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# Spatial mobility of the inhabitants of the countries of NATO's eastern flank in the event of a military conflict

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## Abstract

*In this article, we identify the spatial mobility of the populations of selected urban centres in Poland, Romania, Slovakia and Hungary. In total, 1,616 interviews were conducted. Additionally also interviews with the employees responsible for crisis management were conducted. Based on the analyses, five different clusters were identified, with different patterns of inhabitants in terms of their spatial mobility in the event of war. The most significant factors influencing their mobility in crisis situations are country of residence, age, number of people in the household and sex. This research can help develop evacuation strategies at different levels of governance.*

**Keywords:** spatial mobility, planning evacuation, NATO, military conflict, Computer Assisted Telephone Interview (CATI), cluster analysis, Poland, Romania, Slovakia, Hungary

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## 1. Introduction

The geopolitical conditions and security issues in Europe dramatically changed as a result of Russia's annexation of Crimea (18<sup>th</sup> March 2014), the instigation of the 'dirty war' in Donbass (Fryc, 2015), and, finally, the invasion of Ukraine (24<sup>th</sup> February 2022). This situation has led to the forced migration of the population, which has significantly increased since the end of February 2022. According to UNHCR data (the UN Refugee Agency), nearly 5.89 million people have fled from Ukraine's territory since the beginning of the war. By far, the largest number of refugees have crossed the Polish-Ukrainian border, exceeding 3.3 million people (as of May 2022), while Romania has occupied the second place (ca. 757,000 of refugees from Ukraine). In addition to the widely understood problems of mass migration of people, it is worth noting that the issue of relations between the Russian Federation and Western countries, which have never been easy, now appear to be the worst since the collapse of the USSR.

Since ancient times, situations posing a threat to people have forced them to seek safe places and, consequently, to migrate. According to the definition provided by the European Commission's

Directorate-General for Migration and Home Affairs, this type of migration is characterised by an element of coercion, related to threats to life and lack of basic living conditions that result from natural or man-made causes (The European Commission, 2021: Glossary of terms). These migrations primarily involved chaotic escapes. Experiences gained from armed conflicts, however, including the present ones, have helped understand the role of early and planned evacuation in protecting their health and, above all, their lives. It is fundamental to point out the causes, nature, effects and scale of mass forced migration caused by armed conflicts (Szabaciuk, 2018).

The example of Ukraine demonstrates the importance of top-down and planned actions to ensure the safety of women, children, the sick, disabled individuals, and the elderly. Evacuation is a common strategy for dealing with emergency situations. It is one of the fundamental actions taken to protect the health and lives of people and animals, save property in all kinds of threats. Evacuation is a process in which people are moved from endangered areas to safe areas where they can stay until it is appropriate for them to return (Lumbroso et al., 2010;

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Saadatseresht et al., 2009). Evacuation can be conducted in a planned (preemptive) or immediate (urgent) manner. Planned (organised) evacuation refers to the prepared movement of the population from endangered areas. One of the key objectives of emergency evacuation planning is to ensure that evacuees leave the endangered area as quickly as possible and reach safe places. Therefore, when planning the evacuation process, the aim is to minimise the overall evacuation time to protect the health and lives of the population (Dulebenets, 2021). Hence, from this perspective and due to the highly dynamic situation in Ukraine, it is important to understand the spatial mobility characteristics of individuals in case the Russian Federation decides to escalate the war to NATO countries. Modelling the evacuation process is crucial, especially for authorities and those managing the process, to ensure efficient movement of evacuees to safe places and provide them with shelter. In the case of fleeing due to war, coordinated actions between the countries people are fleeing from and the countries they intend to reach are also important.

Incorporating human behaviour into modelling the risk associated with war is essential for developing effective management strategies. It should be emphasised however that the socio-demographic characteristics of individuals, such as age and health status, can significantly affect their evacuation capabilities (Dulebenets et al., 2019). In his research, Boyce (2017) noted that “disability” resulting from factors such as age has a significant impact on the time and manner of evacuation. Effective emergency evacuation is crucial, especially for particularly vulnerable populations disproportionately affected by threats, primarily due to age or gender (in the event of war, only children, women, and the elderly, i.e. the most vulnerable population, will be able to evacuate). The example of the conflict in Ukraine illustrates that in the event of the Russian Federation rapidly penetrating NATO territory and engaging in open armed conflict, the Alliance’s response may be delayed due to lengthy decision-making processes and a lack of rapid crisis management implementation mechanisms. Therefore, it is extremely important to take all actions to improve the process of civilian evacuation (Banasik, 2020).

To study the spatial mobility of the population resulting from the outbreak of war, four countries (and urban centres) were selected: Poland (Suwałki), Romania (Galați), Slovakia (Michalovce) and Hungary (Nyíregyháza): countries on the eastern flank of NATO, directly bordering Ukraine, and most threatened by Russian military invasion. Geographical literature on population mass-evacuation as a consequence of military conflict is very neglected. This article brings new knowledge in three relevant fields of research: geography of hazards, behavioural geography and geography of migration. This research aspires to contribute to the broader understanding of spatial mobility in the context of military conflict and to provide practical recommendations for improving evacuation planning and crisis management strategies in the selected cities and NATO countries. This study draws attention to the need for preventive measures that increase the population’s sense of security and prepare them for possible emergencies.

The paper is divided into six sections. Section two provides a review of the literature on the evacuation process, crisis management in NATO countries and factors determining human behaviour during disasters. Section three describes the material, methods and research area. Section four contains the results and the next section is discussion, while the final, sixth section provides conclusions and recommendations.

## 2. Theoretical background

### 2.1 Evacuation – types, planning, stages

Wars and military activities have triggered considerable flows of people in modern history. Human conflicts generate and

accelerate migration waves, some of them have major impact on demographic trends and ethnic patterns of the places of origin and destination areas. The importance of war-related forced migration – including refugee flows, asylum seekers, internal displacement – has increased significantly in its quantity and its political relevancy since the end of the Cold War (Castles, 2003).

The common strategy for managing emergency situations and essential activities taken to protect people and animals (their health and lives) and to save property in the event of any hazard (including war-related incidents) is called evacuation. It is the process in which people are moved from risk zones to safe areas where they can stay until their return (Lumbroso et al., 2010; Saadatseresht et al., 2009).

Evacuations can be associated with a broad range of man-made threats and natural events and are classified as one of three types: “voluntary”, “recommended”, and “mandatory” (Urbina & Wolshon, 2003). Evacuation can be conducted at different stages of the military-related event or incident – either before or after it triggers, it may be “planned” (pre-emptive, anticipatory) or “emergency” (immediate, urgent, *ad hoc*) (Borowska-Stefańska et al., 2022).

It is important whether evacuation is “conducted” (supervised and controlled) by an external entity (emergency services or military in particular) or by “self-evacuation” (Kolmann, 2020), and may be performed in an “organised manner” (co-ordinated) or “spontaneously” (*ad hoc*) (Gromek & Koziół, 2015). What differentiates these two latter forms is primarily that self-evacuation lacks management, supervision and control over its course by the authorities, leading to the spontaneous nature of the actions taken, where the lack of accurate information may lead to chaos (Kolmann, 2020). Evacuation may be conducted by “all means of transport”, even “on foot”.

An additional proposed division of evacuation includes four types: by invitation, choice, default or compromise (Drabek & Stephenson, 1971). Obviously, people should be properly informed about the evacuation process, and communication to the public and between individuals which improved intensively due to technological development and even cultural changes during the last decades. The process of evacuation includes five stages in this order (1) decision to evacuate, (2) warning, (3) withdrawal, (4) shelter, (5) return (Lim et al., 2013). The first three stages of evacuation are critical to carry out the planned evacuation sufficiently (Urbina & Wolshon, 2003). A key objective of planning evacuation in emergency situations is to ensure that evacuees leave the affected area as quickly as possible and reach safe places. Therefore, total evacuation time should be minimised, thereby protecting the health and lives of the population (Dulebenets, 2021). The objective of evacuation planning is to reduce the loss of human life and tangible damage caused by disasters (Jafari et al., 2005) (including war-related incidents). Two conflicting premises can be found in the scientific debates in relation to crisis management (including disasters) – on the one hand evacuation plans and their implementation are regarded as pointless (Clarke, 1999) and, on the other, better schemes and planning can improve crisis management (Cook & Melo Zurita, 2016). From our perspective, the latter one is regarded as better.

In research studies, many analyses are concerned with how to optimise the transport component of evacuation (Murray-Tuite & Wolshon, 2013). These are focused on evacuation in terms of the availability of people evacuated to temporary accommodation until the threat has disappeared (Borowska-Stefańska et al., 2017) or take into account the departure of evacuees from danger zones (Church & Cova, 2000). The aim of transport analyses, on the other is to optimise evacuation routes using various algorithms (Chen et al., 2012; Shahabi & Wilson, 2014; Borowska-Stefańska, et al., 2022).

