NATIONAL UNIVERSITY OF PUBLIC SERVICE

Doctoral School of Military Sciences

Lieutenant Colonel Péter Balog

THE POSSIBILITY OF DEVELOPING GEOSPATIAL ASSESSMENT-ANALYSIS SYSTEMS FOR THE SECURITY AND DEFENCE GEOGRAPHIC ANALYSES OF CRISIS ZONES IN THE HUNGARIAN DEFENCE FORCES

DOCTOR (PHD) THESIS

Supervisor:

Attila Kállai PhD, Lieutenant Colonel

Associate Professor

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1. JUSTIFICATION AND RELEVANCE OF THE CHOICE OF TOPIC

The relationship between military activities in geographical space, which are closely linked to it, and the environment has always been studied. At first, they only observed the terrain itself, later analyzing its complex interrelationships, and then military geography emerged as a science in its own right. Thanks to industrial development, by the 19th century geographical distances had become so much shorter through the development of transport and communications that they generated major changes in warfare too. The study of the geographical conditions affecting armed combat evolved into a science in its own right as experience was processed. The theory developed, which influenced the development of warfare, the planning of operations and strategic analysis and decision-making.

In the 21st century, nations that prioritize economic development and seek cooperation *"continue to see the use of military force as an alternative to managing the conflicts of interest that inevitably arise between them."*[1] To this must be added, for example, the impact of climate change and the resulting food, water and other resource supply crises, the unequal distribution of wealth, and the security threats posed by mass immigration.[2] For all these reasons, there is no doubt that identifying the emergence of crises and analyzing risk factors remains essential and necessary. The solution to these emerging problems also requires the active involvement of the scientific community, including military scientists. This necessity motivated me to start my doctoral research, which was confirmed by my personal work experience.

In the field of military geography analysis and assessment, it has always been a challenge to reconcile the vast resources and research opportunities available with the time available for analysis. To illustrate this, I would like to mention the consequences of the mass immigration crisis in 2017. At that time, my colleagues and I were assigned the task of preparing and updating a military geography assessment of the countries bordering Hungary at the Military Geography and Professional Training Department of the Geospatial Service of the Hungarian

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[1] KÁLLAI Attila (2023): Előszó. In BALOG Péter (2023): Geoinformációs Válságindex – biztonságföldrajzi elemzésekhez használható geoinformációs elemző-értékelő rendszer kialakításának lehetősége a Magyar Honvédségben. *Scientia et Securitas,* 3(3), 2023. 155–165.

[2] ISASZEGI János (2015): *A 21. század élettérháborúi a földért, a vízért, az élelemért, a ...létezésért - Válságövezetek konfliktusai és háborúi.* Budapest: Gondolat.

Defence Forces. The preparation of such a publication of the highest professional standard for the seven countries takes several weeks or even months of work – the analysis and detailed explanation of this is part of my thesis. The department was then given two weeks for the seven neighboring countries, which presented the drafting staff with a professionally impossible challenge. Data collection could not be done automatically at the push of a button. The data and maps available were not up-to-date in all respects and were not thematically appropriate. The tasks could not be prioritized in a deterministic and professionally supported way, so that, for example, the Alpine passes had to be assessed in the same detail as the crossings of the Drava, which was subject to migratory pressure from the south.

It was then that the possibility of developing a system that would speed up and simplify the process of data collection and storage, and provide a professionally based, scientifically sound argument for area-based and crisis-factor-based prioritization, supporting the appropriate levels of command decision-making, arose. I called this type of classification and result the crisis index at the time. It was this idea that led me in the direction of the present research.

2. PRESENTATION THE SCIENTIFIC PROBLEM

My doctoral research was aimed at developing a geospatial assessment and analysis system (hereinafter: geospatial system), which will make the analyses and assessments of the military geography specialists of the Hungarian Defence Forces more efficient and its use can potentially have a positive impact on all elements of the Hungarian Defence Forces. The system, by delineating the geographic and operational space and introducing a geospatial crisis index, will allow the prioritization of areas of interest in relation to a given risk factor. By taking into account the probability of a crisis occurring, the geospatial assessment of areas of potential threat can be prioritized to support decision making. The usability of such a geospatial system potentially goes beyond the areas of responsibility and application of the Hungarian Defence Forces. By specifying the data and information to be analyzed and by setting parameters appropriate to the type of analysis, it also could be used in other specialization.

