCaDSDs – storage and recreation – helps increase biodiversity by acting as a store for the gene pool, thereby creating a habitat for plants and animals and increasing groundwater resources, i.e. a drinking water reservoir for use now and providing protection for future generations. This group of small-scale retention functions also creates favourable conditions for recreation and relaxation. The third and last group of small-scale retention functions is the economic and aesthetic – small-scale retention water can be used in caring for green areas, while the hydrological elements and their aquatic plant habitats aesthetically improve the urban landscape.

One interesting conclusion from the analyses is that several SCaDSDs attend to retention functions other than those mentioned above. The most commonly mentioned "other" small-scale retention function in SCaDSDs was, simply, increasing the biologi-

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

cally active surface (e.g. Kraków, Katowice, Warsaw). Small-scale retention water bodies were mentioned as elements shaping green belts (e.g. Białystok), which fits the current trend towards linear parks (Kimic, 2013). In the SCaDSD for Wrocław, the need to create small-scale retention features such as rain gardens and green walls was indicated. These are innovative activities that can be conducted almost anywhere in a city (Kimic & Ostrysz, 2021; Kuller et al., 2017). It should also be noted that the analysed documents raised the issue of climate-change mitigation through small-scale retention. It should be stated that SCaDSDs play an important role in creating and shaping a small-scale retention system, because they constitute an indicator of – or set of guidelines on the nature of – spatial location or function of small-scale retention in a city. The content of the SCaDSD depends on a city's spatial policy, and this should be oriented towards pro-environmental activities (Mersal, 2017).

Answering the second research question (Q2), it should be emphasised that the conclusions show that the treatment of small-scale retention in SCaDSDs varies in both quantitative and qualitative terms, and this may hinder the implementation of the eco-city concept with regard to small-scale retention. One important recommendation resulting from the research is that the polyfunctionality of small-scale retention should be taken into account in strategic documents, including those examined by the authors (SCaDSDs). A polyfunctional approach to retention is one in which all or most retention functions appear in a document, rather than multiple mentions of one or two isolated functions. Such an approach to retention in SCaDSDs will facilitate the holistic implementation of the eco-city concept in urban planning and management. The role of strategic documents is, after all, to engender a systemic approach that considers a balance of all groups of small-scale retention functions. The integrating role of these documents is important in preventing the issue from being addressed in such a fragmented manner as to be incoherent and ineffective.

The SCaDSD should differentiate urban areas in terms of environmental values and assign them appropriate prohibitions and guidelines regarding development and protection, as well as referring to social functions in a broader sense. This correlation between the actual state of the environment and the need to protect it on the one hand, and legal acts and social expectations on the other, is extremely important (Szulczewska, 2004). The SCaDSD should be the basis for ensuring that such a correlation is brought about. Meanwhile, the most appropriate variant of the SCaDSD should be constructed to constitute a response to key and current challenges (related to changing economic, social, environmental conditions, etc.) to create a sustainable urban habitat (Sneddon et al., 2006).

As indicated in the literature, European regional planning laws contain various options for tackling the water retention problem in local spatial planning tools. Municipalities are granted various degrees of self-determination. For example, in Upper Austria, a municipality must issue its own sewerage regulations and can thus define the conditions of the discharge. The Lower Austrian municipalities, on the other hand, can only set fees for the discharge of rainwater (Pokrývková et al., 2020). Nevertheless, this tool can also potentially be used for research in other countries. Of course, their conclusions may differ from those presented above.

The demand for water should be expected to increase, which is why the retention of water, and rainwater in particular, is so important. As far as Poland is concerned, a serious limitation in water retention may be imposed by the conflicting interests of landowners or other water users adjacent to the planned retention facility. For this reason, it is important to raise the profile of small-scale retention by including the issue as extensively as possible in strategic documents. Including retention in documents of various types means that, in the SCaDSD strategic document, the issue of retention may become less prominent, making it more difficult to implement small-scale retention postulates due to their dispersion.

In context of the above, the analyses contained in this manuscript add to the existing knowledge

✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

linking the issue of small-scale retention with planning strategic documents in the largest cities in Poland. This topic is addresses as part of the research on the environmental dimension of cities. The results obtained during the research procedure can be used for cross-country analysis in the context of both small--scale retention and planning issues. Moreover, the tool designed by the authors to assess small-scale retention in strategic documents can also be used for other document types that lend themselves to comparative research, and especially strategic documents. Such research may produce satisfactory results when the compared documents share the same content scope and spatial scope (country, region, city). This tool can also potentially be used for research in other countries.

CONCLUSIONS

Taking care of the hydrological resources of cities (and more broadly speaking of entire ecosystems) by planning and managing small-scale retention brings urban centres closer to qualifying as eco-cities. This concept is implemented in the SCaDSD through its provisions regarding small-scale retention. The role of small-scale retention in storage, cleansing and ultimately in protecting (e.g. against floods) is crucial. It is therefore encouraging that the most important strategic document in any commune (i.e. the SCaDSD, which plans and coordinates the spatial, economic and social development of a municipal unit) contains provisions supporting small-scale retention, although these differ in both qualitative and quantitative terms.

Currently, Poland is reforming the Spatial Planning and Development Act of 27 March 2003. According to the amendment to the above-mentioned act, the new planning document that will replace the SCaDSD ("master plan" post-reform) will be similar to the ones analysed in this article. Pursuant to Article 59 para. 1 of the amendment, studies of the conditions and directions of spatial development of communes will remain in force after the act enters into force, until the commune's general plan is adopted, but no longer than until the end of 2025. Moreover, the solutions in the amendment of 7 July 2023 provide that the master plan will be a legally binding local act, contrary to the current status of the SCaDSD. In addition, the practical applicability of the document will also increase, which will enable the implementation of eco-city assumptions, including those related to small-scale retention. In particular, it will be possible to designate areas of downtown development in the general plan, for which specific development rules may be formulated, concerning, for example, a minimal biologically active area.

Adopting a specific city development policy, then undertaking planning activities in line with that policy and executing plans such that their outcomes can be assessed may all lead to the sustainable development of urban centres. If we combine these activities with following eco-city guidelines, we can achieve the spatial and social city structure we seek – one adjusted to current needs, resistant to crises and having a high pro-environmental impact.