Evacuation planning is especially necessary for authorities, planners and those managing actual evacuations where evacuees must be relocated efficiently to safety, and with the help of it, bottlenecks and other weaknesses can be discovered. Evacuation planning includes many behavioural and management aspects making this issue expressly complex. Emergency services use geographic information systems to support proper evacuation planning (Kevany, 2003). Emergency management should operate both on a macro scale (across administrative units) and a micro scale (across buildings) (Eckes, 2008; Li et al., 2016).

Mass evacuation tools applied for several hazards worldwide are as follows – simulation models based on human behaviour and based on traffic, time-line/critical path management diagrams. As part of the evacuation, behavioural analysis needs to cover these questions: (1) how many people will evacuate (evacuation participation rate); (2) when will evacuees leave in relation to an evacuation order; (3) what will be the rate of public shelter usage; (4) how many evacuees will leave the local area; (5) how many of the available vehicles will be used? Numerous decisions must be made at the individual level about whether evacuate, when to evacuate, what to take, how to travel, route to travel, where to go and when to return (Alsnihi & Stopher, 2004). Evacuation-related traffic flows are predicted by traffic simulation models from a departure point, which is usually a residential area, to a destination (Lumbroso et al., 2010). A time-line diagram/critical path tool is the most basic form of mass evacuation ‘model’ available and it can then be applied to instruct those responsible for managing the evacuation what needs to be done, when it needs to begin, and approximately how long it might take for a given crisis scenario (Lumbroso et al., 2010).

The efforts of the authorities to ensure success during the evacuation from a risk zone, however, are highly impacted by the behaviour and attitudes of the residents which depend on numerous predictive factors (e.g. demographic features, expectations for evacuation, existence of their own plan, previous disaster (or war-related) experiences, type of government evacuation order, length of residence in the at-risk area, warning sources, psychological predictors and character of the risk) (Thompson et al., 2017).

## 2.2 Factors determining human behaviour during disasters

Disasters or catastrophes are phenomena that generate social and spatial disorganisation of the affected territories, inducing insecurity in the inhabitant communities (Provitolo et al., 2011). They can occur both from natural causes, over which people have no control, such as pandemics, tornadoes, landslides, etc., but also from artificial causes, the most destructive being armed conflicts (Grossi et al., 2020; Rinaldi, 2022; Sargiacomo et al., 2021). In addition to the loss of human lives and the displacement of a significant number of the population, disasters also cause significant material damage, which is reflected in economic losses (Botzen et al., 2019). Thus, in order to limit the impacts of disasters on human societies, it is necessary to take into account both the areas prone to such risks and the possibilities of mitigating them, but also the behaviour of people during and after their occurrence (Ejeta et al., 2015; El-Masri & Tipple, 2002; Gumasing & Sobrevilla, 2023).

For a deep understanding of people's behaviour in the face of a disaster, the psychological impacts that a certain danger can have on the individual must be taken into account. More often than not, the greater the devastation to the community, the greater the psychological impact on the survivors. In these cases, survivors become disoriented and may experience high levels of anxiety, depression, somatic symptoms, and generalised distress associated with widespread community destruction (Kohn & Levav, 1990; Labadee & Bennett, 2012). According to those indicated by New South Wales Health (2000), the common reactions of individuals

during the occurrence of a disaster may differ depending on their age category: the most affected are children and adolescents, who feel strong feelings of fear and want that their fears are both appropriate and shared by others; while adults and the elderly most often lose their lives balanced with the introduction of the enormous time, financial, physical, and emotional demands of recovery.

Individuals can react in the event of a disaster through under-estimation of danger, passivity, denial, over-estimation of capabilities. In the case of under-estimation of danger, individuals misinterpret the information they receive from the authorities or do not take it into account, without evaluating the danger they are in and the short reaction time they have at hand; while over-estimation capabilities happen when individuals are not aware of the gravity of the situation and consider that they are sufficiently prepared to face it (Adam & Gaudou, 2017).

At the same time, different individuals may have different perceptions about the disaster and the risk induced by it, resulting in different emotions, which weigh heavily in making a decision. In general, there is a difference between the behaviour of the two sexes in the face of an imminent disaster. Men prefer to defend their home, while women want to leave but usually end up staying with their partners because they are reluctant to leave them behind (Adam & Gaudou, 2017).

## 3. Material and methods

### 3.1 Study area

The research was carried out on residents in four selected cities. Adult women (18+) and men over 60 were included in the survey (CATI). We conducted surveys among adults who will have the right to evacuate. In Poland, these studies were carried out on the example of Suwałki – a city located in the north-eastern part of Poland, near the border with the Russian Federation (Fig. 1).

The Suwałki Gap is a strategic place that connects the Baltic states with the rest of the Alliance. This is a possible starting point for an armed conflict in the event of Russia's increasingly aggressive policy. In Romania, the city of Galați was selected for the study, it is one of the largest cities in eastern Romania, on the border with Moldova and Ukraine. Moldova's situation is also difficult at the moment – Transnistria is viewed as a flashpoint. On the other hand, in Slovakia, the research was covered the inhabitants of Michalovce. It is a city located in the south-eastern part of Slovakia, on the border with Hungary and Ukraine. The attitude of the Hungarian central authorities towards the armed aggression of the Russian Federation against Ukraine additionally complicates the situation of the inhabitants of this urban centre. In Hungary, the city Nyíregyháza, was selected for the study, it is one of the largest cities in eastern Hungary, on the border with Ukraine. Generally, in the group of four urban centres selected for the study, there are places of various sizes (Tab. 1).

The size diversity of the urban centres selected for the study is an opportunity to observe the declared communication behaviours of the population of local communities of various sizes. There is an additional (apart from the location in different countries and different geopolitical situations) factor that can potentially influence the characteristics of the inhabitants' transport behaviour.

In total, 1,616 surveys were conducted, minimum 400 in each urban centre. In Suwałki live total of 69,639 inhabitants, including women aged 18+ (20,535) and men aged over 60 (9,255). The minimum sample size is 379 with a confidence level of 95%. 298,584 people live in Galați, including women aged 18+ (136,007), and men aged over 60 (30,976). The minimum sample size is 383 with a confidence level of 95%. The town of Michalovce is inhabited by



Fig. 1: Location of the urban centres selected for the study against the background of the state borders of the countries of Central and Eastern Europe  
 Source: authors' elaboration based on database of topographic features and OpenStreetMap data

36,704 people, including women aged 18+ (6,031), and men aged over 60 (8,499). The minimum sample size is 378 with a confidence level of 95%. The city of Nyíregyháza is inhabited by 117,689 people, including women aged 18+ (47,848), and men aged over 60 (12,254). The minimum sample size is 382 with a confidence level of 95%.

The age and gender structure (also crosswise) of all four urban centres is similar. Some subtle distinguishing features can be identified (Tab. 2), however. For example, a Polish city is characterised by the most favourable demographic structure (the largest percentages in groups of young people). In turn, the city in Romania is in the most unfavourable position in this respect. These two basic demographic characteristics are of fundamental importance when making a possible decision regarding evacuation due to the threat of armed aggression. They are related, for example, with specific legal and administrative decisions (e.g. the obligation to defend the country), social roles (e.g. motherhood) or even emotional maturity. In the remainder of this article, the significance of these features was determined statistically.

It is worth taking a closer look at the spatial and functional structure of selected urban centres and the distribution of their buildings along with the spatial differentiation of the road network (Fig. 2). These are the features that also determine the spatial characteristics of mobility related to evacuation, considered in the short term. The mutual relationship between the location of buildings (especially housing and workplaces –

Urban centres	Country	Area [km <sup>2</sup> ]	Population	Population density [person / km <sup>2</sup> ]
Suwałki	Poland	65.52	69,639	1,062.86
Michalovce	Slovakia	52.88	36,704	694.04
Galați	Romania	243.63	298,584	1,225.59
Nyíregyháza	Hungary	611.01	117,689	192.61

Tab. 1: Basic statistical characteristics of the urban centres selected for the study

Source: authors' elaboration based on a database of topographic features, OpenStreetMap data and data from the statistical offices of the countries included in the study

Age category	Nyíregyháza	Suwałki	Michalovce	Galați
0–17	17.50%	19.05%	16.67%	14.68%
18–29	12.77%	13.57%	13.11%	11.20%
30–44	24.97%	24.24%	23.26%	26.05%
45–59	19.32%	19.62%	21.69%	24.10%
60 and more	25.44%	23.52%	25.28%	23.98%

Tab. 2: Age structure of the urban centres selected for the study

Source: authors' elaboration based on data from the statistical offices of the countries included in the study

large traffic generators) and the course of the main elements of the transport network (mainly roads) determines the efficiency of population movements.

