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AN ALGORITHM FOR THE IDENTIFICATION OF NUISANCE OBJECTS IN URBAN SPACE IN RELATION TO THE SOCIAL FUNCTION OF SUSTAINABLE DEVELOPMENT

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ABSTRACT: In this paper, the authors argue that it is necessary to identify and visualise nuisance objects in a given urban space and the level of a nuisance they create. To this end, the authors propose an algorithm, the results of which provide information on residents' preferences. The obtained results are recorded and visualised in Geographic Information System (GIS) software that enables their implementation into open-access map portals.
The added value of the research is broad public access to data, enabling decision-making models within the context of precision spatial planning to help find solutions for limiting the adverse effects of nuisance objects. Studies have shown that nuisance objects are present in urban spaces, and the weight of their impact on society is significant. The aim of the research and of the developed algorithm is to improve residents' quality of life in the context of sustainable urban development.

KEYWORDS: nuisance objects, urban space, sustainable urban development, friendly cities, society

Introduction

The city is made by people, and their quality of life is closely linked to local politics and governance (Haaland & van den Bosch, 2015). As underlined in international reports, a proper urban policy is a driver of the city's sustainable development (UN Habitat, 2015; WBGU, 2016; UN Habitat, 2016; SDGR, 2018).

Several dimensions have been identified in the concept of sustainable development: (i) social (Michelangeli & Türk, 2020), (ii) economic (Ma et al., 2020; Lei Wang et al., 2020), (iii) spatial (Cabernet, 2006; Gomez-Baggethun & Barton, 2013; Faehnle et al., 2015), (iv) environmental (Wolch et al., 2014; Jaganmohan et al., 2016) and (v) functional (Hamnett & Whitelegg, 2007).

Sustainable development of the city is synonymous with harmonious growth, which taps into the city's full potential through a proper spatial policy conducted by the city authorities with the use of planning instruments (Kudłacz & Mazur-Kurach, 2015). In its basic concept, urban policy should take into account the criteria of New Urbanism (NU), such as the availability of services that meet the daily needs of the residents. This concept defines the features of friendly cities, such as enabling an obstacle-free movement of the residents along pedestrian routes, particularly by walking (CNU, 2000; Talen, 2002; Talen, 2013). Organised green spaces should be adapted to the requirements of vehicle movement and to the functional structure of the area (Trudeau & Kaplan, 2016) and targeted to the needs of residents. The NU also takes an interest in architectural forms of buildings (Talen, 2010), including the design of spaces friendly to various social groups (Dawidowicz, 2020) and outdoor activity (Gehl, 1987). As Gehl argues (2016), urban space is visually attractive from the detail to the panorama so that it can engage diverse audiences and users. Therefore, an effective spatial planning policy should strive to improve the quality of life of residents by eliminating (Rześny-Cieplińska et al., 2021), transforming or changing nuisance objects in urban space (Cities of the future, 2011; Zhu & Gu, 2022).

Nuisance objects should be identified to enable the authorities to take actions to eliminate or compensate for their impact on urban space. In international literature, nuisance objects are often defined as (i) spaces with single devastated buildings or clusters of such buildings (Lorens, 2009; Stojakovic & Tepavcevic, 2009; Cienciała & Florek-Paszkowski, 2016), (ii) degraded areas (ICLEI, 2020, Zysk et al. 2020), (iii) slums (in relation to residential areas), (Weinstein, 2014; UN Habitat, 2016; SDGR, 2018), (iv) brownfields (in relation to previously developed non-residential areas). The City of Well-being concept (Barthon, 2017) promotes good urban planning, which

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allows the city's inhabitants to be active, eliminating noise, unpleasant smells, and adverse visual experiences.

The research topic can be considered relevant in the light of global social data, which indicates that the world's population is gradually increasing. In 1961, the population was 3,072 trillion, and in 2020 it was already 7,753 trillion (World Bank). The above statistical data are closely correlated with the increase in the number of people living in cities. In 1960, 33.62% of the population lived in cities, to reach 56.15% in 2020 (World Bank). This poses new challenges for the spatial policy of city authorities in most countries in the context of sustainable development, which aims to create a lasting improvement in the quality of life of present and future generations. Realising the full potential of urban space through spatial policy and design of friendly public space, along with improving the quality of life of residents and eliminating or reducing the impact of nuisance objects (which lower the quality of life), is crucial within the coming years to achieve properly managed urban areas.

The proposed universal algorithm for identifying nuisance objects in cities may prove to be a useful tool for the authorities. The versatility of the procedure consists in its flexible adaptation to the character of the city or a given city space, administrative division units, an open catalogue of types of nuisance objects encountered in the cities and active participation of the public in this procedure. The document defines nuisance objects as those whose impact directly or indirectly contributes to lowering the quality of life of inhabitants in space by affecting the human senses (sight, hearing, smell).

For this study, the following research thesis was formulated: in a given urban space, nuisance objects, as well as the level of nuisance they cause, should be identified and visualised by assigning ranks to individual objects along with determining a tolerable distance from them, in order to implement solutions for eliminating or limiting the negative effects they have on society.

The proposed algorithm for identifying nuisance objects enables to acquire of knowledge about the preferences of residents and on the things themselves. It can also be used in the development of an appropriate spatial planning policy by incorporating these objects and information in the city's development strategy, including its "strategic areas of intervention". "Strategic areas of intervention" are selected areas having social, spatial and economic potential, which have been identified by local government authorities as priorities in the context of sustainable development of the city.

The aim of the research and of the developed algorithm is to improve the quality of life of residents in the context of sustainable urban development.

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Literature review

The concept of sustainable development assumes a sustained improvement in the quality of life of the current and future generations (Dobrzańska et al., 2008) along with an improvement in the state of the environment (Skowroński, 2006). The overarching objective of sustainable development is, therefore, to ensure the quality of life of the society, which is linked to the positive aspects of economic growth, the possibility of living in a clean natural environment and a friendly social environment, while also allowing the future generations to meet their diverse needs. This idea has been recognised as a marker of the effectiveness of the implementation of sustainable development (Bernat, 2010; Valenzuela-Levi et al., 2022).

Given these considerations, it is necessary to determine the objects which may reduce the quality of life. The aim of any initiatives undertaken in this field should be to identify and assess the range of impact of nuisance objects in the urban tissue. No single definition of a nuisance object has been found from the review of EU legislation. Examples of EU legislation concerning the direct impact of objects on their surroundings understood as the natural and social environment include: Directive 2018/850 (the Landfill Directive); Directive 91/271/EEC (the Waste Water Treatment Directive); Directive 2010/75/EU (the Industrial Emissions Directive); Regulation (EU) 1315/2013 (the Trans-European Transport Network Regulation); Regulation (EU) 2017/1938 (the Regulation on measures to safeguard the security of gas supply); Commission Decision 2009/337/EC (the Decision on extractive industries). Also, in Polish legislation, certain provisions can be considered as indirectly referring to the examined concept.

According to the Civil Code Act (1964), a property can be considered a nuisance object if its use causes any kind of interference with neighbouring properties. Interference is all the landowner's actions, the effects of which are felt on the neighbouring land. Based on the type of impact on neighbouring properties, interference can be classified as follows: (i) indirect, (ii) direct, (iii) tangible and (iv) intangible. Indirect interference is unintentional actions of the property owner, in contrast to direct ones. Tangible interference is those actions the impact of which is physically felt (sound/smell/shadows/limitations in the sunshine duration, limitation of the angle of incidence of sunlight, etc.). In contrast, intangible interference affects mental health and sense of security or causes anxiety.