Analyses and assessments applicable to the new types of threats and security challenges of our time require new perspectives. Factors other than those of the past must also be examined. Less time, more effective responses and more targeted information gathering are needed. With advanced sensors and monitoring systems, there is no shortage of data, but the distribution of

data is uneven compared to what is needed, making it crucial to generalize and extract data appropriately. The geographic space in which the defense sector, in particular the Hungarian Defence Forces, plans and executes its operations needs to be redefined. These changes will also have an impact on the role of military geography and the direction of its development.

The Ukrainian–Russian conflict of February 2022 demonstrates that armed conflicts continue to require significant material and trained human resources, and that the amount of these available to the opposing parties has a fundamental impact on strategy. Military geographic analyses, or, in newer terminology, geospatial analyses, use a different toolkit but are also geographically based, must work and plan with these technical requirements in mind.

At the operational level – in this thesis I have argued that the level of analysis of the geospatial system developed is the operational level – one of the most essential components of successful military operational planning is a comprehensive and detailed knowledge of the geographic space in which operations take place.[3] The complexity of this space, due to the complexity of the operations within it, is constantly increasing, while the time available for analysis is decreasing. The role of geospatial support is evolving, with the timeliness and structureability of data becoming increasingly important. Geospatial analyses based on military geography require the collection, organization and maintenance of data in databases, which takes up the majority of the analyses time. In the lack of time and resources for analysis, steps need to be taken in the data collection-analysis-evaluation process to ensure that data collection is targeted, that the selection is already appears in the search phase and that the databases contain the most relevant data.

For the practical implementation of the geospatial system I have developed, it is essential to modify and renew the current Hungarian professional regulatory environment. During my research I have revised the Geoinformation Support Doctrine[4] currently in force in the Hungarian Defence Forces.

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[3] FAZEKAS Ferenc (2022): A NATO összhaderőnemi művelettervezési doktrínájának evolúciója. *Hadtudomány,* 32(1), 28–41.

[4] Ált/213 Magyar Honvédség Geoinformációs Támogatási Doktrína, 1. kiadás. 2014.

I am convinced that the topic I am researching is a topical one and that the development of a geospatial system is necessary. The Doctoral School of Military Science of the National University of Public Service had also voted me confidence when I started the research, and I tried to repay this confidence by developing the geospatial system.

3. RESEARCH HYPOTHESES

I have made the following hypotheses in connection with the study of the topic at the start of my research:

1. The procedures and methods currently used by the Hungarian Defence Forces for the geospatial analyses and assessment of security and defence geography of crisis zones do not meet the increasing expectations and requirements for geospatial support in all aspects. Traditional analytical and assessment procedures no longer provide comprehensive answers to the issues involved in managing complex crises in rapid duration.
2. The geospatial system developed for the geospatial assessment of security and defence zones of crisis requires a new approach to data collection and storage and consequently a new methodology for spatial delimitation.
3. The methodology of a modern geospatial system should be based on the methods of investigation of military geography as a multidisciplinary science.
4. The effectiveness of the assessment of military geography can be enhanced by the development of a geospatial system, using a deterministic measure based on given variables, a geospatial crisis index that can be used to analyze and assess a given area.

4. RESEARCH OBJECTIVES

The main objective of my doctoral research was to justify the need for, and to investigate the feasibility of, developing a novel geospatial system for defence purposes, and to propose the development of a system that would allow the application of modern methods of analysis and assessment of crisis zones. The system is primarily designed to support the participation of the Hungarian Defence Forces in crisis management tasks and is basically designed for use within the Hungarian Defence Forces, but could also be used by the wider defence community if properly implemented.

When defining the objectives of my research, I assumed that processing the considerable amount of data would not be possible in the time available for analysis using only human resources. The results of my research provide a realistic opportunity to develop a system for the geospatial analysis of the security of a well-defined crisis zone, using a database and adapting data collection methods and approaches. The command and control of military operations places demands on geospatial systems that can only be met at the cost of significant trade-offs without the solution I propose. The developed geospatial system, with appropriate analysis methods, will help professionals and decision makers to make an up-to-date assessment, taking into account the given criteria and factors.