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✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

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✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

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✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

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✉krogatka@umk.pl, ✉rawa@law.umk.pl, ✉amal@umk.pl, ✉a_kustra@umk.pl, ✉lemahr@umk.pl

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LONG-TERM TRENDS IN INFANT MORTALITY RATES IN POST-SOCIALIST EU COUNTRIES

Julijan Sutlović[1]✉, Vera Graovac Matassi[2]✉

[1] ORCID: 0009-0005-7843-5383
[2] ORCID: 0000-0002-9020-3439
[1,2] University of Zadar
Franje Tuđmana 24i, 23000 Zadar, **Croatia**

ABSTRACT

Motives: Post-socialist European countries experienced significant political turmoil and economic and social changes in the late 1980s and the early 1990s due to regime change. These changes had a profound impact on their subsequent socioeconomic and demographic development. Since infant mortality rates (IMRs) are closely related to socio-economic changes, this study was undertaken to determine whether these changes affected IMRs in the transitional period.
Aim: The aim of this study was to investigate the changes in IMRs in eleven post-socialist European countries that are currently European Union (EU) members, and to compare IMRs in these countries with the remaining EU Member States. The changes in the slope of the IMR trend line were determined by a joinpoint regression analysis. The influence of gross domestic product (GDP) per capita based on purchasing power parity (PPP) on IMRs in all EU countries was also examined.
Results: It was found that the collapse of the socialist regime increased IMRs in post-socialist EU countries, and that contrary to other EU Member States, the changes in GDP per capita PPP continue to have a significant impact on IMRs in post-socialist EU countries.

Keywords: infant mortality rates, political regime changes, socioeconomic changes, post-socialist EU countries, joinpoint regression analysis, GDP per capita PPP

INTRODUCTION

European post-socialist countries experienced extensive political turmoil and economic and social changes in the late 1980s and the early 1990s due to regime change, which affected their socioeconomic and demographic development. Socialist regimes collapsed due to the events that began in the "revolutionary year" of 1989 and peaked in 1991 when the Union of the Soviet Socialist Republics was dissolved. After more than four decades, the boundary separating the Eastern Bloc and Western Europe ceased to exist. The economic, social and political differentiation of Europe began to decline (Sobotka, 2003). Post-socialist countries transitioned from authoritarianism and central planning to democracy and a market economy. The transition process has been largely completed in the more developed post--socialist countries, but some issues, including legal and regulatory reforms, have not yet been resolved (Havrylyshyn et al., 2016). Radical economic and social transformations gave strong momentum

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

to demographic changes in these countries (Sobotka, 2003). The profound demographic changes experienced by post-socialist European countries have been widely researched, including in studies investigating fertility and family formation (Berde & Drabancz, 2022; Billingsley & Duntava, 2017; Billingsley & Olah, 2022; Bleha & Ďurček, 2019; Brainerd, 2010; Frejka & Gietel-Basten, 2016; Graovac Matassi & Talan, 2021; Mynarska, 2010; Sobotka, 2003, 2011, 2017; Stropnik, 2007).

Numerous research studies have explored the main characteristics and trends in infant mortality rates (IMRs) in individual post-socialist European countries in the transition period. Gavurová et al. (2016) and Rosicova et al. (2011) discussed regional and ethnic differences in infant mortality in Slovakia, with particular emphasis on the Roma population. Analyses conducted in the Czech Republic in the transitional period focused mostly on differences in the risk factors for infant mortality and the key predictors of infant survival (Gerylovova & Holcik, 1997; Rychtaříková, 1999; Rychtaříková & Demko, 2001). Infant mortality trends and the key factors influencing infant mortality were also studied in other post-socialist countries, including Hungary (Nyári et al., 2015), Croatia (Graovac Matassi & Rogić, 2023; Rodin et al., 2010), Romania (Burlea, 2012), Bulgaria (Carlson & Tsvetarsky, 2000), and Poland (Genowska et al., 2015; Wróblewska, 2006).

In addition to infant mortality analyses performed at the country level, several studies compared IMRs among post-socialist states in Europe. Zaborskis et al. (1995) discussed infant and child mortality in Lithuania, Latvia and Estonia between 1988 and 1990, whereas Molikevych (2023) compared IMRs in Ukraine and Poland. Several authors discussed infant mortality trends in selected countries of Central and Eastern Europe, including differences in reporting infant deaths and the development of the health care system (Aleshina & Redmond, 2005; Nolte et al., 2004; Rychtaříková, 1995; Zatoński et al., 2006; Zylbersztejn et al., 2017). A review of the literature indicates that infant mortality in post-socialist European countries has attracted considerable interest in the scientific community, but the conducted studies differed widely in the main objectives and spatial coverage. However, infant mortality trends in post-socialist countries that are currently European Union (EU) Member States have never been investigated separately.

The IMR can be defined as "the number of deaths during the first year of life per 1,000 live births" (Weeks, 2005, p. 154). Similarly to under-five mortality, IMRs measure child survival, and they also reflect the social, economic and environmental conditions in which children (and others in society) live, including their health care (WHO, 2022). Infant mortality decreased significantly with an improvement in global health care, but less so in developing countries, especially in Sub-Saharan Africa, where the IMR is still high, mostly above 50 per 1,000. In 2020, Sierra Leone had the highest IMR in Africa at 80.1 per 1,000. In the EU, IMRs decreased in recent decades, but there are still some differences among the EU countries. Currently, the IMR is lowest in Estonia, Norway and Finland (below 2 per 1,000), and highest in Romania and Bulgaria, (above 5 per 1,000) (World Bank, 2022). Countries with a low IMR are generally characterized by high levels of education, high income (Weeks, 2005), and high values of the Human Development Index (HDI). The decrease in IMRs, in particular in the 20th century, has been well documented in the scientific literature. The main contributors to declining infant mortality include improved health and social conditions (antiseptic delivery, increased availability of pasteurized milk, availability of antibiotics, and advancements in perinatal medicine) (Drevenstedt et al., 2008; Riley, 2001). The decline in infant mortality is consistent with the postulates of the epidemiologic transition theory (McKeown, 2009; Olshansky & Ault, 1986).

Infant mortality is regarded as one of the main indicators of a country's health status (Wang, 2002; Wertheimer-Baletić, 1999). Higher income is closely correlated with better health care. Life expectancy and infant mortality statistics indicate that wealthier people are healthier people (Hague et al., 2008; O'Hare et al., 2013; Preston, 1975; Pritchett & Summers, 1993; Weeks, 2005). Ending all preventable deaths

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

under five years of age is also one of the outcome targets of Sustainable Development Goal 3. Income is important because the citizens of higher-income countries have better access to clean water, sanitation, and health care, and infants are provided with a nutritious and sanitary diet (diarrhea prevention) (Weeks, 2005). Income differentially impacts various causes of death, and diseases correlated with nutrition are more influenced by income levels. Economic development affects public health, education and nutrition, and it contributes to a decrease in mortality (Birchenall, 2007). Mortality and income are bound by a negative relationship, and high incomes are correlated with low mortality rates. The pooled estimate of the relationship between income and infant mortality before adjusting for covariates was determined at -0.95 (95% CI, -1.34 to -0.57) in developing countries, which implies that a 10% increase in the gross domestic product (GDP) per capita based on purchasing power parity (PPP) in a country with an IMR of 50 per 1,000 would decrease infant mortality by approximately 10%, thus reducing the IMR to 45 per 1,000 (O'Hare et al., 2013).