In the case of evacuation (especially *ad hoc*), this relationship determines the number of places on the network where local bandwidth limitations will be activated. In the case of the analysed urban centres, the potentially most favourable situation in this regard concerns cities in Romania and Hungary. There are internal and external bypasses developed here, which have a chance to receive heavy traffic. The most dangerous situation is in Slovakia. There, traffic must be channelised in one artery. It must be borne in mind, however, that it is a small resort, so the streams of vehicles will not be large. In the case of Suwałki, the situation is mixed, as the outer ring road is not fully closed, while the traffic in the city centre must be managed by a relatively radial road system (however, with not very high technical parameters).

In the Polish town, as in the case of Michalovce, it is beneficial to extend the zones of residential development (it is not concentrated only in the centre of the town). Assuming that the evacuation process starts more or less at the same time, the journey will start at different sections of the network and the probability of induction of successive waves of vehicle flows is reduced. The most advantageous in this respect is the large mixing of land functions in the Hungarian city. Of course, this is a positive situation only in the case of self-evacuation. When it comes to organised evacuation, such a dispersion of residential areas is a major obstacle for the services responsible for this process. The very high concentration of residential areas in Galați is a significant challenge for the self-evacuation process. In a given unit of time, the transport system will be forced to handle very limited spatial resources, and huge demand for road infrastructure.

It is also worth mentioning natural transport barriers. Especially in the cases of Galați and Michalovce, there are banded transport barriers in the form of surface water. Bridges are very sensitive points of the transport system and should be carefully monitored during the evacuation process. In the case of the indicated cities, these are watercourses surrounding the areas of residential development from the east, which theoretically should not be the direction of first choice evacuation. This does not rule out a situation, however, in which the most advantageous evacuation path in the first stage will lead to the east, only to change its direction dramatically later. This is when bridge structures can become problematic.

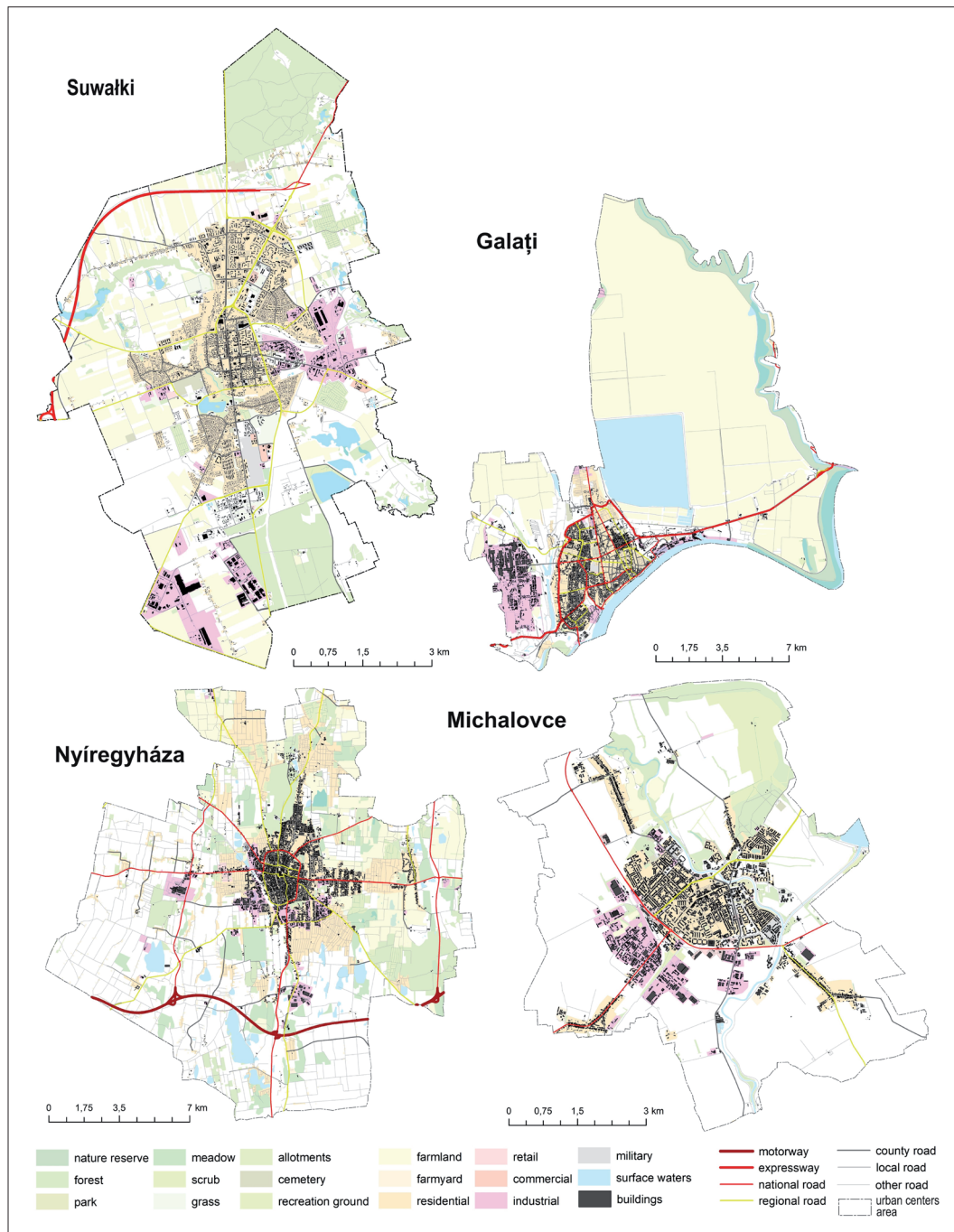


Fig. 2: Road network and spatial distribution of buildings against the background of selected forms of land use in the cities selected for the study  
Source: authors' elaboration based on database of topographic features and OpenStreetMap data

### 3.2 Survey design

The whole research procedure consisted of ten stages: the first involved the development of the survey questionnaire for inhabitants of four urban centres from four countries (Eastern Flank of NATO). The second focused on the preparation of the guidelines for the interviewers who were to conduct the survey with inhabitants and enter data into the questionnaire. The next stage (third) was the pilot stage, combined with the resultant modifications to the questionnaire and the research procedure. During stage four, a meeting with the interviewers (from four countries) was held to discuss the implementation of the survey. Stage five saw the survey being conducted. Next, the acquired questionnaires were analysed, checked, and verified. Stage seven involved the development of the survey questionnaire for employees, who are responsible for crisis management in the surveyed urban centres. In the eighth stage, survey questionnaires

were e-mailed for completion. They were addressed to specific people involved in crisis management in the analysed urban centres, who had been determined in advance through interviews at the offices. At the next stage the questionnaires from the cities/towns halls were analysed, checked, and verified. The last stage (tenth) was devoted to analysing the data, based on which the final report was prepared.

In order to determine the characteristics of the evacuation process carried out by residents of Nyíregyháza (Hungary), Suwałki (Poland), Michalovce (Slovakia) and Galați (Romania), surveys were conducted. The study was carried out using the CATI technique on a sample of minimum 400 residents in each urban centre (from March 1<sup>st</sup> to April 12<sup>th</sup> 2023). It was to cover female adults (18+) and men 60 years of age or more. In total, 1,616 surveys were conducted, among the residents of Suwałki in Poland (ca. 70,000 residents), Galați in Romania (ca. 300,000 residents), Michalovce in Slovakia

(ca. 36,000 residents) and Nyíregyháza in Hungary (ca. 120,000 residents). Residency requirements, gender and age were the only criteria for entering the sample, therefore other characteristics were distributed randomly. The questionnaire consisted of three parts. The first relates to the characteristics of the respondent and household, the next to the awareness of risk, and the last tests knowledge of how to behave in the event of armed conflict (Tab. 3).

In order to assess the city's/town's preparation for war, surveys were conducted with employees responsible for crisis management at the local level. This survey took place in March and April 2023, via e-mail and telephone. Only no feedback was received on the part of the survey relating to the preparation of the city in Hungary for war. On the other hand, documentation at the national, regional and local level was obtained from all countries, relating to the evacuation of the population in the event of a military conflict.

The questionnaire consisted of two parts, including (i) documents related to crisis management (especially evacuation process during military conflict), and (ii) the assessment of the city's/town's preparation for military conflict (Tab. 4).