One of the main objectives of my research is to introduce the concept of geospatial crisis index. The geospatial crisis index is a dimensionless, deterministic numerical value issued by the system. In practice, it is a benchmark that allows the comparison of certain areas in terms of a given risk factor, or the hierarchical ordering of factors by recording the area under study. This helps to sequence potentially more detailed analyses, speeds up the actual textual and mapping evaluation, reduces the need for human resources and supports administrative decision-making.

Based on the above, the objectives of my research are:

1) To identify the shortcomings of the procedures and methods currently used by the Hungarian Defence Forces for the geospatial analysis and evaluation of the security of crisis zones, and to propose a new approach to the creation of a modern geospatial system;
2) To propose the restructuring of the relevant professional regulations within the Hungarian Defence Forces necessary for the application of the system;
3) To develop a new methodology for the geospatial delimitation of crisis zones;
4) To demonstrate that the methodology of the analysis and assessment of a modern geospatial system should be based on the methods of military geography;
5) Analyze and demonstrate the potential for improving the efficiency of geospatial systems;
6) To introduce the concept of a geospatial crisis index and demonstrate its positive impact on the analytical and evaluation processes.

5. RESEARCH METHODS

The result of the research work is the creation of knowledge, thus the aim of scientific research is *"to solve a practical or theoretical problem"* or *"to develop a discipline"*.[5] In my thesis, I have taken as a problem that the current military geography and geospatial publications are not always able to make professional use of the amount of information available, partly because of its immense size and partly because of the short time available for analyses, and thus are not produced with the expected efficiency. The development of this discipline is reflected in the fact that the expected efficiency is achieved by using the created geospatial system, and so indirectly military geography as a discipline and military science itself are also developed.

According to István Gőcze's classification of research methodology[6] , the methodology I used during research belongs to the category of applied research, which is *"research activity aimed at solving problems that arise in practical life, which seeks to introduce a theory, principle, procedure or tool that is already well-functioning in other areas of practice"*. By this I mean that, in general, there are already theoretical and practical solutions and best practices for the collection and structured organization of available data in other fields. I have been able to examine the experience and principles of this and apply them in my research.

In order to develop the system, I first had to define the fields that would use the results of the assessments, security geography, defence geography and geospatial support, and to demonstrate that the methodology of military geography and the study of military geography factors provided a suitable professional basis for the application of the system. The study of existing definitions, the interpretation and application of previous doctoral theses and scientific publications in the field of military geography facilitated my work in this process.

I conducted this theoretical research using an inductive strategy, including action research. According to Gőcze, induction is the method of moving from specific factors and knowledge to general conclusions. In this sense, it is a form of generalization in which the experience is processed. According to the author, this is one of the most important methods in military

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[5] TOMCSÁNYI Pál (2000): *Általános kutatásmódszertan.* Gödöllő, Szent István Egyetem. 14.

[6] GŐCZE István (2011): A tudományos kutatás módszerei. *Hadtudományi Szemle,* 4(3), 159.

science, and I have therefore turned to its application with courage. I have examined and analyzed specific military geography and geospatial methods, data collection and analysis techniques used in security and defence geography and their limitations.

Based on the critique of the existing practice, my aim was to present a new theory and solve the problem raised, since the Hungarian Defence Forces, after the organizational changes that significantly affected the geoinformation field in 2023, are currently still providing some form of geospatial support. Military geographic materials are being produced for the purpose of security and defence geographic analysis by the specialists of the Military Geography Directorate of the Hungarian Defence Forces Logistics Support Command (HDF LSC).

Regarding the concept of security geography, I also based my research on Gőcze's 1997 paper *"Some Theoretical Issues of Complex Military Geography"*.[7] He was the first who created the term security geography in Hungary. Also, the definition of security geography by Árpád Gerencsér,[8] which is based on the research results of István Gőcze and Klára Siposné Kecskeméthy, was helpful in my interpretation and methodological approach to security geography. The analysis of these sources provided an adequate basis for the research in the field of the scientific-systematic place and division of military geography. Thus, I was able to demonstrate that the traditional field of study of military geography has expanded considerably nowadays, and on the basis of these findings I was able to interpret security geography as a joint interdisciplinary field of military science, geography and security studies. In this relation, Gerencsér's approach to geography gave me the opportunity to treat space as a system of interactions built up from complex subsystems where the crises I was researching are created and played out. This system of interactions can be applied to the local, regional and global study of risks affecting security and defence geography.[26] Of these, I have primarily analyzed regional risks when developing the geospatial system.