The degree of such impact is assessed based on the socio-economic purpose of the real property and the property potentially affected by interference and local relations.

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Types of nuisance objects and key nuisance objects, including objects that are a source of environmental impact in accordance with Polish legislation, are presented in Table 1.

Table 1. Nuisance objects and types of nuisance are based on the provisions of Polish law

(Act, 2001)	(Notice, 2019)	(Regulation, 2019)
Objects that are a potential source of nuisance: • sewage treatment plants, • municipal solid waste landfills, • composting plants, • transport routes, • airports, • power lines and substations, • gas transmission network facilities, • radiocommunication, radionavigation and radar systems.	Types of nuisance: • harmful radiation, • impact of electromagnetic fields, • noise and vibrations (vibrations), • air pollution, • soil and water contamination, • floods and flooding from intense rainfall, • landslides, • rock and snow avalanches, • damage caused by mining activities.	Objects that may have a significant impact on the environment include: • airports, • motorways and expressways, • sewage treatment systems, • overhead high-voltage power lines, • livestock farming, • facilities for the manufacture of substances by chemical processes, • agricultural processing plants and food production, • scrap yards, including the scrap reloading sites, • industrial wastewater treatment systems.

Source: author's work.

In addition, the review of international literature showed the following main examples of nuisance objects (Figure 1). The review also found that the studies on the above-mentioned objects had explored in particular: (i) their impact on lowering the value of fundamental properties located in its vicinity, (ii) their impact on the natural environment, (iii) their impact on the social environment and (iv) landscape valorisation.

Nuisance objects in relation to human senses

Landscape aesthetic value is a very important element of the perceived 'quality of life' and a key factor shaping many spiritual characteristics of a person (Wojciechowski, 1986). The neighbouring landscape may have both a positive and negative impact on one's feelings, from providing various types of benefits to creating a nuisance affecting the quality of one's life.

Every person experiences space directly through their senses (Paszkowski, 2011). An analysis of the impact of individual senses on spatial perception was proposed by Edward T. Hall (1978), who considered objects in space from the perspective of three basic human senses, namely hearing, smell and vision (Hall, 1978). Consequently, spatial perception and, therefore the quality of life is significantly impacted by sounds (Lewandowski & Szumacher, 2008) and odours (Bernat, 2010; Wojnarowska et al., 2021; Turek, 2021) and sights (Frydryczak, 2016), respectively. Furthermore, those feel-

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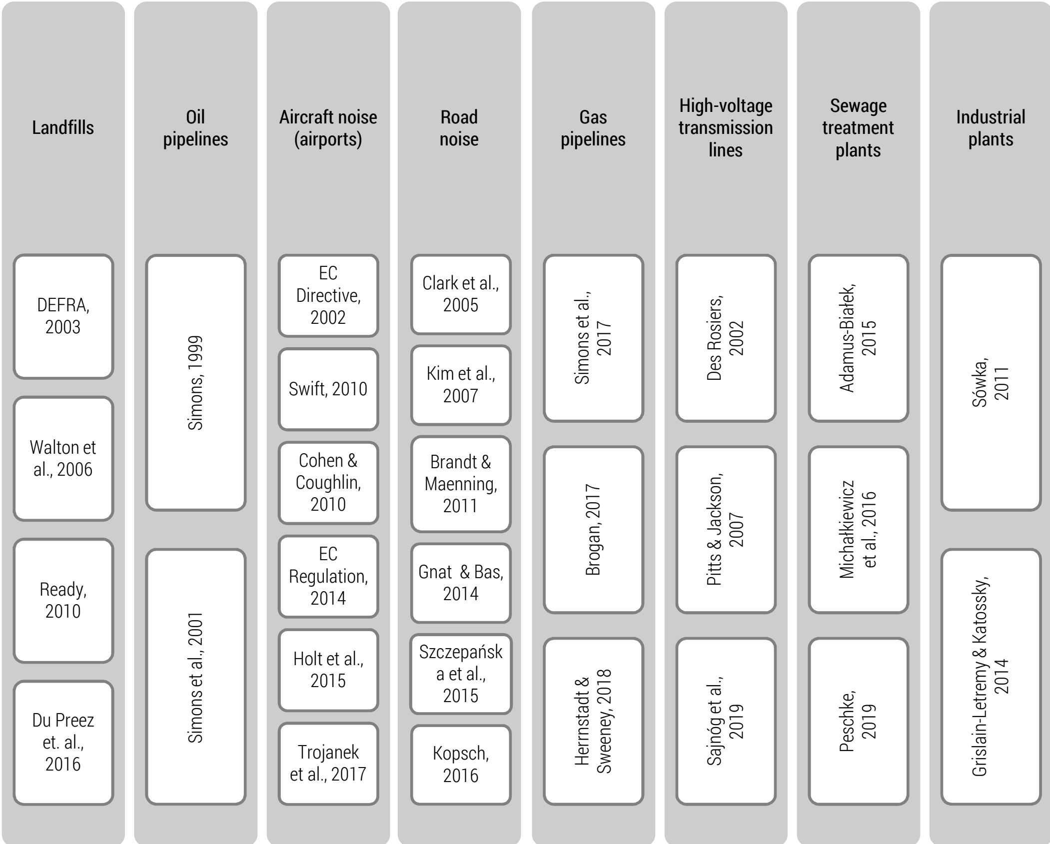

Figure 1. Identification of nuisance objects
Source: authors' work.

ings may occur jointly, and their impact depends on the individual feelings and needs (including social needs) of a person.

Noise is understood as any type of sound that may disturb concentration, work and verbal communication between people as well as cause anxiety, irritation and any type of disruption to a normal lifestyle. Furthermore, acoustic waves with a frequency outside the audible range of the human ear, namely infra- and ultrasounds, are also regarded as noise. Every type of noise has a devastating impact on human health (EEA Report, 2019). The negative impact of noise not only affects the hearing system but also the entire body through the central nervous system. Environmental noise may be divided into categories according to the source of noise and the level of noise harmfulness (Figure 2).

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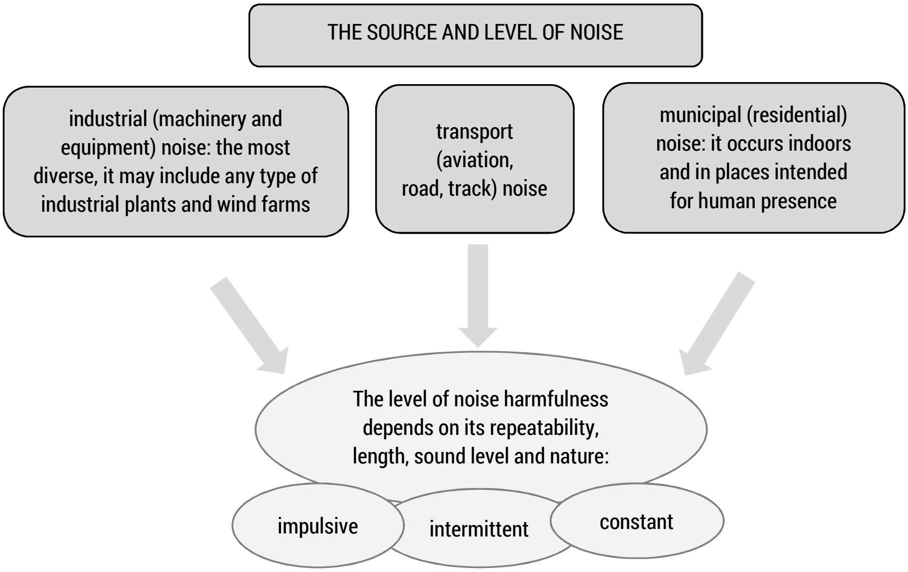

Figure 2. Identification of source and level of noise
Source: authors' work on (Lipowczan, 2018; Pałęga, 2018).