Considering the lack of research dealing with the IMR and the influence of GDP per capita PPP on the IMR of post-socialist countries, the present study was undertaken to examine this relationship in eleven post-socialist European countries that are currently EU Member States, both before and after the collapse of socialist systems (1980–2019). The results were compared with the EU-16 (EU 27 without the post-socialist countries) and EU-27 countries to determine differences and similarities in IMR trends between post-socialist countries and EU-16 and EU-27 countries. The main aim of this study was to examine changes in the slope of the IMR regression line in post-socialist EU countries by the joinpoint regression analysis. An attempt was made to answer two research questions. Did IMRs increase in post-socialist EU countries during the political and socioeconomic changes of the late 1980s and the early 1990s? Does the increase in GDP per capita based on PPP still drive a decrease in IMRs in post-socialist EU countries?

DATA AND METHODS

Infant mortality rates between 1980 and 2019 were analyzed in 11 post-socialist countries which are presently EU Member States as well as the EU-27 countries. Data for the analyzed period were obtained from the statistical office of the EU (Eurostat). According to the Eurostat methodology, infant mortality denotes the death of a live-born infant before the age of one year, and IMR is defined as the ratio of the number of deaths of children under one year of age in a given year to the number of live births in the same year, expressed per 1,000 live births (Eurostat, 2022). Data for GDP per capita PPP were obtained from the World Bank.

According to a number of authors, infant deaths were widely misreported in the former Soviet Union and in many of its successor states (see Aleshina & Redmond, 2005; Buckley, 1998; Velkoff & Miller, 1995; Yeganyan et al., 2001). The Soviet Union had a less rigorous definition of a live birth than the WHO (see Anderson & Silver, 1986). The most important difference was that a newborn had to breathe to be considered live-born (regardless of other evidence of life), and premature birth (under 28 weeks of gestation) and very low birth weight (under 1,000 grams) were considered as miscarriage if the infant survived for less than seven days.

There was also a suspicion that similar practices had been adopted in some countries of South-Eastern Europe, but there is no strong evidence that such practices were widespread (Carlson & Tsvetarsky, 2000; Rechel & McKee, 2003; Serbanescu et al., 2001). Given the fact that there is no univocal agreement on the extent to which infant deaths were underreported (most studies relied on surveys and estimates) in the former Soviet Union states and whether such practices were applied consistently in other post-socialist states, the present study relied on the official infant death statistics provided by Eurostat as the competent statistical institution. Attempts to recalculate the IMR for each country during the analyzed period extend beyond the scope of this paper.

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

The study area included the following countries: Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Infant mortality rates were available for each country and each year of the analyzed period (1980–2019). Data were combined for all studied countries, and average values were computed, including for the EU-27 countries, except the United Kingdom in 2019. Luxembourg was regarded as an outlier due to high GDP per capita PPP which exceeded the sum of the third quartile and 1.5*interquartile values in all analyzed years (Senthamarai Kannan et al., 2015). Therefore, Luxembourg was excluded from the analysis, and in this study, the term "EU-27" denotes EU-28 countries (including the UK) without Luxembourg.

Joinpoint regression software (version 4.9.1.0, National Cancer Institute, USA) was used to analyze changes in infant mortality trends. The software takes trend data and fits the simplest joinpoint model that the data allow. For each six added values, users can set an additional joinpoint to the maximum, and six joinpoints were used as the maximum in the study. The location and number of significant joinpoints were determined using a log-linear model. The Average Annual Percent Change (AAPC), the Average Percent Change (APC), and the corresponding 95% Confidence Intervals (CI) were computed. These parameters were used to describe the magnitude of change in each identified trend. In the applied model, time (years) was the independent variable, and the IMR was the dependent variable. Standard error was also calculated for each trend and taken into consideration in the analysis. Statistical significance was determined in the Monte Carlo Permutation test. The significance of AAPC was determined at $p < 0.05$. In the program, AAPC and APC values are marked when the result is significantly different from zero at the alpha level of 0.05. Inflection points were identified for each range of data where a significant change occurred in the slope of the linear trend (Kim et al., 2001). The joinpoint regression analysis is widely used in analyses of mortality trends (Chaurasia, 2020).

The second analysis was conducted to examine the correlation between the IMR and GDP per capita PPP between 1995 and 2019 because data on GDP per capita PPP were not available for the period before 1995. Pearson's correlation coefficient (PCC) was calculated for each year and for 5-year intervals. The correlation between GDP per capita PPP and the IMR was presented graphically. Coefficients of determination (R^2) were also calculated for 5-year intervals. The values on both axes of the scatter plot with a regression line are shown in logarithmic scales. The model for the EU-27 was significant only in the first three 5-year intervals; therefore, only these periods were considered in the analysis. The log values of infant mortality displayed a linear function when the log values of GPD per capita PPP were used; therefore, a log-log transformation was used in the regression analysis of real income and infant mortality to determine the influence of a 10% increase in GDP per capita PPP on IMR (Benoit, 2011; Tacke & Waldmann, 2009). The natural logarithm (ln) was used for log transformation. A 10% increase in GDP per capita PPP increased IMR by eslope*ln(1.1) (Benoit, 2011). Although PCC and R2 were noticeably more significant after the log-log transformation, ln values are difficult to read, which is why the graphs are based on non-transformed values.

RESULTS AND DISCUSSION

Joinpoint regression analysis

The socialist regime collapsed between 1989 and 1991, and the analyzed countries experienced profound political and economic changes, including a transition from a centrally planned economy to a market economy (Lavigne, 1999). Socialist regimes had a clear impact on infant mortality. Infant mortality was much higher in authoritarian than democratic countries. Between 1950 and 1990, infant mortality remained high even in wealthy dictatorships (Besley & Kudamatsu, 2006; Navia & Zweifel, 2003; Przeworski et al., 2000). Infant mortality often increases in periods of economic downturn (economic

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

shocks) (Brainerd & Cutler, 2005; Cutler et al., 2002; Langer et al., 1991).

As expected, in the analyzed period (1980–2019), the average IMR in the EU-27 was highest in 1980 (15.7 per 1,000) and lowest in 2019 (3.4 per 1,000; same as in 2018). The average IMR in all post-socialist countries which are currently EU Member States was also highest in 1980 (19.9 per 1,000) and lowest in 2019 (3.7 per 1,000; same as in 2018). Even greater variations were noted when the post-socialist EU countries were excluded from the analysis. In the EU-16, the average IMR was highest in 1980 (12.8 per 1000) and lowest in 2019 (3.2 per 1000, it was already as low as 3.23 in 2014). The difference between the highest IMR values was significant: in 1980, the IMR in the EU-16 was 7.1 per 1000 lower than in 11 post-socialist EU countries.