### 3.3 Cluster analysis

Cluster analysis is one of a myriad of techniques utilised in Exploratory Data Analysis applicable for pattern recognition in survey analysis. Acknowledging these patterns may yield

a better understanding of underlying social processes, cultural determinants, and general tendencies in the population. We have decided to use the K-means procedure for clustering the survey results.

As far as the software we have used is concerned:

- Pandas and numpy (Python libraries) were utilised for data preprocessing;
- Scikit-learn (also a Python library) was used for performing the clustering and evaluating the quality of resulting clusters;
- Matplotlib and seaborn (Python data visualisation libraries) were used for data visualisation; and
- Statistical software package R was used for statistical analysis of relationships.

#### 3.3.1 Brief description of K-means method

Below we present an outline of a widespread representative-based cluster analysis, namely the K-means algorithm. The hyperparameters of this method (which have to be defined prior to execution of the algorithm itself) are the number of clusters  $K$  and the metric utilised to calculate dissimilarity of data. While the metric itself is usually connected to the problem statement and data we utilise, the choice of parameter  $K$  is up to the analyst. The algorithm begins by randomly selecting  $K$ -points  $v_1, \dots, v_K$  from

Respondent's particulars	Household	Total number of members Age of each members of household No. of cars Net income per capita
	Respondent	Gender Age Estate of residence Type of housing Education Driving licence Primary occupation Place of employment/school Experience in the evacuation process Duration of residence in the city/town
Questions about awareness of risk	Awareness of risk	The threat of war Periodic change of residence in case of war Who of the household would undertake the evacuation Who of the household would stay Reason for possible staying in the city/town
Knowledge about behaviour in the situation of war	Knowledge and human behaviour during evacuation	Educational activities in the field of conduct during war Behaviour after an alarm is announced The most important items to take with you during an evacuation Knowledge of evacuation instructions, evacuation paths, evacuation places Places of potential evacuation (places of refuge) Number of people used self-evacuation Number of people directed for evacuation by the service Evacuation directions Means of transport used for evacuation Assessment of the preparation of the country and the city/town for the war

Tab. 3: Schematic structure of the questionnaire  
Source: authors' survey

Documentations of crisis management	National level	<ul style="list-style-type: none"> <li>• List of documents at the national and regional level used by the city/town in the field of evacuation of the population in the event of war</li> <li>• List of documents and records relating to the evacuation process and the rules of conduct in the event of war.</li> <li>• Places of refuge or shelters in the city/town</li> <li>• Organisation of training on how to proceed during war for residents and employees responsible for crisis management.</li> <li>• Actions taken by the city/town to increase the safety of residents in connection with the military conflict.</li> <li>• Kind of support for town in improving the safety of the population</li> </ul>
	Regional level	
	Local (city/town) level	
Preparing the city/town for a military conflict	Knowledge and training in the field of evacuation	

Tab. 4: Questionnaire for employees responsible for crisis management  
Source: authors' survey

the space and assigning the observations contained in the dataset  $D := \{x_1, \dots, x_n\}$  to one of the clusters, based on their proximity to the points  $v_1^1, \dots, v_K^1$ . This forms us an initial set of clusters, denoted by  $A_1^1, \dots, A_K^1$ . As we keep adding the subsequent points to the clusters, their geometrical centres are subjected to shift. Thus, we recalculate the new centroid for each cluster, obtaining  $v_1^2, \dots, v_K^2$ .

Traditionally, the centroids are the multivariate means of the observations belonging to the given cluster and are used as a reference point, when calculating the distance between an observation and a cluster. And, as one may already suspect, this update of cluster centres causes the assignment to become outdated – therefore a new assignment must be calculated, resulting in the clusters  $A_1^2, \dots, A_K^2$ . This new configuration is unlikely to be satisfactory and so the algorithm continues, aiming to improve it. Therefore, the process iterates between the following two actions: calculating the centroid for each cluster and updating the assignment of every observation. If any observation is taken out of its currently assigned cluster and put into another, then the centroids of each cluster are bound to change – therefore, the algorithm continues until no reassignment takes place.

### 3.3.2 Data preprocessing

Preparing the data for the clustering procedure resulted in the selection of 104 columns and trimming the number of observations to 1,615. Some variables, like occupation, had to be translated to binary values by one-hot Encoding. Others, like education, years spent at current place of residence or Likert scale questions, were simply mapped to respective integer values, allowing comparison between them.

In cases of questions regarding number of people in the household etc., the outliers were trimmed to the maximal value in the range of the majority of answers, although they were mostly isolated cases. Lastly, the standardisation of data was conducted on columns with non-binary values.

### 3.3.3 Selecting number of clusters

Selection of appropriate number of clusters cannot be done otherwise than performing K-means multiple times for different number of clusters and then selecting the best approximation. But how does one compare two distinct results of clustering.

To this end, one can use various validity indices, which are well described in chapter 17 of (ASA) (Gan et al., 2007). The selection of the final number of clusters  $K$  was based on three criteria:

- Within-cluster sum of squared distances (so-called inertia). The most common heuristic approach for determining the number of clusters in K-means algorithm is via elbow method. It consists of determining the position of the inflection point, i.e. the number of clusters, where the loss of inertia slows down significantly;
- Silhouette index and plots, which depict the similarity of observations to other points from their cluster and compare it with the similarity to the points of neighbouring clusters. The greater the score is, the better (more distinguishable) clusters are. This statistic can be computed collectively for each cluster, or shown as a mean value for all groups; and
- Finally, the Davies-Bouldin Index (DBI in short) (see Fig. 3), signifies the ratio of cluster dispersion (which can be thought of as self-similarity) to cluster distinctiveness from other clusters. The number of clusters can be chosen to maximise this worst-case-scenario index amongst all the clusters (Davies and Bouldin, 1979; Halkidi et al., 2002a, 2002b).

Based on the presented computations, we have decided to perform subsequent analysis for  $K$  equal to 5. Although the inertia plot does not clearly show, where the inflection point is, the peak of

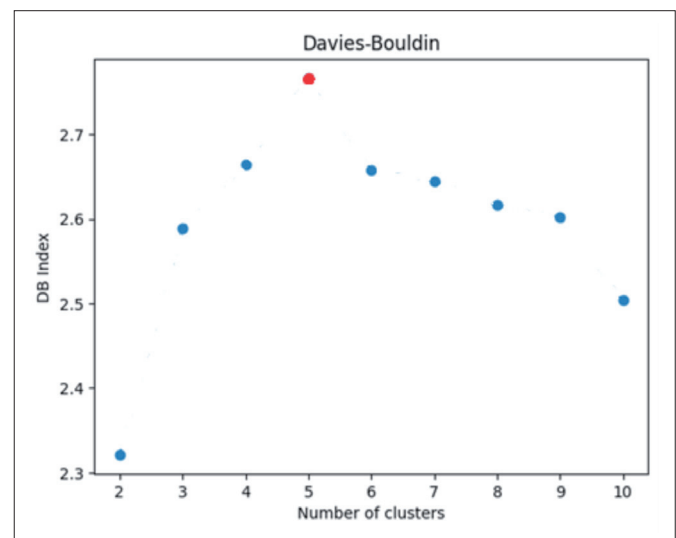


Fig. 3: Values of Davies-Bouldin Index for different numbers of clusters. Red colour marks the maximum of the obtained values, which is attained at the number of 5 clusters.

Source: authors' calculations

Davies-Bouldin Index is clearly visible and silhouette plots for this number of clusters are not outstandingly bad. The findings of this analysis are presented in the subsequent section.

## 4. Results

### 4.1 Analysis of survey with inhabitants

Based on this analysis, 5 different clusters were identified, which are characterised by different profiles of residents of the four urban centres in terms of their spatial mobility in the event of war. The most significant factors influencing their mobility in crisis situations are country of residence, age, number of people in the household and sex (Tab. 5).

Based on the conducted research, the following profiles were created.

#### Cluster 1

Respondents of the first cluster are primarily women (91.64%), mainly residents of two urban centres: Michalovce (Slovakia) – 34.49% and Galați (Romania) – 30.31%. These respondents are actively employed (working mainly outside the home). They primarily live in multi-family buildings (71.68%) and create two-person households. Their income per person in the household is within the minimum wage (35.54%) or within the average wage (31.71%). Over half of them have a driver's license (62.37%), and a significant portion of them declare that there is one car in their household (46.81%) (Tab. 5).

More than 50% of people in this cluster declare that they do not feel threatened by war in their place of residence, rather (26.4%) or definitely not (24.74%). At the same time, as many as 82.58% of them say that if war were to occur in their country, they would consider at least temporarily changing their place of residence (44.25% – responded definitely yes to this question; 38.33% – rather yes). Others do not know what they would do (16.38%) and only 1.05% of respondents said they would not change their place of residence even if war broke out in their country. At the same time, in the case of 88.67% of respondents' households (which have more than one person), other members would evacuate together with the respondent.