Odour nuisance causes a person to experience physical and mental discomfort. Prolonged exposure to offensive odours may trigger depression, respiratory problems, headaches, eye and throat irritation, and nausea. This type of nuisance is caused by the emission of offensive odour compounds generated by various business operations as well as the natural environment.

The types of emissions can be divided by their source: (i) point sources (stacks, exhaust vents), (ii) superficial sources (landfills), and (iii) linear sources (rivers, canals). Furthermore, such emissions may be organised or unorganised in nature. In addition, emissions may be felt seasonally or constantly.

The most noxious and most common sources of odour emissions in cities include (i) the food industry, (ii) the chemical industry, (iii) waste management, (iv) sewage treatment plants, and (v) the refinery industry (fuel distribution). Nuisance generated by this type of facility consists of many variables. Based on studies carried out for landfill sites, one may distinguish (i) odours, (ii) airborne microorganisms, and (iii) pests as well as (iv) visual nuisance (Grądalski & BojanowiczBablok, 2014; Michałkiewicz et al., 2016).

The aesthetic sense of local residents, passers-by and third parties may be offended by unpleasant sights, including that of (i) a landfill site; (ii) combined heat and power stations; (iii) automobile repair shops, and (iv) scrap yards (Domański, 2000).

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Visual nuisance is any objects that visually reduce the sense of space, limit access to light or are simply visually intrusive (Longo & Campbell, 2017). An important aspect is the impact of certain nuisance objects on the mental health of the persons affected. Examples include sites or facilities that appear to be in poor condition or to cause a safety hazard (Jarczewski & Kuryło, 2009). Unauthorised or unreasonable development that leads to the creation of high-density built-up areas and reduction of urban green spaces to a minimum can also be considered a source of visual nuisance (Kabisch et al., 2015). This type of nuisance is mostly experienced individually, and tolerance of sights varies from person to person (Bieda, 2019).

Based on a detailed literature and legislation review for the purpose of this paper, nuisance objects were defined as objects that cause a state of mental and physical discomfort experienced by a person as a result of the impact of olfactory, visual and sound stimuli, repeated over time, contributing to a lower quality of life.

Research methods

The complexity of the problems addressed by this study required a comprehensive approach. Therefore, a combination of research methods and techniques was used. The historical-interpretative method was applied, among other methods, to and nuisance objects with their classification into types, senses they affect and the limitations they create.

Building on the existing knowledge, an algorithm for identifying nuisance objects was developed, in which spatial data sources were used, as well as cartographic documentation from public and commercial registers and public map portals. In particular, the analyses were based on the cadastral data, the base map, the topographic objects database, the orthophotomap, and the local spatial development plans. All possible data sources were therefore used that enabled creating a preliminary inventory of nuisance objects and their location. In addition, specialist studies dedicated to specific nuisance objects present in the analysed research area were used, as well as statistical data characterising the social situation in the area. The preliminary findings were confronted with the situation on the ground using a qualitative research method, i.e. a field survey with nuisance objects inventory collection.

In the next step, as part of the developed algorithm, the diagnostic survey method was used, i.e. a survey addressed to the local community, in order to verify the pre-selected nuisance objects and/or indicate new ones, assigning ranks to each of them and the tolerable separation distance from them. In summary, several techniques were used in the paper, including documentary research, field surveys, data collection and the creation of databases.

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The stages of research analysis were presented in accordance with the scheme shown in Figure 3.

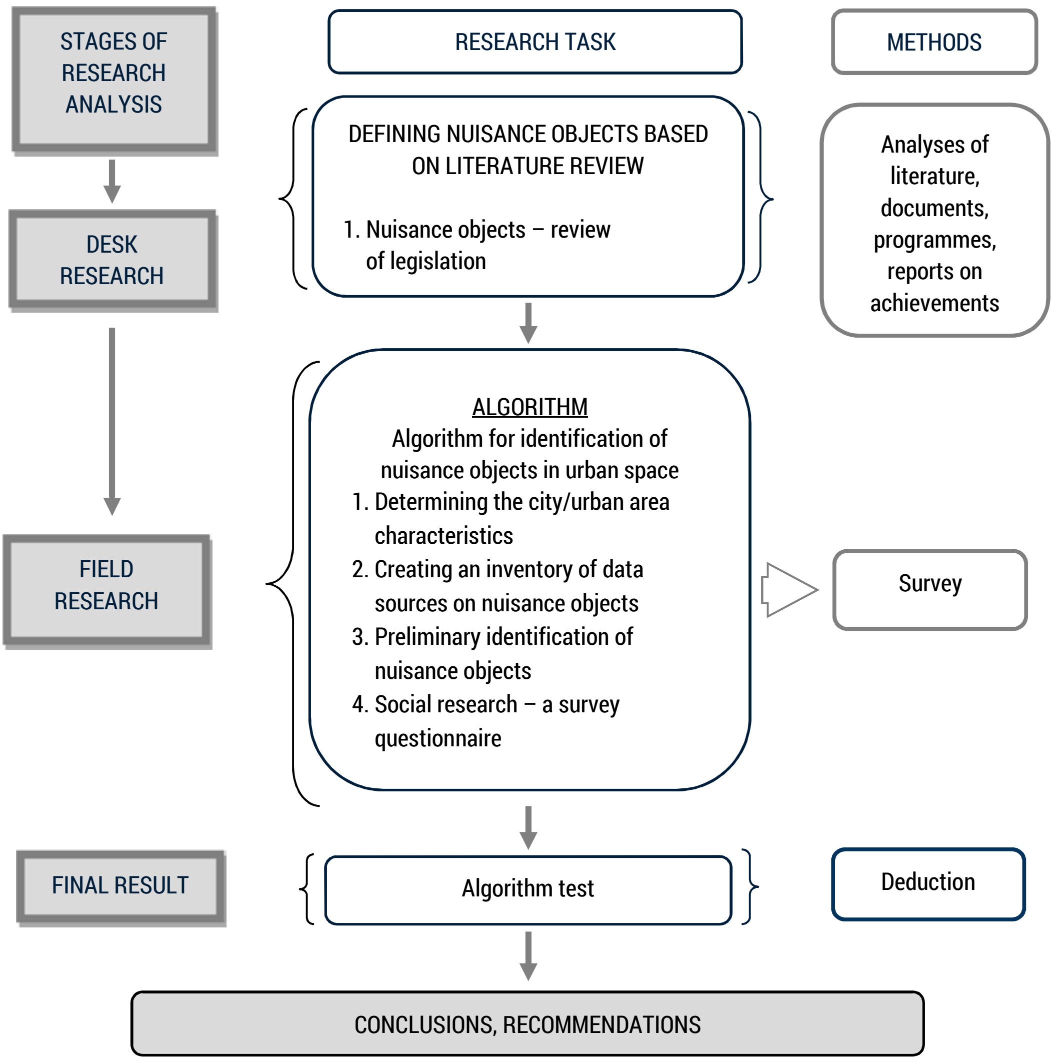

Figure 3. Stages of research

Source: authors' work.