In the group of the analyzed post-socialist EU countries, the IMR was highest in Romania in each year of the examined period (1980–2019), where it peaked in 1980 (29.3 per 1,000) and 1987 (28.9 per 1,000). In contrast, the lowest IMR was noted in Slovenia (in 27 out of 40 records). Slovenia's IMR was highest in 1980 (15.3 per 1,000) and lowest in 2012 and 2015 (1.6 per 1,000), and a similarly low IMR was noted only in Estonia in 2018 and 2019. In the first few years of the analyzed period, the lowest IMRs were noted in Slovenia, Lithuania, Latvia, and Czechia, and in successive years (1987–2002), the IMR was lowest in Slovenia. In the last years of the examined period, Slovenia, Estonia and Czechia took turns as countries with the lowest IMR. An overall decrease in IMRs was observed in all post-socialist EU countries in the past four decades (AAPC = -4.5; 95% CI, -4.8 to -4.1), and it proceeded more rapidly than in the EU-16 (AAPC = -3.5; 95% CI, -3.9 to -3.1) (Table 1).

Three joinpoints (1989, 1992 and 2006) can be clearly identified in the data calculated for the EU-27 countries (AAPC = -3.9; 95%CI -4.2 to -3.6) (Table 1). The slope of the trend line was steepest in the third interval (1992–2006; APC = -5.2; 95% CI, -7.0 to -5.3) and flattest in the second interval (1989–1992; APC = -1.5; 95% CI -4.6 to -1.8) (Fig. 1). The results for the second interval were not significantly different from zero at the alpha level of 0.05 due to the impact of changes in IMRs in post-socialist EU countries. A clear decrease in IMR values was noted in the entire EU-27, which could be attributed to social welfare policies and the development welfare state systems. Welfare systems and policies differ across the studied

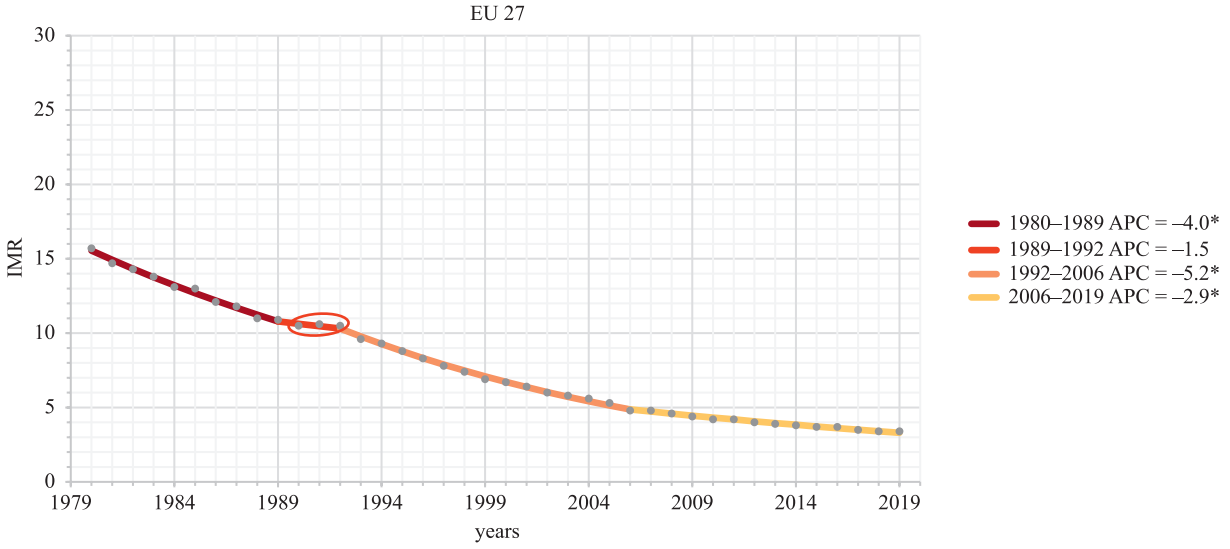

Fig. 1. Infant mortality rates in the EU-27, 1980–2019
* significantly different from zero at the alpha level of 0.05
Note: Red circle indicates changes (increase) in the IMR in the year during, or close to, the fall of the socialist regime.
Source: own elaboration based on Eurostat data (Eurostat, 2022).

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

countries, which could explain the higher IMR values in post-socialist EU countries during the studied period (Onambele et al., 2019).

Three joinpoints (1991, 1994 and 2006) were identified in the results for the EU-16 countries (Fig. 2). APC was determined at -4.2 (95%CI -4.5 to -4.0) in the first interval (1980–1991), -6.4 (95% CI -11.0 to -1.5) in the second interval (1991–1994), -4.4 (95% CI -5.5 to -5.2) in the third interval (1994–2006), and -1.3 (95%CI -1.8 to -0.7) in the fourth and last

Table 1. Joinpoint regression analysis of infant mortality rates in post-socialist EU countries, EU-16, and EU-27 countries in 1980–2019

Country/ Group od countries	Analyzed period				First interval				Second interval				Third interval			
	Years	AAPC	95% CI		Years	APC	95% CI		Years	APC	95% CI		Years	APC	95% CI	
EU 27	1980–2019	-3,9	-4,2	-3,6	1980–1989	-4,0	-4,2	-3,7	1989–1992	-1,5	-4,6	1,8	1992–2006	-5,2	-5,5	-5,0
EU 16	1980–2019	-3,5	-3,9	-3,1	1980–1991	-4,2	-4,5	-4,0	1991–1994	-6,4	-11,0	-1,5	1994–2006	-4,4	-4,9	-4,0
Post-socialist EU countries	1980–2019	-4,5	-4,8	-4,1	1980–1989	-3,7	-4,0	-3,4	1989–1992	1,2	-3,2	5,8	1992–2019	-5,3	-5,5	-5,2
Bulgaria	1980–2019	-3,2	-3,7	-2,8	1980–1986	-5,3	-7,0	-3,6	1986–1997	1,1	0,1	2,1	1997–2019	-4,8	-5,2	-4,3
Croatia	1980–2019	-4,4	-5,3	-3,6	1980–1986	-4,1	-5,5	-2,8	1986–1989	-9,2	-19,0	1,7	1989–2019	-4,0	-4,4	-3,7
Czech Republic	1980–2019	-4,6	-5,5	-3,6	1980–1989	-5,0	-5,4	-4,5	1989–1992	-2,0	-8,5	5,0	1992–2000	-10,2	-11,6	-8,8
Estonia	1980–2019	-5,6	-6,4	-4,8	1980–1994	-1,1	-2,0	-0,2	1994–2019	-8,1	-9,3	-6,9	–	–	–	–
Hungary	1980–2019	-4,9	-5,8	-3,9	1980–1982	-8,2	-12,4	-3,7	1982–1985	1,8	-3,4	7,3	1985–1988	-8,3	-13,4	-2,9
Latvia	1980–2019	-4,0	-4,9	-3,1	1980–1988	-4,0	-6,1	-1,8	1988–1994	7,9	3,2	12,8	1994–2019	-6,7	-7,3	-6,0
Lithuania	1980–2019	-4,0	-5,3	-2,7	1980–1989	-4,4	-5,6	-3,2	1989–1992	15,6	-0,9	34,7	1992–1997	-9,5	-13,5	-5,3
Poland	1980–2019	-5,0	-5,2	-4,7	1980–1992	-2,9	-3,1	-2,8	1992–2000	-9,6	-10,3	-8,8	2000–2019	-4,2	-4,6	-3,9
Romania	1980–2019	-4,3	-5,2	-3,3	1980–1984	-6,1	-9,0	-3,2	1984–1987	5,8	-5,0	17,7	1987–2002	-2,8	-3,4	-2,3
Slovakia	1980–2019	-3,5	-4,1	-3,0	1980–2008	-4,3	-4,6	-4,1	2008–2019	-1,4	-3,4	0,6	–	–	–	–
Slovenia	1980–2018	-5,3	-6,1	-4,5	1980–1984	-1,4	-4,6	2,0	1984–1996	-7,3	-8,4	-6,2	1996–2019	-4,9	-6,0	-3,8