In terms of their knowledge and participation in evacuation training, the situation looks bad. Only 6.62% of people in this cluster stated that educational activities on how to behave in

Characteristics (N = 1,616)		Total sample [%]				
		Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
City/Town	Nyíregyháza (Hungary)	16.03	14.07	27.75	53.26	18.24
	Suwałki (Poland)	19.16	19.63	35.44	13.79	29.33
	Michalovce (Slovakia)	34.49	24.81	17.58	10.73	34.41
	Galați (Romania)	30.31	41.48	19.23	22.22	18.01
Gender	Female	91.64	77.41	75.0	76.25	89.38
	Male	8.36	22.59	25.0	23.75	10.62
Education	Primary or less	9.09	12.96	6.93	17.31	3.7
	Vocational	5.94	7.04	7.76	15.77	4.4
	Secondary	43.71	39.63	36.57	36.15	34.95
	Post-secondary	4.55	5.56	5.26	3.46	2.31
Age	Tertiary	36.71	34.81	43.49	27.31	54.63
	18–29	14.98	4.44	6.87	3.45	17.55
	30–44	27.18	12.22	17.31	12.26	30.02
	45–59	25.44	17.41	23.08	16.48	29.56
Type of residence	60 and more	32.4	65.93	52.75	67.82	22.86
	Single Family	28.32	29.63	35.38	34.62	29.4
Driving licence	Multifamily	71.68	70.37	64.62	65.38	70.6
	Yes	62.37	51.85	71.55	40.23	78.94
Number of cars in household	No	37.63	48.15	28.45	59.77	21.06
	0	24.82	47.85	16.06	55.64	14.79
	1	46.81	44.50	58.87	37.35	51.41
	2	22.7	6.22	20.0	6.61	26.76
Household size	3 or more	5.67	1.44	5.07	0.39	7.04
	1	16.38	30.74	19.23	40.23	11.09
	2	29.97	38.89	44.23	39.46	30.72
	3	25.78	15.93	16.76	10.34	26.56
	4	20.91	9.26	13.19	4.6	23.33
Work activity (in the last 7 days)	5 or more	6.97	5.19	6.59	5.36	8.31
	Student	0.7	0	0	0.38	0.23
	University Student	3.48	0.75	0.83	0.77	3.01
	Working away from home	45.99	24.63	34.99	19.92	48.15
	Working in hybrid mode	3.83	2.61	3.58	2.68	7.87
	Working from home	4.18	1.12	1.93	1.15	5.56
	Pensioner/retired	27.87	63.06	49.59	68.97	19.44
	Unemployed	4.88	1.49	2.2	1.15	4.17
Household's income	Not working for other reasons	9.06	6.34	6.89	4.98	11.57
	Subsistence minimum for 2022	4.18	1.85	2.2	4.21	2.77
	Minimum net salary in 2022	35.54	39.63	32.14	33.33	26.33
	Average net salary in 2022	31.71	32.59	24.45	32.57	27.94
	More than average salary	10.8	9.63	17.86	14.18	18.24
Professionally participate in the evacuation process	Refuse to answer	17.77	16.3	23.35	15.71	24.71
	Yes	8.71	7.78	10.74	3.45	8.08
Length of living in the current place of residence	No	91.29	92.22	89.26	96.55	91.92
	Since birth	33.8	25.19	27.9	29.5	37.96
	0–5 years	8.01	5.19	4.7	5.75	9.03
	6–10 years	6.27	5.93	3.31	4.98	7.87
	11–20 years	12.89	9.26	11.05	3.83	10.42
> 20 years	39.02	54.44	53.04	55.94	34.72	

Tab. 5: The respondents' characteristics in each cluster  
Source: authors' survey and calculations

the event of war had been conducted in their place of residence in the last six months. In addition, as many as 81.18% of people in this cluster stated that they had never participated in such training. The positive fact is that 72.12% of the respondents would participate in such training if it was organised. Almost all of them (94.77%) stated that they had not been familiarised with the evacuation instructions in the event of war in their place of residence.

A majority of respondents in this cluster (60.98%) do not know where they should hide in case of war. They also do not know if there is a shelter or refuge in their place of residence (52.61%). Those who answered affirmatively to this question (they know there are shelters or safe places in their place of residence) point out that there is one or several such places, but only less than half of them (48.32%) know exactly where they are located. Over half of respondents (55.75%) declare that they do not know how to behave after the alarm is announced (due to the outbreak of war). If such an alarm was announced, 25.78% of them would call their families first, and as many as 21.25% would run away

from home. The positive fact is that the vast majority of people representing this group (69.69%) know what they should take with them when evacuating from the endangered area. The most commonly mentioned things to take were documents (23.47%), clothes (15.92%), food (12.5%), and money (11.56%).

All respondents in this cluster were asked where they would evacuate if war broke out in their place of residence, and one-third of them (31.77%) identified shelters or bunkers in their urban centre, while 19.49% identified public places in their place of residence. Only 10.47% of respondents from this group declared a departure to another country, and 9.75% to another urban centre in their country. The vast majority of people in this group answered affirmatively (80.49%) to the question of whether they would evacuate in the event of war, of which 82.68% would use a car for this purpose (44.16% of respondents declared self-evacuation by car as drivers, 38.53% by car as passengers). 79% of respondents would travel directly to a safe place during evacuation, and those who would stop along the way stated that they would like to take other family members with them (83.33%). At the same



time, 21.63% of households have people requiring evacuation by services due to their age or health status. Close to half of people in this cluster do not know if the place of residence is prepared for war (49.48%). The assessment of the country's preparedness for war is better – 39.37% of respondents believe that it is rather prepared, and 9.41% responded answered – definitely yes.

### Cluster 2

Cluster 2 respondents are predominantly women (77.41%), but men also represent a significant group (22.59%). They are mostly residents of two urban centres: Galați, Romania (41.48%) and Michalovce, Slovakia (24.81%). The majority of these respondents are seniors (65 years and older – 65.93%), retired or on a pension (63.06% of cluster respondents). These respondents primarily reside in multi-family homes (70.37%) and have single or two-person households (38.89% and 30.74%, respectively). Their income per person in the household is either at the minimum wage level (39.63%) or falls within the national average (32.59%). More than half of them possess a driver's license (51.85%). A significant portion of them reported that there is no car in their household (47.85%), or there is only one car (44.5%) (Tab. 5).

Over 50% of respondents from this cluster stated that they do not feel threatened by war in their place of residence, either somewhat (22.22%) or strongly (25.56%). Nevertheless, a substantial 72.59% of respondents declared that they would not consider relocating if a war broke out in their country (51.11% responded with a strong “no” to this question, and 21.48% responded with “probably not”). Others are unsure (23.7%), and only 3.7% of respondents answered that they would probably or definitely relocate if a war broke out in their country. In 65.12% of the households of respondents who have more than one member, however, other members would also remain in place, together with the primary respondent. These respondents stated that their decision to stay in their current place of residence is connected to health (33.15%) and caring for other family members (22.83%).

Their knowledge about evacuation procedures is not sufficient. Only 3.7% of people from this cluster said that there were educational actions about dealing with war in their place of residence in the past six months. Additionally, 69.52% of these respondents reported never having participated in any similar training. The positive note is that 52.22% of respondents would participate in such training if organised. Almost all of them (97.04%) stated that they were not acquainted with instructions regarding evacuation in case of war in their place of residence. A vast majority of these respondents (58.15%) do not know where they should hide in case of war. They are also commonly uncertain if their place of residence has shelters or safe havens (49.63%). Those who responded positively to this question (knowing that there are shelters or safe havens in their place of residence) indicated that there is one or several such places, and more than half of them (66.28%) know exactly where they are. Over half of respondents (52.22%) stated that they do not know how to behave after an alarm is announced (resulting from the occurrence of war). If such an alarm were announced, 23.8% of them would barricade themselves in their apartment, and 21.48% would call their family. The substantial majority of people representing this group (72.22%) know what they should take with them when evacuating from the endangered area. The most commonly mentioned things to take were documents (19.16%), food (16.44%), clothes, and water (13.04% each), and medicine (10.87%).

All respondents from this cluster were asked where they would evacuate if war broke out in their place of residence, and 27.45% of them declared that they would stay at home, while 26.27% indicated that shelters or safe havens in their urban centre would be their choice. None from this group of respondents would

attempt a self-evacuation, and 40.74% responded that they would definitely not undertake it, 20.37% would probably not, and the remaining are still unsure. Almost half of the studied households would require evacuation by authorities (48.86%). 67.29% of respondents from this cluster have a negative opinion of the city's/ town preparedness in case of war. The preparedness of the country for war is even more disappointing – 75.75% indicated that it is not prepared (probably not – 26.49%, definitely not – 49.25%).