The idea behind the procedure discussed here, the nuisance identification algorithm, is to adopt a transparent and objective approach to identifying objects in an urban area that contribute to lowering the quality of life of its residents. The algorithm comprises five stages:

1. Determining the city/urban area characteristics.
2. Creating an inventory of the sources of data on the research area and nuisance objects.
3. Preliminary identification of nuisance objects.
4. Social research – a survey questionnaire.
5. Making an inventory of nuisance objects in a geographic information system (GIS) software.

Re 1. The first stage of the study is to characterise a city across the following parameters: location, population, population density, and general characteristics (significant environmental, infrastructural, socio-economic and cultural determinants). The identification of the city's characteristics makes it possible to define the needs of its residents in the context of the quality of life and presents significant parameters for further diagnostic steps.

Re 2. An important stage in developing the algorithm is to identify the spatial data and sources of spatial information that come from public registers, as well as commercial or community mapping sites. This information should be expanded to include media reports as well as expert reports and analyses on specific nuisance objects located in the area analysed. A direct field survey with an on-the-ground inventory collection is also a key element at this stage of research (Figure 4).

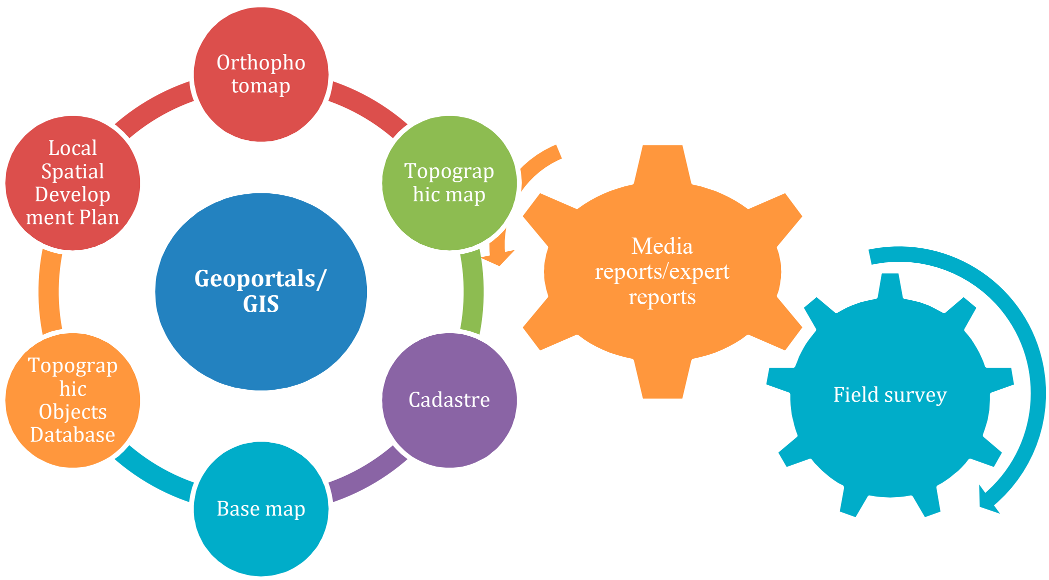

Figure 4. Sources of data on nuisance objects in a given urban area

Source: authors' work.

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Re 3. The preliminary identification of objects creating a nuisance in an urban area should be made in the process of pre-selection performed on the basis of three activities, namely (i) a review of legislation, literature, common knowledge and media reports on a given area; (ii) surveying geospatial data to identify potential nuisance objects, and (iii) a field survey (Figure 5).

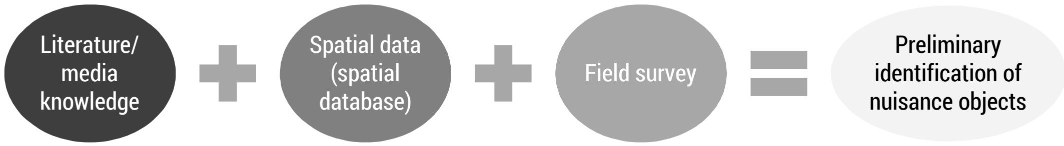

Figure 5. Preliminary identification of objects causing a nuisance

Source: authors' work.

Re 4. The developed preliminary inventory of nuisance objects should be subjected to verification by the public that should confirm, in particular, the presence of nuisances as well as their scale and range of impact.

Survey research enables active public participation and is an essential tool for measuring the residents' quality of life. The local community is a reliable source of information, as it can best indicate objects which create for them a sense of discomfort or danger.

The survey should be conducted using IT tools, automating the analytical process and accelerating data interpretation to facilitate research.

The survey questionnaire should be designed using both closed- and open-ended questions. Single-choice questions should be used to profile the respondent and obtain unequivocal answers that express a judgment about the objects under study. Open-ended questions enable respondents to make a personal comment, which is important, especially in order to identify any objects that were not taken into account at the preliminary identification stage.

The survey questionnaire should consist of two parts (Appendix 1). The first part should be composed of questions to profile the respondents. The second part should contain a list of nuisance objects in a given urban area (based on the preliminary inventory of nuisance objects) to confirm that they constitute a nuisance, with impact ranks and ranges to assign to them.

The list of objects proposed in the survey questionnaire should be verified by grading, according to a rule where the higher the score, the higher the nuisance rank. It is recommended that a grading scale from 0 to 6 be adopted, where '0' means that the presence of the object is of no significance and '6' means that the significance is the greatest. Studies on the number of value influencing factors conducted by G. A. Miller from Harvard University showed

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that a potential buyer is unable to make a decision based on more than seven value influencing factors (Polny & Wójciak, 2015). Correspondingly, a 7-point grading scale was adopted to rate the level of nuisance caused by the objects.

At the subsequent stage, the final values of nuisance ranks for individual objects should be calculated to determine the phenomenon's intensity and visualise it in GIS software. It seems advisable to use the arithmetic mean and weighted median of all sample observations. The authors recommend that the final analyses be based on the median as the value most resistant to deviations, where every specific comment is assigned a weight.

The respondents should indicate the distance to nuisance objects that they are willing to accept, depending on the senses which those objects affect. They should assess the distance with regard to visual, noise and odour nuisance objects.

The authors suggest that the best assessment reference in this regard should be the distance from the place of residence, proposing the following criteria: (i) the distance is of no significance (the object is not a nuisance); (ii) over 100 metres; (iii) over 200 metres; (iv) over 500 metres, and (v) over 1 kilometre. These assumptions (with a distance of over 1 km set as the upper limit) seem reasonable for at least two reasons. First, reports on the safe distance of odour nuisance from buildings usually divide the volume of odour emissions into small, i.e. up to 50 m; medium, 50÷1,000 m, and large above 1,000 m (Report, 2020). Second, research into the urban fabric, including the accessibility of a variety of objects in an urban area, indicates a 10-minute walk as the optimal time for covering a distance of 1 km for an average person (functionality within a 10-minute walk) (CNU, 2000; Talen, 2002; Talen, 2013).