Country/ Group od countries	Fourth interval				Fifth interval				Sixth interval			
	Years	APC	95% CI		Years	APC	95% CI		Years	APC	95% CI	
EU 27	2006–2019	-2,9	-3,4	-2,5	–	–	–	–	–	–	–	–
EU 16	2006–2019	-1,3	-1,8	-0,7	–	–	–	–	–	–	–	–
Post-socialist EU countries	–	–	–	–	–	–	–	–	–	–	–	–
Bulgaria	–	–	–	–	–	–	–	–	–	–	–	–
Croatia	–	–	–	–	–	–	–	–	–	–	–	–
Czech Republic	2000–2013	-4,0	-5,3	-2,7	2013–2019	1,5	-3,4	6,6	–	–	–	–
Estonia	–	–	–	–	–	–	–	–	–	–	–	–
Hungary	1988–1991	-1,0	-7,5	5,9	1991–1994	-9,1	-16	-2	1994–2019	-4,9	-5,2	-4,5
Latvia	–	–	–	–	–	–	–	–	–	–	–	–
Lithuania	1997–2019	-4,9	-5,7	-4,2	–	–	–	–	–	–	–	–
Poland	–	–	–	–	–	–	–	–	–	–	–	–
Romania	2002–2019	-6,7	-7,6	-5,8	–	–	–	–	–	–	–	–
Slovakia	–	–	–	–	–	–	–	–	–	–	–	–
Slovenia	–	–	–	–	–	–	–	–	–	–	–	–

Note: significantly different from zero at the alpha level of 0.05
Source: own elaboration based on Eurostat data (Eurostat, 2022).

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

interval. The IMR did not increase in the EU-16 in the studied period. The slope of the trend line was steepest in the second interval and flattest in the fourth interval.

Two joinpoints (1989 and 1992) were identified in the results for post-socialist EU countries (Fig. 3). APC was determined at -3.7 (95% CI, -4.0 to -3.4) in the first interval and at 1.2 (95% CI, -3.2 to 5.8) in the second interval, which points to an overall increase in IMRs in this group of countries. Despite the fact that these results did not differ significantly from zero at the alpha level of 0.05, IMRs in post-socialist

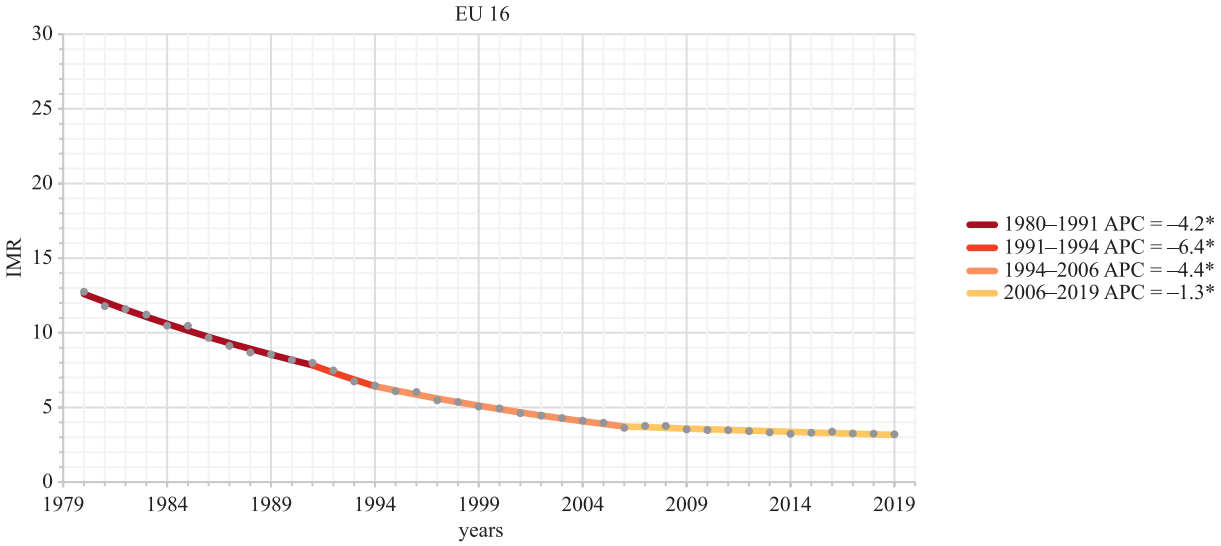

Fig. 2. Infant mortality rates in the EU-16, 1980–2019
* significantly different from zero at the alpha level of 0.05
Source: own elaboration based on Eurostat data (Eurostat, 2022).