The methodology of security geography distinguishes between physical, human, economic and military factors. In the research I followed this division in the relation of risk types and military geography factors, with the modification that I embedded economic factors under human

[7] GŐCZE István (1997): A komplex katonaföldrajz néhány elméleti kérdése. *Földrajzi Értesítő,* 46(3-4) 263–273.

[8] GERENCSÉR Árpád (2016): A Kaukázus térség biztonságföldrajzi értékelése. PhD-disszertáció. Nemzeti Közszolgálati Egyetem Hadtudományi Doktori Iskola.

geography – following the MTA's discipline classification[9] which names these two disciplines of geography, physical and human geography, within the earth sciences. Thus, the three major fields of relational study mentioned above became physical geography, human geography and military factors.

I analyzed, evaluated and synthesized existing definitions to clarify the concepts of security and defence geography. The concept of defence geography, as part of regional military geography, is much less represented in publications. According to Siposné Kecskeméthy Klára's definition,[10] defence geography seeks answers to the interrelations between the geographical environment and the threats to the region, analyzing military and non-military threats to the complex security of the area. An important element of the definition for my research is that it explores *"the possibilities of their emergence, their nature, magnitude and expected development trend"*, thus it is a discipline that can be used to investigate the chances of the emergence and development of crises.

I have based some dimensions of security and types of crises on the book *"Basics of Security Studies*" by Ferenc Gazdag and Éva Remek.[11] This allowed me to define the most important security problems in the crisis area, to explore their interrelationships and to analyze their likely evolution. In identifying the crises and defining them for the analysis, I adapted the priority security risks defined by the National Security Strategy[12] for Hungary to each region after resource analysis and assessment.

As a grant holder of the New National Excellence Programme, a part of my doctoral research has demonstrated that the development of a geospatial system requires the renewal of the relevant doctrinal regulation. I conducted a comprehensive study and detailed analysis of the relevant and existing domestic professional regulations (regulations, doctrines, codes, other

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[9] *Tudományági nómenklatúra.* (2017) Magyar Tudományos Akadémia Doktori Tanács. Online: https://mta.hu/doktori-tanacs/tudomanyagi-nomenklatura-106809

[10] SIPOSNÉ KECSKEMÉTHY Klára (2019): Védelemföldrajz címszó. In KRAJNC Zoltán (főszerk.): *Hadtudományi lexikon – Új kötet.* Budapest: Dialóg Campus. 1142.

[11] GAZDAG Ferenc – REMEK Éva (2018): *A biztonsági tanulmányok alapjai.* Budapest: Dialóg Campus.

[12] *Magyarország Nemzeti Biztonsági Stratégiája. 1. melléklet az 1163/2020. (IV. 21.) Korm. Határozathoz.*

documents) and assessed their demonstrable impact on the proper functioning and development of the geospatial field of defence.

To test and prove the effectiveness of the developed system, I used a special method of scientific data collection,[13] I conducted a questionnaire survey among the specialists of the Military Geography Directorate HDF LSC. The methodology of the questionnaire survey was based on the book *"Theory and Methodology of Scientific Research"* by Júlia Hornyacsek. The results of the survey are presented in subchapter 3.2.1.

I developed the theory of the system on a scientific basis, based on the methodology of the military geography discipline. I then had the opportunity to create a demonstration version of the system in the framework of the Cooperative Doctoral Programme, for which, lacking the appropriate mathematical and IT development skills, I consulted mathematicians and IT developers, and sought and took their advice.

To develop the system, I conducted logical research, which implies the use of both theoretical and experimental procedures.[14] The design of the algorithms that build the system was basically carried out using a regression model based on the principles of induction and deduction, using analogy and mathematical methods. Regression analysis is a way of finding trends in data, where the system performs practically unlimited number of calculations using programmed formulas or functions up to the extent of the database specified in the system, or even using newer databases. In this way, it reaches a level where the number of variables – the data sources used to determine the risk factors – exceeds the number of equations available. The equations and the concrete analysis are presented in subsection 5.1 Methodology for the determination of the geospatial crisis index in my thesis.