### Cluster 3

Respondents from the third cluster are mainly women (75.0%), although the participation of men is also significant (25.0%). They are mainly residents of two urban centres: Suwałki (Poland) – 35.44% and Nyíregyháza (Hungary) – 27.75%. These respondents are middle-aged people, 45–59 years old (23.08%) or older (60 years and above – 52.27%), retired or on a pension (49.59% of respondents in this cluster) or working outside of home (34.99%). The respondents primarily inhabit multi-family buildings (64.62%) and form households of two people (44.23%). Their income per person in the household is within the minimum wage range (32.14%), or within the average wage range (24.45%). A significant majority of respondents in this cluster have a driver's license (71.55%). A significant proportion of them declare that there is one car in their household (58.87%) (Tab. 5).

Over 65% of people in this cluster declare that they do not feel threatened by war in their place of residence, rather (31.32%) or definitely (34.07%). At the same time, a very large 86.26% of respondents state that if a war were to occur in their country, they would not consider changing their place of residence (51.92% replied definitely not to this question, and 34.34% replied rather not). The rest do not know what they would do (13.74%). At the same time, 61.92% of household respondents (consisting of more than one person) stated that other members would also stay in place with the respondent. Respondents stated that their remaining in their current place of residence is primarily due to health reasons (20.0%) and care for other family members (28.1%). A fairly large percentage of these people (18.1%) also indicated patriotism as a reason for staying in their current place, even in the event of a war.

Their knowledge of evacuation procedures is also not at an adequate level (as with respondents from other clusters). Only 4.12% of people in this cluster stated that educational activities on how to act in the event of war have been conducted in their urban centre over the last six months. Additionally, 71.7% of people in this cluster stated that they have never participated in such training. A positive fact is that 53.3% of respondents would participate in such training if it were organised. Almost all of them (97.25%) stated that they have not been acquainted with evacuation instructions in the event of war in their place of residence. The significant majority of respondents in this cluster (66.21%) do not know where they should hide in the event of war. They are also often unaware whether there are any shelter or bunkers in their place of residence (48.08%). Those who answered affirmatively to this question (knowing that there are shelters or bunkers in their place of residence) indicate that there is one or several such places, and over half of them (61.82%) know exactly where they are located. Over half of respondents (51.65%) declared that they know how to behave after an alarm is announced (resulting from the occurrence of war) – which distinguishes this group. If such an alarm were to be announced, 19.51% would call their family and 19.23% would turn on the radio, television, or the Internet. A significant majority of people from this group (74.45%) know what they should take with them during an evacuation from an endangered area. The most frequently mentioned items to take include: documents (21.29%), food (16.32%), clothes (13.41%), money (10.23%), and water (10.13%).

All respondents in this cluster were asked where they would evacuate if a war were to occur in their place of residence, and 29.57% indicated shelters or bunkers in their urban centre. Over half of the respondents in this cluster (55.77%) definitely said they would undertake self-evacuation, 43.68% would rather do so, and only two people did not know if they would do it. Nobody indicated that they would not undertake self-evacuation. During self-evacuation, they would use a car – 84.81% of them, including 53.31% as drivers and 31.49% as passengers. These people would evacuate directly to a safe place without any stops along the way (78.85% replied). Those who declared any stops would have them in order to take other family members (87% response from those who would stop during evacuation). 24.02% of people in households in this group require evacuation by services. Nearly half of the respondents negatively evaluate the city's/town's preparation for war (rather negatively – 29.92%, definitely negatively – 20.5%), while the rest do not know whether the city/town is prepared (33.52%), or evaluate it positively – 11.36%, or definitely positively – 4.71%. The evaluation of the country's preparation for war is similar – 50.28% stated that it is not unprepared (rather not – 29.56%, definitely not – 20.72%).

#### Cluster 4

The respondents of cluster four are mainly women (76.25%), although the participation of men is also significant (23.75%). They are mainly residents of Nyíregyháza (Hungary) – 53.26%. These respondents are mainly elderly people (60 years and older – 67.82%), who are retired or receiving a pension (68.97% of respondents in this cluster). The discussed respondents mainly live in multi-family houses (65.38%) and form one or two-person households (40.23% and 39.46%, respectively). Their income per person in the household is within the minimum national wage per person (33.33%), or within the national average (32.57%). Over half of the respondents in this cluster do not have a driver's license (59.77%). A significant proportion of respondents declare that there is no car in their household (55.64%) (Tab. 5).

Over 83% of people in this cluster declare that they do not feel threatened by war in their place of residence, rather than somewhat (18.77%) or definitely (64.37%). At the same time, as many as 77.39% of respondents state that if war broke out in their country, they would not consider changing their place of residence (63.6% – answered definitely no to this question; 13.39% – rather not). In the case of 74.48% of households of respondents (which have more than one person), other members would also stay in place, together with the respondent. Respondents stated that their staying in the current place of residence is related to health (28.14%) and care for other family members (24.12%). A quite significant percentage of these people (19.6%) also pointed to patriotism as the reason for staying in the current location, even if war broke out.

Their knowledge of evacuation procedures is also not at an appropriate level (as with respondents from other clusters). Only 3.83% of people in this cluster said that in the last six months, educational activities on how to behave in the event of war were carried out in their place of residence. Additionally, 76.92% of people in this cluster stated that they have never participated in such training. Unfortunately, what distinguishes these respondents from other clusters is the fact that up to 43.68% of respondents would not participate in such training if it were organised. Almost all (96.55%) stated that they were not familiar with the evacuation instructions in the event of war in their place of residence. The vast majority of respondents in this cluster (71.26%) do not know where they should hide in the event of war. They also often do not know if there is a shelter in their place of residence (53.26%). Those who answered affirmatively to this question (know that there are shelters or places of shelter in their urban centre) indicate that there is one or several such places, but

more than half of them (53.85%) do not know exactly where they are. Over half (51.34%) of the respondents declare that they know how to behave after an alarm is announced (resulting from the outbreak of war). If such an alarm were announced, 20.69% would call their family, and 16.48% would turn on the radio, television, or the Internet, while 15.33% would lock themselves in their own home. It is favourable that the vast majority of people representing this group (63.98%) know what they should take with them during evacuation from an endangered area. The most often mentioned things to take were documents (18.07%), clothes (15.93%), food (15.22%), and money (10.38%).

All respondents in this cluster were asked where they would evacuate to if war broke out in their place of residence, and 36.93% pointed to shelters or bunkers in their urban centre. Only one respondent from this cluster would undertake self-evacuation in the event of war. 62.45% definitely would not undertake self-evacuation, and 19.16% rather would not, while 18.01% do not know what they would do. 35.22% of household members of respondents in this group need evacuation by services. Nearly half of the respondents do not have an opinion on the city's/town's preparedness in the event of war, and generally, positive ratings dominate in the other evaluations – rather positive (23.37%) or definitely positive (13.41%). Similarly, in terms of assessing the country's preparedness in the event of war, positive ratings dominate – 57.47%, including definitely positive (16.86%) and rather positive (40.61%).

#### Cluster 5

The respondents of the fifth cluster are predominantly women (89.38%). They mainly reside in two towns – Michalovce (Slovakia) (34.41%) and Suwałki (Poland) (29.33%). These respondents are the youngest among all analysed groups, with the majority being aged 30–44 (30.02%) and the second largest age group being 45–59 (29.56%), who mostly work outside of their homes (48.15%). These respondents mostly live in multi-family buildings (70.6%) and households of two people (30.72%), or larger households with children. Their income per person in the household is around the national average (27.94%), but there is also a significant percentage of respondents who declare earnings much higher than the national average (18.24%). The vast majority of respondents in this cluster have a driver's license (78.94%). A significant percentage of respondents report having one car or more in their household (85.21%, of which 51.41% have one car and the rest have more) (Tab. 5).

Over 65% of people in this cluster declare that they do not feel threatened by the presence of war in their town (37.64% somewhat disagree and 28.18% strongly disagree). As many as 91.22% of respondents say that if war were to break out in their country, however, they would consider changing their place of residence (61.66% strongly agree and 29.56% somewhat agree). In the case of 82.71% of households with more than one person who responded, other members would also evacuate with them.