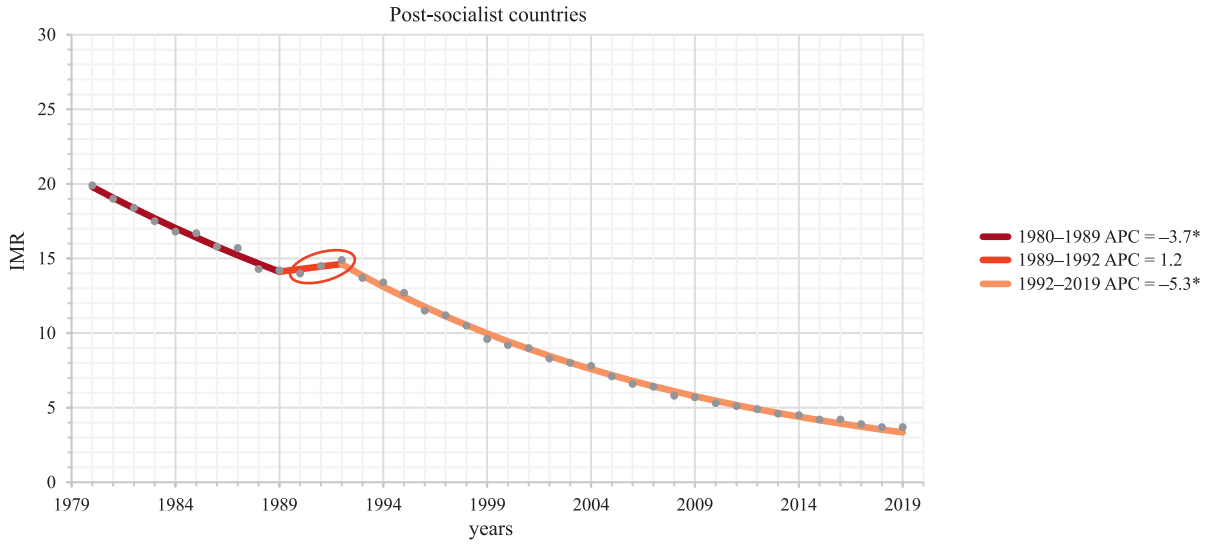

Fig. 3. Infant mortality rates in post-socialist EU countries, 1980–2019
* significantly different from zero at the alpha level of 0.05
Note: Red circle indicates changes (increase) in the IMR in the year during, or close to, the fall of the socialist regime.
Source: own elaboration based on Eurostat data (Eurostat, 2022).

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

EU countries changed in the examined period. The identified joinpoints occurred precisely at the time when the socialist regime collapsed. Most Eastern Bloc countries declared independence or experienced the fall of the socialist regime between 1989 and 1991. During that period, the IMR increased in all post-socialist EU countries (per 1,000). The IMR increased from 13.6 in 1988 to 16.9 in 1991 in Bulgaria, from 10.7 in 1990 to 11.6 in 1992 in Croatia, from 10.0 in 1989 to 10.8 in 1990 in Czechia, from 12.3 in 1990 to 15.7 in 1992 in Estonia, from 11.0 in 1988 to 17.6 in 1992 in Latvia (Latvia's IMR peaked in 1995 at 18.8 per 1,000), from 10.2 in 1990 to 16.3 in 1992 in Lithuania, from 14.8 in 1990 to 15.6 in 1991 in Hungary, from 19,3 in 1989 to 19.4 in 1990 in Poland, from 25.4 in 1988 to 26.9 in 1991 in Romania, from

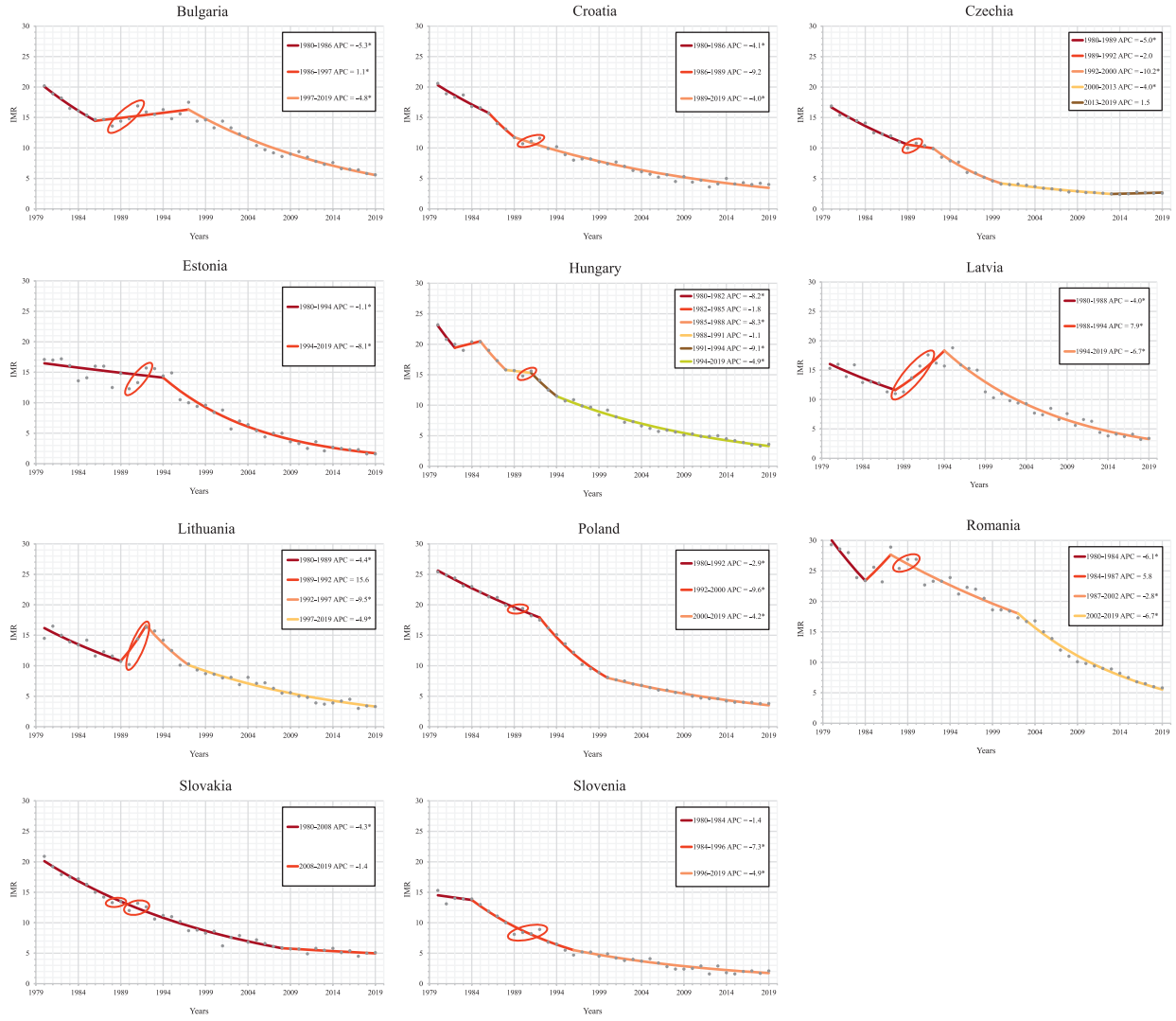

Fig. 4. Infant mortality rates in 11 post-socialist EU countries, 1980–2019
* significantly different from zero at the alpha level of 0.05
Note: Red circles indicate changes (increase) in the IMR in the years during or close to the collapse of the socialist regime.
Source: own elaboration based on Eurostat data (Eurostat, 2022).

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

13.3 in 1988 to 13.5 in 1989 in Slovakia, and from 8.1 in 1989 to 8.9 in 1992 in Slovenia.