The specific code implementing the tasks was written by a developer contracted separately in the Cooperative Doctoral Programme. I laid out the mathematical principles that would perform the analyses and checked the finished equations with two mathematicians who made the necessary corrections to ensure that the results were indeed what I had intended.

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[13] HORNYACSEK Júlia (2014): *A tudományos kutatás elmélete és módszertana.* Budapest: Ludovika. 91.

[14] GŐCZE 2011: 162

In order to achieve the set objectives, I used mainly secondary research methods, mainly exploratory methods (document analysis, observation, questionnaire). In doing so:

- I have studied the domestic and foreign literature, publications and studies on the research subject;
- in addition to processing published papers, I have also used the summaries of my personal consultations with representatives of the domestic scientific and professional community;
- I organized and adapted the experiences of the research and professional projects I have been involved in on this topic;
- as a lecturer and student, I have participated in national and international conferences and academic sessions on topics related to my research area, and adapted the presentations;
- I studied the legislation, doctrines and regulations on the research topic;
- I have demonstrated through a questionnaire survey that the system developed is more efficient than the current practice in collecting, structuring and sorting data for geospatial analysis and evaluation;
- in the framework of the Cooperative Doctoral Programme, I developed the scientific principles of the geoinformation assessment and analysis system for practical implementation; I held professional consultations with system developers and mathematicians who participated in the creation of the demonstration version of the system under a separate contract.

6. BRIEF DESCRIPTION OF THE RESEARCH, CHAPTER BY CHAPTER

In the first seven unnumbered chapters of this thesis, I introduce the scientific problem and justify its topicality. I describe my research hypotheses, my research objectives, the methodology used, and then summarize the literature on the research topic.

In the first two numbered chapters I analyze the concepts of security and defence geography, military geography and geospatial information, and the relationship between them, and I deal with the problem of defining and delimiting crisis zones.

In the first chapter, I show that, due to the topic of the thesis, it is important to define the concepts of security and defence geography, to clarify the definition and the research aspects of military

geography, the methodology and the relation of these to the concept of geospatial information. According to definitions, security geography and defence geography are part of the modern theory of military geography, including regional military geography, and geospatial information is based on military geography in its methodology. I analyze the classical, complex, dynamic and modern trends in military geography, their essence and their applicability in the development of the system principle. I examine the relationship between geography and security, determine military geography as a multidisciplinary discipline at the interface of geography and military science, and place security geography at the intersection of military science, geography and security studies.

I justify the need to develop the geospatial system at the operational level, and I will show the difference between general and specific military geographic assessments and how they can be applied in the developed system, where the assessment is mission-specific. At the end of the chapter, I show how military geography has evolved into a science and why geospatial information can draw on this evolutionary process. I examine and adapt the analysis and evaluation method of military geography and geospatial information for the system perspective. I present the current situation of the geospatial support of the Hungarian Defence Forces, and highlight the most relevant deficiencies and regulatory problems in terms of the development of the system. I examine the transformed military-geographical support and demonstrate that the role of military-geographical factors and the importance of evaluation and analyses have been preserved. I demonstrate that general, sectoral, and regional military geography, including regional defence geography and local theatre of war knowledge, should be integrated into domestic doctrinal regulation accordingly. Basic principles, responsibilities, principles of data collection and use, and minimum requirements for publications must be defined. I confirm that the military geography methodology provides an appropriate basis for the development of a geospatial system in the early 21st century, in line with the changing – largely IT-based – opportunities and resulting expectations, and can be integrated.

In the second chapter, I show that one of the key factors in the analysis of crisis zones is the delimitation of the area to be analyzed. In the case of a country, this is the national border, and in the case of a well-defined region, its administrative boundaries. But this is not always so clear-cut, some non-military crises do not end at borders, and the military nature of most of them is directly related to the dispute over borders. I define the crisis space from several sources and analyze how the space can be interpreted in warfare. Phase 1 of the planning process at

the operational level is the collection, processing, systematization and evaluation of information and data on the situation that has arisen or is about to arise, based on defined criteria, contributing to the creation of conditions for effective command and control and the formulation of command decisions.[15] This justifies the need for geospatial analyses. The relationship between space and armed conflicts no longer limited to geographical space and the concept of war. I analyze the problems posed by the new type of delimitation of space and demonstrate that the change in the perception of space justifies the introduction of a hybrid delimitation methodology. The methodology is basically implemented by combining and mixing the complexes developed by Buzan and Wæver[16] and Marton,[17] so I have reviewed the works of these authors and adapted their principles in the development of the system.