Their knowledge of evacuation procedures is also not at an appropriate level (like respondents from other clusters). Only 2.31% of people in this cluster stated that there have been educational activities on how to behave in a war situation in their town in the last six months. Additionally, 83.1% of people in this cluster stated that they have never participated in such training. A positive aspect is that as many as 65.82% of respondents would participate in this kind of training if it were organised. Almost all respondents (99.08%) stated that they have not been acquainted with the evacuation instructions in case of war in their town. The vast majority of respondents in this cluster (66.74%) do not know where they should hide in case of war. They also mostly do not know if there is a shelter or refuge in their place of residence (50.58%). Those who answered positively to this question (knowing that

there are shelters or refuges in their place of residence) say that there is one or several such places and that more than half of them (63.87%) know exactly where they are located. More than half of respondents (64.9%) declare that they do not know how to behave after the warning alarm is sounded (as a result of war breaking out). If such an alarm were to be announced, 20.09% would flee their home, and 19.4% would turn on the radio, television or the Internet. The majority of people representing this group (70.21%) know what they should take with them during evacuation from a threatened area. The most common things mentioned to take were: documents (24.13%), money (14.51%), food (13.41%), and clothes (12.62%).

All respondents from this cluster were asked where they would evacuate if war were to break out in their town, and 23.81% indicated that they would go to another country (the only group with the highest percentage indicating evacuation to a distant place), while 22.38% indicated shelters or refuges in their town. 91.69% of respondents in this cluster would attempt self-evacuation in the event of war, with 64.2% definitely attempting self-evacuation and 27.48% rather attempting it. In the case of self-evacuation, they would primarily use a car for transportation (87.91%, of which 58.19% as a driver and 29.72% as a passenger). Their evacuation would mostly lead directly to a safe place (78.64%), and those who would stop along the way would do

so mainly to pick up their family (84.44%). 19.58% of people in households of respondents from this group would require evacuation by emergency services.

In the case of respondents from this cluster, they mostly negatively evaluate both their city/town and country's preparation for war (88.68% and 92.84% of respondents gave negative evaluations in these areas, respectively). No one evaluated actions by authorities at both levels as definitely positive, and only three people rather positively evaluated actions at the local level, while seven people positively evaluated actions at the national level. A small group of respondents did not have an opinion on these issues.

#### 4.2 Analysis of survey with employees responsible for crisis management

The information obtained from the persons responsible for crisis management in each urban centre made it possible to identify a list of documents at local, regional and national level in the field of evacuation of the population in the event of war (Tab. 6).

A total of 8 documents, including as many as 6 from the national level, were identified as the basis for emergency management activities in the city of Nyíregyháza in Hungary. It can be noted that all the most important documents at the national level, as well as at the regional or local level, were adopted in 2021–2023.

#### HUNGARY

##### National level

- Law on the coordination of defense and security activities (Law 2021. XCIII.)
- Law on the disaster management and the amendment of certain laws related to it (Law 2011.CXXVIII.)
- 427/2022 (X.28.) Government Decree on the territorial and local rules of the defense and security administration
- 234/2011 (XI.10.) Government Decree about the implementation of the Law 2011.CXXVIII.
- 16/2013 (V.9.) decree of the Interior Ministry on sectoral national defense tasks affecting the responsibilities of the Minister of the Interior
- 62/2011 (XII.29.) decree of the Interior Ministry on certain rules of disaster prevention

##### Regional level

- Territorial emergency response plan of Szabolcs-Szatmár-Bereg county (reviewed in 2023)

##### Local level

- Emergency response plan of the city of Nyíregyháza (2021 – reviewed in 2022)

#### POLAND

##### National level

- Guidelines of the Chief of National Defence of 17.10.2008 on the evacuation of population, animals and property in case of a mass emergency
- Instruction on the principles of evacuation of population, animals and property in case of a mass emergency

##### Local level

- Municipal Crisis Management Plan (2022)
- Evacuation/Reception Plan for the Population in the town of Suwałki (2021)
- Civil protection plan 2012/2022
- Operational plan functioning of the town of Suwałki in conditions external threat security state and war (2021/2022)
- Organisational Regulations of the Town Hall in time of war (2022)
- Plan for the technical adaptation and relocation of the office to a command post at an alternate place of work in an external threat to security and in time of war, or in the event of specific threats making it impossible to continue operations at the current place of work

#### ROMANIA

##### National level

- Government Decision no. 1222 of 13.10.2005 regarding the establishment of evacuation principles in situations of armed conflict
- Order no. 1184 of 06.02.2006 of the Minister of Administration and Interior for the approval of the Norms regarding the organisation and assurance of evacuation activities in emergency situations
- Order no. 1352 of 23.06.2006 of the Minister of Administration and Interior for approval of the Organisational Methodology, ensuring evacuation activities of people, goods, documents and materials containing classified information, in situations of armed conflict
- The national response concept in the event of a nuclear – radiological accident

##### Local level

- Order-no.189-03.04.2023
- Order of the Inspector General No. 2 of 04.01.2019 approving the framework structure of the Emergency Preparedness Plan
- Decision No 862 of 16 November 2016 approving the categories of buildings for which the construction of civil protection shelters is mandatory, as well as those for which civil protection command points are installed

#### SLOVAKIA

##### National level

- Act No. 42/1994 on Civil Protection of Population
- Regulation of the Ministry of Interior No. 328/2012 on Evacuation
- Regulation of the Ministry of Interior No. 388/2006 on Details for Ensuring the Technical and Operational Conditions of the Civil Protection Information System

##### Local level

- Information for the public on civil protection in Michalovce district (based on Act No. 42/1994 on Civil Protection of Population)

Tab. 6: Documentation in the field of evacuation of the civil population  
Source: authors' survey

Suwałki in Poland identified 6 documents at local level relating to emergency response, two of which related to the functioning and organisation of the office itself. The others are various types of plans: crisis management, evacuation and reception of population, civil defence and the functioning of the town of Suwałki in a situation of external threat to security and war. At regional level, no documents were identified. In Slovakia, the key documents at the national level date back to previous decades. The local authority in the Slovak town of Michalovce declares a lack of recent relevant documents that would assist them to control an evacuation process in case of emergency at the local level. Based on the valid national legislative documents, so-called district authorities (with selected administrative competences deconcentrated to LAU1 units) are responsible for regional civil protection information documents. These are, however, very general and do not include details on evacuation management. In Romania, the military conflicts emergency evacuations are organised from the legal perspective, at national level, the regulations generating effects for the local levels (local communities or counties). For example, the order No. 1184 of 06.02.2006 of the Romanian Minister of Administration and Interior, explains the regulations regarding the emergency evacuations procedures. Another order No. 1352 of 23.06.2006 of the Romanian Minister of Administration and Interior completes the previous order, by further explaining the activities for evacuation of people, goods, or documents with classified information, in case of a military conflict. At the county level, there are no specific relevant regulations, but strategical documents like the Galați Strategy for Development for the period 2016–2025, considers the military conflict evacuations, as risk situations for the local situation. The existing local regulations only explain how the county or local committees for emergency situations are organised. The local level only implements the measures designed in the national level regulations.

According to the survey conducted with employees responsible for crisis management at the local level in Poland and Slovakia since 2001, they have not organised any instructions for residents on how to respond in the event of war concerning civil defense and evacuation for inhabitants. This unfavorable situation also applies to the period directly from the outbreak of the war in

Ukraine (i.e. from 2022). The situation in Galați looks better in this respect, where such trainings for residents were organised, although it was long before the outbreak of the war – in the years 2001–2014. The next questions in the survey concerned employee training. Unfortunately, in this case, both in Michalovce and Galați, they were not conducted. Employees dealing directly with crisis management in Suwałki are definitely better prepared in this respect. They are constantly trained. After 2001, training courses on how to proceed in a war situation (in the context of civil defense and the evacuation process) were organised in Suwałki for the employees of the office involved in crisis management, this also applies to subsequent years, including the period immediately after the outbreak of war in Ukraine. Since 2022, the town has conducted two such trainings. According to the employees of Suwałki, the town is "rather yes" prepared for war. In the case of the urban centres of Michalovce and Galați, the respondents marked the answer – "difficult to say" (Tab. 7)

Respondents from all urban centres stated that additional measures should be taken in 2023 to increase the safety of residents in connection with a military threat, which relate to various aspects (Tab. 8).

## 5. Discussion

The analysis of spatial mobility of residents representing selected countries of the eastern flank of NATO indicated similarities in their transportation behaviour related to evacuation during wartime, between respondents from Slovakia and Romania, as well as Slovakia and Poland, and partially between Poland and Hungary (for middle-aged and younger seniors). The oldest Hungarian residents form a separate group of people with different declared behaviours. Residents in Hungary do not feel threatened by a potential war in their country and assess the actions of their authorities towards preparation for such situations both on a local and national level more positively. Hungarian residents declare greater knowledge of how to deal with the threat of war. In general, it should be emphasised that Hungary stands out among Central and Eastern European countries in terms of relations with Russia (Hennessy, 2023).