On average, the IMR increased from 14.0 in 1990 to 14.9 in 1992 in post-socialist EU countries. The greatest increase in the IMR was reported in the Baltic countries. A considerable increase was also noted in Bulgaria and Romania. It took Bulgaria more than 10 years to bring its IMR to the previous level (13.6 per 1,000 in 1998; 13.3 per 1,000 in 2002), and Romania was faced with a similar challenge (23.4 per 1,000 in 1984, 21.2 per 1,000 in 1995). Latvia was one of the Baltic countries which experienced a similar problem (IMR of 11.0 per 1,000 in 1988, 10.3 per 1,000 in 2000) (Fig. 4). The observed increase in the IMR was clearly linked with the fall of the socialist regime. In the third and final interval (1992–2019), APC reached -5.3 (96% CI, -5.5 to -5.2), which indicates that the decrease in IMRs proceeded most rapidly in this period or that it accelerated after the collapse of the socialist regime. The rapid decrease in IMR values in this period could be attributed to economic development and social and political reforms that led to changes in public health policies (Onambele et al., 2019). According to Asandului et al. (2014) (as cited by Onambele et al., 2019), demographic and socioeconomic factors which are closely related to health factors could explain the decline in IMR values in Central and Eastern European countries.

In the joinpoint analysis, several results were not significantly different from zero at the alpha level of 0.05. In most cases, these values were noted during the fall of the socialist regime. For instance, in Czechia, APC reached -2.0, but 95% CI ranged from -8.5 to 5 (second interval, 1989–1992), whereas Lithuania was an extreme example, where APC reached 15.6 and 95% CI ranged from -0.9 to 34.7 (second interval, 1989–1992).

The increase in mortality (including infant mortality) could be related to the difficulties experienced by the analyzed countries in the period of socioeconomic and political transition (economic crisis, rising unemployment, lower living standards, decline in health care services) (Wertheimer-Baletić, 2000). Several research studies have shown that the collapse of socialist health care system, decrease in health care spending, and mass privatization programs could have significantly contributed to the post-socialist mortality crisis (Budhdeo et. al., 2015; Paniccià, 2000; Stuckler et al., 2009; Velkova et al., 1997). In the literature, Durkheim's concept of social disintegration is also regarded as an important social determinant of the post-socialist mortality crisis. Several cross-country studies revealed that different measures of social disintegration (including crime, divorce, or loss of control over one's life) are significantly and positively associated with mortality. Social disintegration has often been presented as a situation where people do not have the necessary resources to achieve desirable goals (Scheiring et al., 2019).

Political regimes have a pronounced impact on IMRs. Regardless of the estimation method or the applied model, infant mortality is much higher in authoritarian regimes than in democratic societies. Differences in infant mortality persist even when regimes are matched for exogenous conditions (Przeworski et al., 2000).

Correlation between IMR and GDP per capita PPP

The IMR is considered a robust indicator of the overall social welfare which reflects a country's socioeconomic status and quality of health care (Navia & Zweifel, 2003; Rosenberg, 2018). Income is an important factor that directly or indirectly affects health care. Income influences a country's living standards, including housing, sanitation, consumption, quality of life, and health, whereas infant mortality is an important indicator of a country's overall health status. The IMR is influenced by several factors, including sanitation, immunization, nutrition, genetic status, abortion rate, consumption of alcohol, drugs and tobacco, income, social disparities, access to health care, and war, which implies that all environmental and socioeconomic factors have a major impact on the IMR (Andrews et al., 2008; Corman & Grossman, 1985). An increase in GDP

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

per capita contributes to equal distribution of wealth. In developed countries, the health status of the adult population is positively correlated with economic prosperity (Kammerlander & Schulze, 2021). In high-income countries, the IMR is bound by a significant and negative relationship with real GDP per capita. The IMR of a country decreases as it becomes rich and powerful (Erdoğan et al., 2013). An increase in GDP is also correlated with lower IMR values (Ensor et al., 2010; Muldoon et al., 2011; Prisco et al., 2015; Tavares, 2017; Zakir & Wunnava, 1999).

Pearson's correlation coefficient is a measure of the linear correlation between two data sets. This parameter was calculated (after log-log transformation) for the EU-27 and 11 post-socialist EU countries for each year of the analyzed period (1995–2019). Between 1995 and 2009, PCC for the EU-27 was below or very close to -0.70 (Table 2), which points to a strong negative correlation between GDP per capita PPP and IMR. A strong correlation was observed in the first three 5-year intervals (1995–1999, 2000–2004, and 2005–2009) when PCC was below -0.70. An even stronger correlation was noted in post-socialist countries (-0.89 to -0.78) during the entire period of the analysis (Table 3). The values of PCC ranged from -0.87 to -0.82 in all five intervals, and such a strong correlation could be attributed to lower GDP per capita PPP and higher IMR in post-socialist EU countries. In these countries, the average GDP per capita PPP was still not high enough to prevent a decrease in the IMR. When a country reaches a high level of development, the increase in GDP per capita PPP has a negligent impact on infant mortality. Income and child mortality show a significant counter relationship, and consequently, infant mortality and GDP per capita PPP become detached (O'Hare et al., 2013; Preston, 1975; Schell et al., 2007).

The least-square regression line is the line that minimizes the sum of the squares of the vertical distance between the line and data points (Moore & Notz, 2021). Therefore, the average expected IMR for a given GDP per capita PPP can be calculated based on the IMR of the EU-27 countries (including post-socialist EU countries) for their GDP per capita PPP. If a country is above the regression line, the infant survival rate is below the average, and vice versa, if a country is below the regression line, the infant survival rate is above the average. Two

Table 2. Pearson's correlation coefficient for the EU-27, 1995–2019

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PCC	-0,85	-0,80	-0,80	-0,80	-0,80	-0,76	-0,72	-0,74	-0,74	-0,73	-0,72	-0,69	-0,75
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
PCC	-0,68	-0,72	-0,62	-0,63	-0,55	-0,47	-0,50	-0,41	-0,42	-0,31	-0,33	-0,33	
Interval	1995-1999		2000-2004		2005-2009		2010-2014		2015-2019				
PCC	-0,82		-0,74		-0,73		-0,57		-0,37				

Note: PCC>-0.7
Source: own elaboration based on Eurostat (2022) and World Bank (2022) data.

Table 3. Pearson's correlation coefficient for 11 post-socialist EU countries, 1995–2019

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PCC	-0,84	-0,78	-0,83	-0,84	-0,86	-0,83	-0,86	-0,85	-0,86	-0,86	-0,84	-0,85	-0,89
Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
PCC	-0,84	-0,85	-0,79	-0,88	-0,82	-0,78	-0,82	-0,79	-0,78	-0,85	-0,81	-0,79	
Interval	1995-1999		2000-2004		2005-2009		2010-2014		2015-2019				
PCC	-0,84		-0,86		-0,87		-0,84		-0,82				

Source: own elaboration based on Eurostat (2022) and World Bank (2022) data.