Re 5. Recording the acquired data and their visual presentation is the last stage in identifying nuisance objects. Phenomena and processes that occur in a given area can be analysed using standard statistical analysis software such as Microsoft Excel or Statistica. For spatial analysis and results visualisation, software that employs a geographic information system, i.e. ArcGIS and QGIS, is recommended. It is essential that the results obtained can be implemented into an open-access map portal that contains all spatial data services available as part of the nationwide spatial data infrastructure. The environment must be, therefore, common so that any party interested can use it and build new decision-making models based on those results. An example of a national open-access map portal in Poland is the Open Spatial Data Geoportal (https://polska.e-mapa.net).

The primary reason for proposing an algorithm for the identification of nuisance objects is the lack of universal approaches to the identification of such objects in the city, as revealed from the analysis of legal acts, acts of local law and urban development strategies. The developed algorithm organises

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the subsequent stages of the process in order to identify objects causing a nuisance and determine their nuisance levels based on the ranks assigned by local residents, as well as the tolerable distance from such objects. As shown from the literature review, the proposed solution has not been discussed in any international and domestic scientific publications or strategic documents so far, indicating the novel character of the proposed research topic.

Study area

The subject of research is one of the provincial capitals in Poland. Poland is located in Central Europe. Numerous raids, wars and partitions shaped the history of this country. Traces of history are still visible in architecture and land use across Poland, conveying information on trends, fashions and legal regulations that were in effect in a given period.

Until 1989, Poland was a communist country with a centrally planned economy. Remnants of those planning measures can be seen in the spatial development of Polish cities and the parts of their built-up areas. After the fall of communism, spatial planning concepts and residents' expectations have changed. This is why good practices developed in Poland since that time can serve as an example of what practices are possible in other Central and Eastern European countries and beyond.

Under the current administrative division, Poland is divided into 16 provinces (*województwa*), each of which is further divided into districts (*powiaty*), which in turn are divided into municipalities (*gminy*). The capital of the Warmińsko-Mazurskie Province, which is examined here, is Olsztyn. The city served as a subject of a case study based on which the algorithm proposed was tested.

Olsztyn is the capital of Warmia and Mazury, a region referred to as the 'Green Lungs of Poland'. The city is located near 15 lakes, which makes it unique in the whole country. Olsztyn is the northernmost urban area in Poland, situated near the border with Kaliningrad Oblast, Lithuania and Belarus. Through the ages, the city has been witness to important political, cultural and scientific events. For many centuries, it was under the rule of Prussia and was only incorporated into Poland after the Second World War.

History lives in the city's architecture and space and has also left its mark on the local community, which has its distinct culture, religion and ethnic identity. Research into this community may produce interesting results furthering the goal set in this paper. The current demographics of Olsztyn compared to nationwide data is illustrated in Table 2.

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Table 2. Demographics of Poland, Olsztyn

Description	Poland	Olsztyn
Population	38,265,013	171,249
Area	312,679 km²	88.3 km²
Population density	123 people/km²	1,951.3 people/km²
Population by sex:		
– women	51.6%	53.5%
– men	48.4%	46.5%
Population:		
– working age	59.5%	58.4%
– pre-working age	18.2%	17.6%
– post-working age	22.3%	24.0%

Source: (PL, 2021).

Olsztyn is divided into 23 neighbourhoods (Figure 6). The neighbourhoods differ in terms of the prevalent type of development, architecture and population structure.

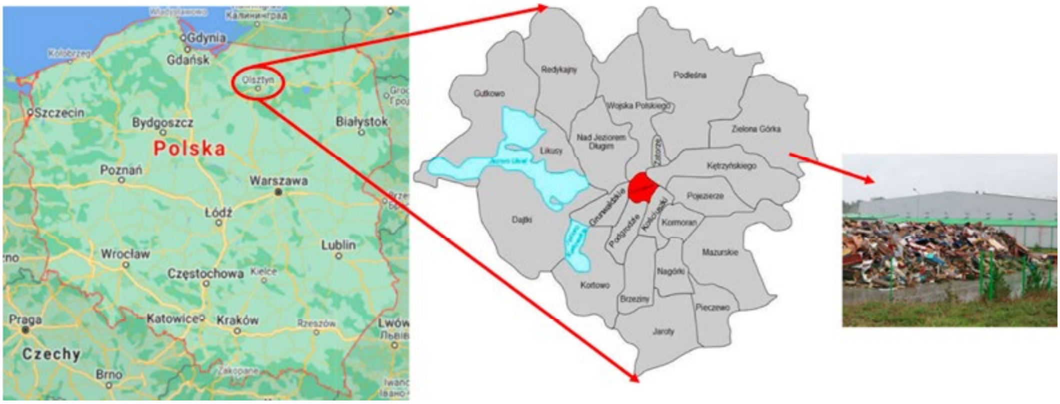

Figure 6. Olsztyn neighbourhoods map

Source: authors' work based on: Google Maps, gazetaolsztynska.pl.

Spatial data and sources of spatial information used as part of the preliminary identification of nuisance objects in the research area analysed:

- Geoportal (https://geoportal.gov.pl), including:
- Cadastre,
- Local spatial development plans,
- Topographic Objects Database
- Base map,
- Topographic map,
- Orthophotomap;

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- Media reports (articles, publications);
- Field survey.

Based on a review of international and national literature on nuisances, media reports and a field survey conducted by the authors, as well as geospatial information systems, preliminary identification revealed the following 12 types of nuisances in Olsztyn:

- automobile repair shops,
- construction plants,
- the sewage treatment plant,
- the cemetery,
- linear utility infrastructure (e.g. oil pipeline, heat pipe),
- power transmission poles,
- high-voltage overhead lines,
- the airport,
- industrial brownfields,
- disused railway lines and stations,
- railway areas,
- the landfill.

The nuisance objects identified were subjected to public verification using a survey questionnaire, where the respondents assigned nuisance ranks to the objects and assessed their range of impact. The questionnaire was designed and shared via Google Forms. The form was distributed via direct mail and open access through social media from July to August 2020. 148 filled-in questionnaires were received, and the answers were subjected to statistical analysis. The sample size is in line with the standards accepted in international literature, e.g. reliable results on living spaces were obtained from a survey of 60 people (Percival, 2002). According to Krok (2015), the sample should be of sufficient size as to ensure the statistical significance of the results. Furthermore, sampling should match the unit under observation (Mayntz et al., 1985; Sawiński et al., 2000).

Results

The majority of respondents were women, making up 61% of total answers. The research sample was dominated by young people aged 21–30, accounting for 64%, and 31–40, accounting for 19% of all answers. 75% of the respondents were people with higher education. No people with an education below the secondary level were recorded. The respondents were also asked about their marital status. The answers indicate that 67% of the respondents were single, i.e. never married, and 29% living with a partner. Accounting for 56% of the research sample, most respondents lived in a housing unit of a multifamily building, while 30% of respondents occupied a detached family house. Other options were selected by individual respondents.

Identification of nuisance objects

Among the objects included in the survey, two were considered to cause the greatest nuisance, i.e. the landfill and the sewage treatment plant, which were assigned the highest nuisance rank, i.e. 6 on the 0-6 scale by over 50% of respondents. It should be noted that the above objects create a visual nuisance while also being a source of unpleasant smell and noise. Other objects considered to cause significant annoyances were the airport (median 5) and the railway, and the industrial/post-industrial areas (median 4).