Aspect / response	Definitely yes	Rather yes	Difficult to say	Rather no	Definitely no
Managing a large-scale evacuation of the population – relevant guidelines are contained in documentation		S	M, G		
Managing a large-scale evacuation of the population – the relevant services have been adequately trained		S	M, G		
Capacity of safe places for civilians is adequate for the number of residents		S		M, G	
Residents are familiar with evacuation and protection measures in the event of war (e.g. evacuation routes and methods, means of transport)			S, M	G	
City/Town Hall employees (especially emergency management staff) are familiar with evacuation and protection measures in the event of war (e.g. evacuation routes and methods, means of transport)	S	M	G		
There is an inventory of relevant equipment (including personal protective equipment) for residents		M, G			S

Tab. 7: Preparedness of the urban centres to protect civilians and evacuate in case of war (Notes: S – Suwałki (Poland); M – Michalovce (Slovakia); G – Galați (Romania); Nyiregyháza (Hungary) – n/a)  
Source: authors' survey

City/Town	Recommendations
Suwałki	<ul style="list-style-type: none"> <li>• Provide air raid shelters for residents</li> <li>• Other (please, specify) acquire equipment and personal protective equipment for city residents</li> </ul>
Michalovce	<ul style="list-style-type: none"> <li>• Update crisis management documentation</li> <li>• Organise instructions for residents on the expected conduct in the event of war</li> <li>• Organise instructions for the personnel involved in crisis management on the expected conduct in the event of war</li> </ul>
Galați	<ul style="list-style-type: none"> <li>• Update crisis management documentation</li> <li>• More detailed provisions in the documentation on crisis management as regards the evacuation process following the occurrence of war</li> <li>• Organise instructions for residents on the expected conduct in the event of war</li> <li>• Organise instructions for the personnel involved in crisis management on the expected conduct in the event of war</li> </ul>

Tab. 8: Recommendations for the urban centres to increase the residents' safety with regard to military threats  
Source: authors' survey

Age also influences differences in mobility. Older people more frequently declare the intention to remain in their current place of residence, most often due to health reasons, the necessity to take care of other family members, and rarely patriotism. On the other hand, younger people (18–44) are significantly more likely to declare that they would change their place of residence if war occurred in their country (slightly over 60% of respondents from these age groups). Additionally, individuals from these age groups state that the remaining members of their households would also change their place of residence (around 75%). If war broke out in their place of residence, younger respondents (18–44) are significantly more likely to declare that they would undertake self-evacuation – about 75%. The older people would less often undertake self-evacuation (less than 50% of respondents from the two oldest age groups declare that they would undertake self-evacuation), and more often due to their age and health status, indicate the potential necessity for evacuation by services. Research conducted by Gershon et al. (2012) on the evacuation resulting from the terrorist attack on 9/11 on the World Trade Centre also confirms that age and health status influence people's mobility during the evacuation process. Individuals who declare the desire for self-evacuation most often indicate the car as the means of transportation used for movement, which is also confirmed by research conducted (Borowska-Stefańska et al., 2023; Efrat, 1992). In addition, all respondents most often indicated that in the event of a war (in their place of residence) and the need for evacuation, they would look for shelter within their place of residence, less frequently outside it. In this case, however, individuals from the youngest age groups, approximately 30% of respondents aged 18–44, would definitely go outside of their place of residence. In the case of individuals aged 45+, only about 17% declared their willingness to leave their place of residence if a war broke out in its territory.

The percentage of people declaring knowledge about the principles of behaviour in case of evacuation also increases with age. Such people declare that they have participated in previous training in this area. They also have greater knowledge of the location of shelter facilities (although they declare significantly more passive behaviour). Unfortunately, with age, there is a decrease in the willingness to participate in training aimed at increasing knowledge about the principles of behaviour in case of war. Younger people definitely more often declare the intention to evacuate, and the younger they are, the more likely they are to indicate another country as the escape destination (areas requiring evacuation at much greater distances). Younger people have often children under their care, hence their greater willingness to flee and protect themselves from military actions. Dash and Gladwin (2007) also confirm that the presence of children in the household influences parents' behaviours during evacuation. Unfortunately, younger people have less knowledge about how to behave in the event of a war. Additionally, they more often negatively evaluate the actions of the authorities in protecting the civilian population, both at the local and national levels.

It should also be noted that there are differences in spatial mobility of the population due to gender. Women are more likely to evacuate than men (who more often declare the intention to stay in place for reasons of state of health and patriotism), which is also confirmed by a study conducted by Strang (2013).

Unfortunately, these studies have also shown that the majority of respondents did not participate in training on evacuation in case of war. Additionally, they do not know the evacuation instructions, and have not been familiarised with them. On the other hand, as confirmed by research conducted by Gershon et al. (2007), experience and knowledge of readiness for emergency situations accelerate the evacuation process. It should be emphasised that knowledge of evacuation instructions – including locations to which one should evacuate in case of danger, as well as evacuation

paths – facilitates decision making (Simonovic & Ahmad, 2005). Unfortunately, the populations of the countries surveyed do not declare adequate preparation in this regard.

Additionally, it should be emphasised that the lack of knowledge about evacuation in case of war usually translates into a low assessment of the actions taken by the city/town or country in this regard. Only in Hungary does the situation look slightly different, as there are documents on the evacuation of the population in case of a war – primarily at the national level, which is also reflected in opinions about the country's (and city's/town's) readiness for a potential war.

## 6. Conclusions and policy implications

The research conducted in the four selected urban centres with their inhabitants revealed valuable insights into the complex behaviour of transportation during evacuation processes in the event of a military conflict. The study showed that demographic structure, country of residence, and knowledge of risk play significant roles in shaping the efficiency of population movements during evacuation.

The research showed that residents of the selected urban centres, representing countries on NATO's eastern flank, would mostly undertake evacuation in the event of a war. They are willing to do self-evacuation, using their personal vehicles, and would most often choose a facility located in their place of residence as a place of shelter (although younger residents are more likely to declare a willingness to leave the country in case of war). Only the oldest residents exhibit more passive behaviours, however – they frequently declare a desire to remain in their homes, which is related to both health concerns and patriotism. Unfortunately, residents of the studied countries do not possess knowledge of proper evacuation behaviour, particularly among younger people who declare a greater willingness to evacuate, including self-evacuation. This is an extremely unfavorable situation since this process affects the capacity of transportation systems and, therefore, the time required for evacuation. Hence, local authorities should organise educational activities – adjusted to residents' declared behaviours – while considering the specific challenges posed by each urban centre, such as demographic structure or limited road networks.

Moreover, civilians should be regularly informed about available evacuation routes, which should be adapted to the current traffic situation. Otherwise, they may use only familiar roads, which can delay the evacuation process. Unfortunately, according to the research, the authorities do not organise training in this area for residents.

The present research should be used, among other things, for the modelling of the evacuation process, preparing documents on this topic at a local level. This is particularly important since interviews with crisis management team members in these urban centres showed that such documents are missing, or residents are not aware of them. Authorities should consider these factors when developing comprehensive evacuation plans that cater to self-evacuation and organised evacuation scenarios, ensuring safety and well-being for affected populations. Such plans should address the specific challenges posed by the dispersion of residential areas, road network limitations, and demographic structures in each urban centre. By considering these factors and addressing the unique challenges faced by each urban centre, authorities can improve evacuation planning, ultimately promoting the safety and well-being of affected populations and local communities within NATO's eastern flank countries.

This research proves that the preparation of residents in the event of war is an important task for the city/town authorities, which should be carried out with due diligence and taking into account various factors.

Authorities should focus on:

- Information and education: the city/town government should regularly provide residents with important information regarding war threats, security procedures, and steps to be taken in the event of a conflict. They can organise meetings, seminars and workshops to raise public awareness of risks and rules of conduct;
- Evacuation planning: in the event of a war threat, city/town authorities should develop evacuation plans, identifying safe places of refuge and evacuation routes. These plans should be communicated to residents and updated regularly. Also organising drills and evacuation simulations can help residents familiarise themselves with the procedures and increase their preparedness in the event of a real emergency;
- Creating warning systems: the city/town authorities should invest in warning systems, such as emergency sirens or mass notification systems, which will be able to effectively inform residents about the threat of war. In the event of such an alarm, residents will know how to react and how to find a safe place of refuge; and
- Cities/towns should ensure proper spatial development planning – taking into account transport opportunities during mass evacuations, or providing shelters for residents (which have often been neglected for years).

The specific way to prepare residents for war may vary depending on local conditions, threats and available resources. Authorities should also work with the relevant security services, such as emergency services or the armed forces, to ensure consistency and effectiveness.

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*The data underlying this article will be shared on reasonable request to the corresponding author. There is no conflict of interests concerning all authors.*

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