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

Fig. 5. Regression lines for IMR based on GDP per capita PPP in the EU-27 in 5-year intervals between 1995 and 2009 (red dots represent 11 post-socialist EU countries, and blue dots represent the remaining 16 EU countries)
Source: own elaboration based on Eurostat (2022) and World Bank (2022) data.

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Table 4. Influence of the increase in GDP per capita PPP on the IMR, 5-year intervals, 1995–2019 (in %)

	Increase in GDP PC PPP	1995–1999	2000–2004	2005–2009	2010–2014	2015–2019
EU 27	1	-0,79	-0,74	-0,86	-0,70	-0,45
	10	-7,24	-6,87	-7,91	-6,49	-4,19
EU 16	1	-0,79	-0,11	-0,35	-0,09	-0,08
	10	-7,29	-1,06	-3,27	-0,94	-0,78
Post-socialist EU countries	1	-1,19	-1,31	-1,69	-1,96	-1,95
	10	-10,80	-11,86	-15,08	-17,24	-17,17

Note: p>0.005
Source: own elaboration based on Eurostat (2022) and World Bank (2022) data.

separate analyses were conducted for the EU-27 and post-socialist EU countries.

The analysis of post-socialist EU countries revealed interesting results. As stated before, PCC exceeded -0.7 in 2010; therefore, regression was not analyzed in detail in the following years. In the first three intervals (1995–1999, 2000–2004 and 2005–2009), PCC was below -0.72, R^2 ranged from 0.68 to 0.53, and P values were below 0.005, which points to a strong correlation between these variables. In these intervals, Bulgaria, Romania, and Latvia were consistently above the regression line, and Slovakia joined this group of countries in the third interval (2005–2009). The remaining post-socialist EU countries were below the regression line in these intervals. Despite the fact that GDP per capita PPP was low in the countries above the line, their IMR should have been even lower.

All post-socialist EU countries are on the left side of the scatter plot with lower GDP per capita PPP values. Czechia and Slovenia are the only exceptions because their GDP per capita PPP was considerably higher and IMRs were lower and closer to the EU-27 average (Fig. 5). In the EU-27, PCC was higher than -0.7 in 2010 when the average GDP per capita PPP exceeded USD 30,000 and the average IMR decreased below 4.4 per 1,000.

The analysis revealed that a 10% increase in GDP per capita PPP induced a significantly greater decrease in the IMR in post-socialist EU countries than in the EU-16. In the first interval (1995–1999), a 10% increase in GDP per capita PPP decreased the IMR by 7.29% in the EU-16 and by 10.8% in post-socialist EU countries, and the corresponding decrease in the EU-27 was nearly identical to that noted in the EU-16. In the last interval (2015–2019), a 10% increase in GDP per capita PPP led to only a 0.78% decrease in the IMR in the EU-16, but the corresponding decrease in post-socialist EU countries reached 17.17% (Table 4).

CONCLUSIONS

The analysis revealed a significant decrease in IMRs in all studied countries. During the entire analyzed period (1980–2019), IMRs were higher in post-socialist EU countries than in the remaining EU Member States (EU-16), in particular at the beginning of the examined period, but these differences were less pronounced at the end of the analyzed period. Notable differences were also observed between post-socialist EU countries, where IMRs were highest in Romania and lowest in Slovenia. During the entire analyzed period, the AAPC was more pronounced in post-socialist EU countries (-4.5) than in the EU-16 (-3.5). Three joinpoints were identified for the EU-16 and the entire EU (EU-27), whereas two joinpoints were identified for post-socialist EU countries. In the EU-16, a decrease was observed in all analyzed intervals, whereas an increase was noted in post-socialist EU countries between 1989 and 1992 (APC = 1.2). Despite the fact that the result did not differ significantly from zero at the alpha level of 0.05, a certain change (increase) was noted in IMRs during the collapse of socialist systems, which answers our first research question.

✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

Numerous research studies have shown that the IMR is influenced by various socioeconomic factors and that an increase in income leads to a decrease in infant mortality; therefore, the correlation between the IMR and GDP per capita PPP was analyzed between 1995 and 2019 (because GDP per capita PPP was not available for previous years). The calculated values of PCC revealed a strong negative correlation between GDP per capita PPP and the IMR in the EU-27 in the first three 5-year intervals (1995–2009). A weaker correlation was observed in the following years because the IMR decreased considerably, whereas income continued to increase. In contrast, a strong negative correlation was noted in post-socialist EU countries in the entire period of the analysis (1995–2019), which indicates that the average GDP per capita PPP is still not high enough to prevent a decrease in IMRs. Czechia and Slovenia were the only exceptions because their GDP per capita PPP was considerably higher and IMRs were lower and closer to the EU-27 average. An additional analysis also revealed that a 10% increase in GDP per capita PPP induced a much greater decrease in IMRs in post-socialist EU countries than in the EU-16. Between 2015 and 2019, a 10% increase in GDP per capita PPP led to only a 0.78% decrease in the IMR in the EU-16, but the corresponding decrease in post-socialist EU countries reached 17.17%. These findings answer our second research question. The study revealed notable differences in IMRs and income between post-socialist EU countries and the EU-16, but the trends in selected post-socialist EU countries (notably Czechia and Slovenia) were far more similar to those observed in the EU-27 than in the remaining post-socialist EU countries, in particular in Romania and Bulgaria which still lag behind other EU Member States. The observed trends and differences could be further investigated using different indicators, in particular those related to health care.

The main limitation of this study is the quality of data for the former Soviet republics because some researchers have suggested that the official IMR data were underreported due to differences in methodology. The second limitation stems from the fact that GDP per capita PPP is an important, but not the only factor that influences IMRs. Regardless of these limitations, the study provides relevant conclusions on IMR trends in the analyzed countries.

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Note: The results of this study were presented in a poster during a scientific conference.

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✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

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✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

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✉jsutlovic21@unizd.hr, ✉vgraovac@unizd.hr

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Marianna Jacyna – Warsaw University of Technology, Warsaw, Poland
Agnieszka Jaszczak – University of Warmia and Mazury in Olsztyn, Poland
Viera Joklová – Slovak University of Technology in Bratislava, Slovakia
Jan Kazak – Wrocław University of Environmental and Life Sciences, Wrocław, Poland
Andrzej Klimczuk – SGH Warsaw School of Economics, Warsaw, Poland
Pavlo Kolodiy – Lviv National Agrarian University, Lviv, Ukraine
Piotr Kosiński – University of Warmia and Mazury in Olsztyn, Poland
Pyotr Kovalenko – National Academy of Agrarian Sciences of Ukraine, Kyiv, Ukraine
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