Table 3. Ranking of the nuisance level of objects

Nuisance objects	Rank of nuisance (Number of responses) 0	1	2	3	4	5	6	Average	Median
Car repair workshops	39	34	24	16	20	3	12	2.0	2
Construction plants	15	16	21	37	29	18	12	3.0	3
The sewage treatment plant	3	5	7	9	16	23	**85**	5.0	6
The cemetery	25	15	23	12	26	17	30	3.1	3
Linear utilities infrastructure (e.g. oil pipeline, heat pipe)	12	22	29	22	26	19	18	3.0	3
Power transmission poles	17	20	28	22	28	11	22	2.9	3
High-voltage overhead lines	14	17	18	24	32	17	26	3.3	3
The airport	4	6	19	15	11	26	**67**	**4.5**	**5**
Industrial and post-industrial areas	4	14	14	29	27	33	27	**3.8**	**4**
Disused railway lines and stations	23	22	25	36	23	9	10	2.5	3
Railway areas	7	8	16	23	28	40	26	**3.9**	**4**
The landfill site	3	3	5	3	0	11	**123**	**5.5**	**6**

Source: authors' work.

A large group of objects were assigned a lower rank, including high-voltage lines, power transmission poles, construction plants, the municipal cemetery, linear utility infrastructure (e.g. oil pipeline, heat pipe), and the disused railway areas (median 3). Car repair workshops were rated as causing the

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least nuisance (median 2). It should be noted that none of the identified objects produced a median result of 0 (no significance) or 1 (low significance). A detailed summary of the results is provided in Table 3. As "other nuisance objects" (not listed in the survey), the respondents tended to select high-traffic roads. This response was given twelve times, achieving a nuisance rank at the median level 5. In addition, with the number of at least two votes cast, the following objects were listed as causing the greatest nuisance: homeless shelters and nightclubs (median 5.5), followed by crematoria and unmanaged vegetation (median 5). A detailed summary is presented in Figure 7.

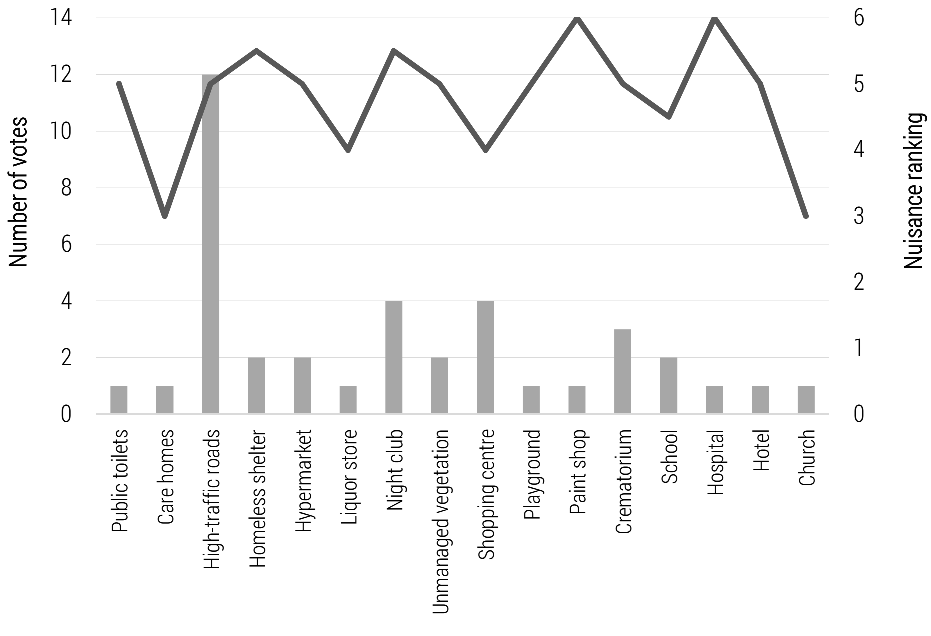

Figure 7. Nuisance objects are indicated by the respondents and their ranking
Source: authors' work.

Objects from Table 3 rated at the median level of 3 and more were included in the final list. Among the additional objects indicated by the respondents (Figure 7), heavy-traffic roads, the homeless shelter and nightclubs were included in the list. The other objects that received only a few votes and/or were assigned lower nuisance ranks were omitted. However, it should be emphasised that all objects indicated by the respondents should be a starting point for future surveys in order to verify the scale of their impact on a statistically significant research sample, all the while recognising the needs of the local community.

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Determining the tolerable distances between nuisance objects and one's home

Considering the senses that nuisance objects affected, it was assumed that the best measure of the significance of the nuisance impact would be the tolerable distance between a nuisance object and one's home. In order to simplify the survey form, however, any natural and anthropogenic forms of land development that might limit the impact of these nuisance objects were omitted from the study.

The vast majority of the survey population stated that the objects which were a source of unpleasant smell or noise emissions should be located at a distance of more than 1 km, with 81% of respondents and 61% of respondents (120 and 91 responses) respectively. When estimating the tolerable distance from visual nuisances, the opinions varied considerably but were quite evenly distributed. Eighty-six people (58% of respondents) stated that the impact range of these objects was 200 m (Figure 8).

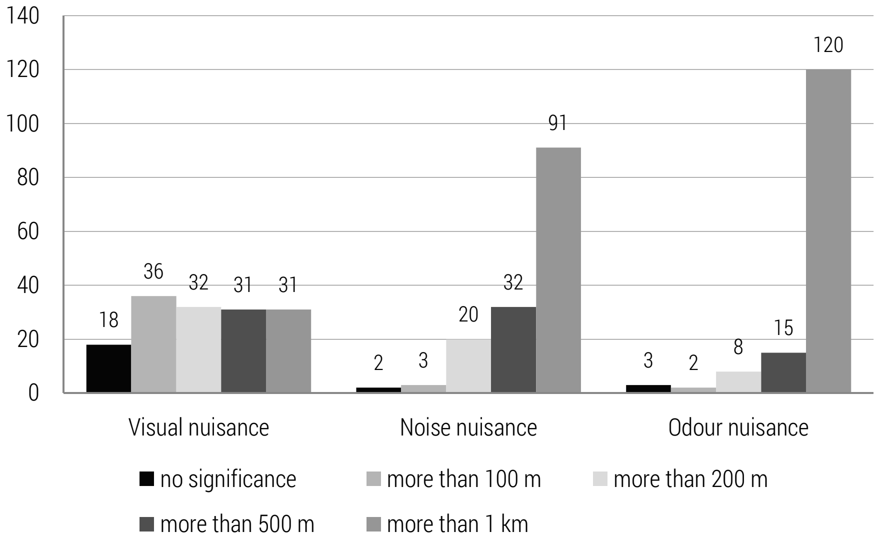
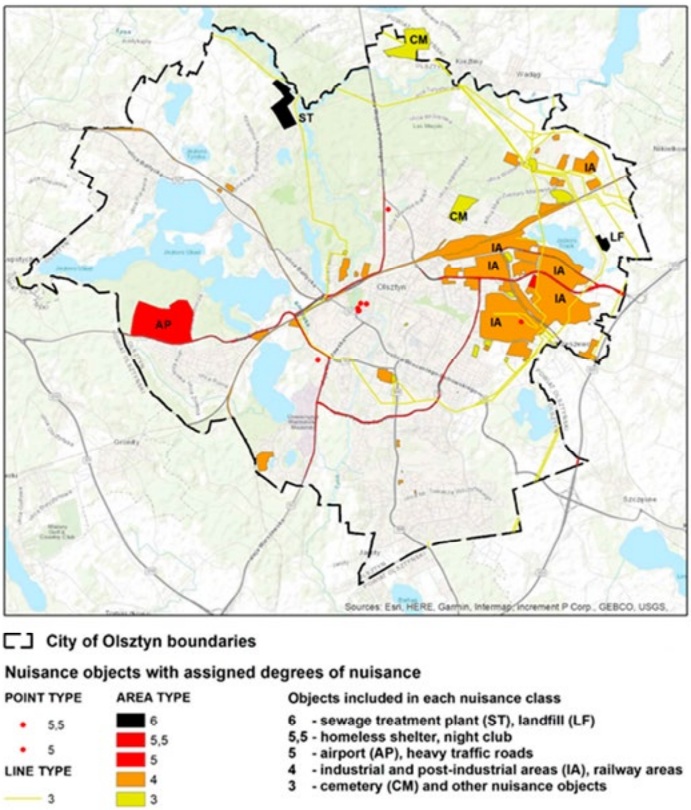


Figure 8. Tolerable distance between nuisance objects and one's home

Source: authors' work.

The identification of objects considered a nuisance, along with the range of their impact, was carried out in ArcGIS and QGIS software on a base open access topographic map of the research area (the city of Olsztyn). The data on the location and the size of the objects needed for the inventory collection were obtained from open sources. The data on the routes of utility infrastructure, including road and railway lines, were obtained from the topographic objects database and from the data provided by network operators. The data on cemeteries, industrial sites, nightclubs, sewage treatment plants, landfills, and power transmission poles were obtained from the Open Street Map database (https://openstreetmap.org) by making queries through the Overpass API (https://overpass-turbo.eu/). These data were subsequently verified and updated on the basis of the current orthophoto map of Poland displayed with the use of the "Raster Topographic Map of Poland" WMTS service (https://www.geoportal.gov.pl/). The data identifying the objects that could not be obtained with the use of the above-described services (i.e., the airport, construction plants and homeless shelters) were manually vectorised on the base topographic map. In addition, railway areas and industrial and post-industrial areas, due to their location and the equal nuisance rank assigned to them, were aggregated into larger units for clarity of the study.

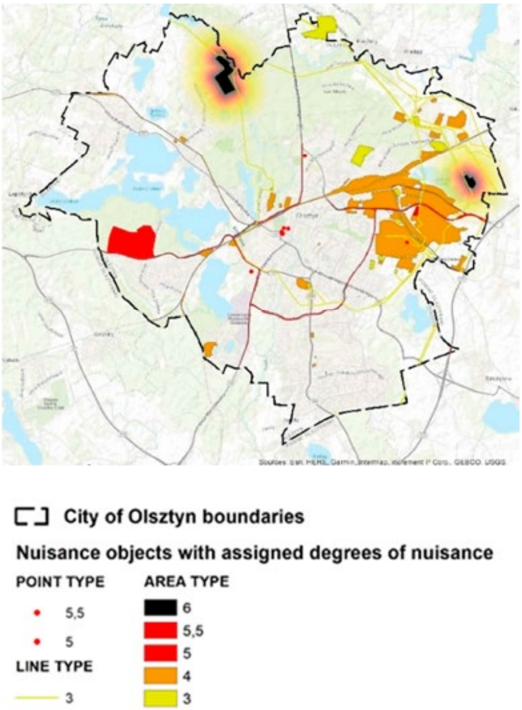
The resulting inventory of objects with nuisance levels indicated by the respondents is shown on Map 1.

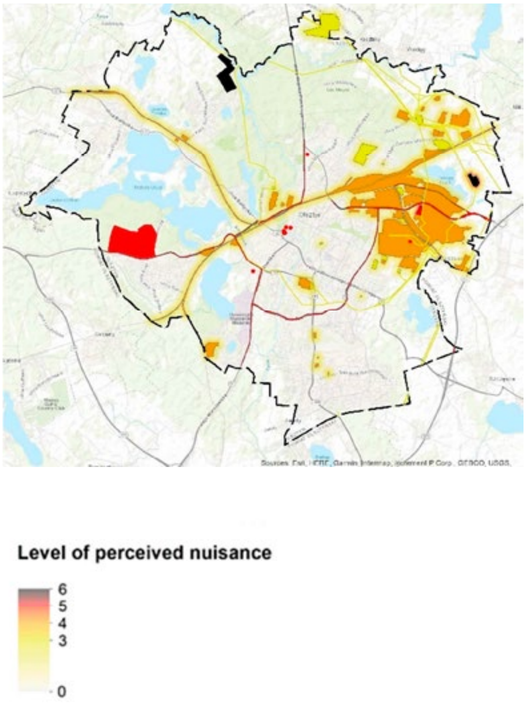


Map 1. Collecting an inventory of nuisance objects in the city of Olsztyn

Source: authors' work.

The objects were divided along with nuisance categories, i.e. into odour, visual, and noise nuisances, and visualised to show their impact range (Map 2, Map 3, Map 4, respectively). Due to the fact that the minimum tolerable distances from nuisance objects indicated by the respondents were simplified for clarity (they disregarded the natural and anthropogenic land development forms which may limit the actual nuisance impact), the range of the objects' impact was determined on the assumption that the level of nuisance decreases in a linear manner, i.e. it is the highest at the site where the object is located and decreases to the impact range boundary (where the impact value is the smallest and equal to no or 0 impact). In accordance with the responses of the respondents, the impact range boundary was set at 1 km for objects that are an odour and noise nuisance and 200 m for objects that are a visual nuisance (Figure 3). Finally, the nuisance degree and the range of impact of nuisance objects in the city of Olsztyn was presented on Map 5, which is the result of the logical sum of nuisances visualized on Maps 2÷4, with the same 0-6 nuisance scale adopted.





Map 2. Range of impact of odour nuisances

Source: authors' work.

Map 3. Range of impact of visual nuisances

Source: authors' work.

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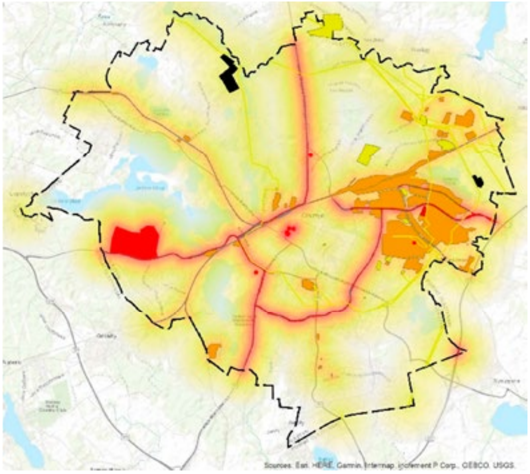

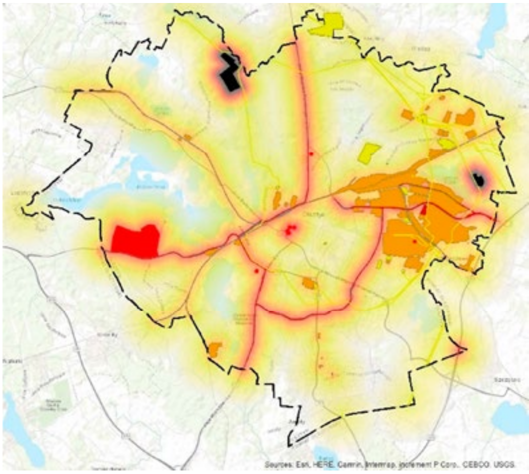

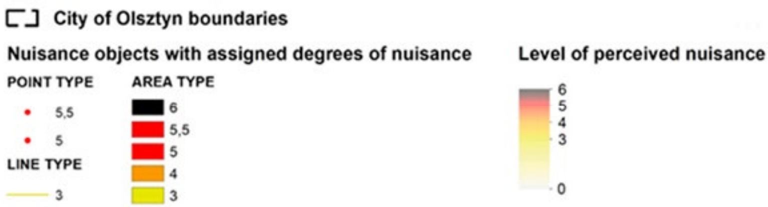

Map 4. Range of impact of noise nuisances

Source: authors' work.

Map 5. Cumulative map – the range of impact of nuisances

Source: authors' work.

Discussion

Testing the algorithm allowed us to identify nuisance objects and the surrounding areas in the city of Olsztyn. The public played the key role in the study. As rated by the public, the objects with the strongest negative impact (rank 6) are the sewage treatment plant, located in the northern part of the city, and the landfill, located in its eastern part. According to the respondents, both sites cause odour nuisance with the largest range of impact (according to the respondents, more than 1 km) and have a relatively large area.

Homeless shelters and night clubs have appeared to be only slightly less significant (rank 5.5). These small sites located mainly in the city centre were reported to be a cause of visual and noise nuisance, respectively.

The objects assigned the rank of 5 are the airport located in the western part of the city in the Dajtki residential area (the predominant function of the area is single-family housing development) and high-traffic roads. Both types of facilities are also a source of noise nuisance.

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The large industrial, post-industrial and railway areas located in the eastern part of the city of Olsztyn (Kętrzyńskie, Kormoran residential development and the southern part of the Zatorze residential development) were assigned the nuisance rank of 4 by the respondents. These objects act upon the sense of sight and hearing.

The other types of objects (including high voltage lines, power poles, construction plants, and the cemetery) were assigned by the respondents the rank of 3 on the seven-point nuisance scale (0-6), i.e. the middle value. These objects are primarily a visual nuisance, and the responses were evenly distributed between the proposed impact range values. For the needs of this article, the limit value of 200 m was adopted based on the rating of 58% of the respondents. The lowest nuisance rating (rank 2) was assigned to car repair workshops.

If it is necessary to obtain detailed data on the range of the impact of nuisance objects, taking into account the forms of land development, the authors see the need to carry out measurements on the ground, with the participation of the local community.

Significantly, the objects pre-selected by the authors have indeed been determined to be of major nuisance to the community, as confirmed by the high nuisance ranks assigned by the respondents. Roads with high traffic density were overlooked at the stage of collecting the initial inventory of nuisance objects and were indicated by the respondents in the open-ended question provided in the questionnaire form. This demonstrates the respondents' awareness and level of engagement in the survey.

The conducted survey and the visualisation of study results have allowed determining the sites that significantly affect the quality of life of Olsztyn inhabitants. Nuisance objects are concentrated in the eastern part of the city, where a residential development from the 1970s is located. In the vicinity, there is also a municipal park, which is undoubtedly an asset that improves the quality of life of the residents and compensates, to a certain extent, for the proximity of industrial and post-industrial areas. It is worth noting that a significant part of the southern area of the city, as well as green areas (municipal forest) and the lakes area located mainly in the north-western part of Olsztyn, constitute a space free of nuisance objects.

Conclusions and recommendations

The algorithm test shows that the proposed procedure can be implemented using the generally available information systems. The processing of spatial data by utilising modern IT tools enables the integration of data from various sources, which significantly accelerates and facilitates the implemen-

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tation of the proposed algorithm. The most convenient method of presenting spatial data is visualisation. This enables to the identification of the sites easily, causing a high level of a nuisance for the surrounding community.

The research described confirms the thesis of this article. The proposed solution enables to clearly determine the sites in the urban space that significantly reduce the quality of life of residents and consequently may require the implementation of intervention measures for eliminating or limiting the negative effects on society.

The spatial policy of a city has multiple dimensions. It should aim at rational use of urban areas so that they contribute to the improvement of the quality of life of residents in a sustainable manner.

Urban authorities have the means and tools to use and develop new research trends. When implemented in a given area, the proposed algorithm enables to the acquisition of knowledge about nuisance objects identified by the public, ranks the level of nuisance and delineates the impacted area. The information it provides should be fed to public geospatial databases and used to implement the concept of sustainable development and improve the quality of life of residents. The algorithm should also help the authorities identify the "strategic areas of intervention", which are the priority for urban development. For the information society, the data obtained in this manner constitute an exciting source of knowledge on the area. In particular, the results of the described analyses can be helpful for residents, investors and tourists who wish to avoid, for example, odour, noise and visual nuisances in a given area. The proposed algorithm can be used in decision-making models to help plan urban space, including, for example, the planning of view openings, pedestrian routes or housing development.

The recommended solution does not entail excessive costs, which makes it economically justified to implement it as a systemic solution. In the case of its implementation, it could be reviewed and updated periodically, e.g. every year. The proposed algorithm involves public participation, so it takes into account the perspective of the residents and can be adapted to their needs. Its functionality delivers the objectives of sustainable development of cities (Sustainable Development Goal 11) and the recent trend of "people-friendly cities". This human-centred approach aims at sustainable spatial and social development and, above all, at taking initiatives and actions that should focus on local communities needs. The proposed concept can also be an inspiration for the actions of urban authorities based on reliable spatial data and local community surveys in line with the OECD Global Forum idea of "Better policies for better lives".

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The contribution of the authors

Natalia Sajnóg – 40% (conception, literature review, acquisition of data, methodology, data curation, analysis and interpretation of data, formal analysis, funding acquisition, writing – original draft).

Elżbieta Zysk – 40% (conception, literature review, acquisition of data, methodology, data curation, analysis and interpretation of data, formal analysis, writing – original draft).

Mariusz Prokopczuk – 15% (acquisition of data, analysis of data).

Justyna Duma – 5% (acquisition of data).

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Appendix 1
THE IDENTIFICATION OF NUISANCE OBJECTS IN URBAN SPACE

I. Part: Metrics Question:
   Gender, Age, Education, Marital status, Place of residence.
II. Part Specific Questions: The identification of nuisance objects in urban space

Which of the following objects do you consider a nuisance and would not want them in your neighbourhood? Assign each of the listed indicators points from 0 to 6, where 0 points means that the presence of the given object in the neighbourhood is of no importance, and 6 means that it is of the most significant importance. Please consider each successive object without suggesting how the previous one was rated.

Nuisance objects	0	1	2	3	4	5	6
Car repair workshops							
Construction plants							
The sewage treatment plant							
The cemetery							
Linear utilities infrastructure (e.g. oil pipeline, heat pipe)							
Power transmission poles							
High-voltage overhead lines							
The airport							
Industrial and post-industrial areas							
Disused railway lines and stations							
Railway areas							
The landfill site							

In your opinion, are there any other oppressive objects which you would not like in the vicinity of your residence? Please list them and rate the nuisance on a scale of 0-6, where 0 means that the object is insignificant, 6 means that it is the most significant………..
At what distance would you be able to accept the presence of a nuisance object in the vicinity of your residence?

	No significance	More than 100 m	More than 200 m	More than 500 m	More than 1 km
Object with visual nuisance					
Object creating noise nuisance					
Object with odour nuisance					

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