Crisis zones can be defined in several ways, on the one hand on the basis of the principle of regional complexes, and on the other on the basis of crisis-specific complexes, which are both essential and indispensable. This led me to the conclusion that the analysis should develop a methodology that can adapt both principles, using a dual - hybrid - delimitation, which implies a dual data storage. In this way, the system can collect, analyze and evaluate crisis-specific spatial data for each type of crisis. In my research, I have thus developed a new methodology for the geographic delineation of security and defence crisis zones.

In the third, fourth and fifth chapters, the design and creation of the geospatial system and the geospatial crisis index are the subject of my thesis.

In the third chapter, I present the design of the geospatial system. As part of the doctoral research, I was able to develop a demonstration version of the geospatial system in the framework of the Cooperative Doctoral Programme, so I developed the system not only in theory but also in practice. On the basis of the research plan submitted within the framework

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[15] BÁRÁNY Zoltán (2014): A hadműveleti szinten végrehajtott művelettervezés folyamata. *Honvédségi Szemle*, 142(2), 57–59.

[16] BUZAN, Barry – WÆVER, Ole (2003): *Regions and Powers – The Structure of International Security*. Cambridge: Cambridge University Press.

[17] MARTON Péter (2019): *Biztonsági komplexumok - A biztonság empirikus elemzésének alapjai*. Budapest: Budapesti Corvinus Egyetem.

of the Cooperative Doctoral Programme, I developed a system design of the IT developments carried out during the development. Following the outline of the plan, I developed tables describing the relationship between the risk factors and the relevant geographical factors to be investigated in relation to the risk factors undertaken in the research plan. In the demonstration version, I developed the tables derived from the National Security Strategy, taking into account the resources available – time and financial resources – In consultation with my subject leader and the company expert regarding the following crises:

- illegal migration;
- an act of terrorism in the demarcated area;
- the development of a failed state in the demarcated area;
- an epidemic causing mass disease;
- the development of major flooding and extensive inland flooding;
- persistent water scarcity due to global warming.

I defined the system, justified the necessity of creating the system, and verified through a questionnaire survey that the system developed would increase the efficiency of the analyses, since one of my hypotheses when I started developing the system was that the efficiency of the geospatial system would be increased by developing a geospatial system. I prove that the deterministic measure based on given variables, the geospatial crisis index that can be used to analyze and evaluate a given area, will help in this. The questionnaire is presented and analyzed in detail in the thesis. I outline the system design; the procedures used and define the planned requirements for the implementation and maintenance of the system within the Hungarian Defence Forces.

In the fourth chapter, I present the detailed functional principle of the demo version of the geospatial system developed in accordance with the research plan submitted in the framework of the Cooperative Doctoral Programme grant, based on the IT developments that have been implemented. I have taken stock of the geographically related security challenges in the planned assessment areas and mapped them to military-geographical factors. For each risk factor, I have posed questions in each geographic aspect section, to which the system seeks answers. More precisely, it searches, downloads and organizes data based on the sources I have defined, and then, based on the algorithm I have defined, it produces a result from which a specialist can draw a conclusion, in practice the answer to the question that has been asked.

The relationship between the defined risks, the geographical and military factors to be examined is presented in detailed tables in the thesis. The tables present the military geography factor being analyzed, the element within that factor to be analyzed, and the geographic data influencing the specific risk factor to be analyzed, according to the two branches of geography – physical geography and human geography – and the larger grouping of military factors. For each of these, where relevant, I have formulated a question. These questions, or even individual items, can be modified, deleted or even new ones defined in the system. The demo version was created with these data.

I define the data collection methodology by which the system collects data for analyses and I analyze the possibility of using open information for geospatial support of the Hungarian Defence Forces. I analyze the challenges of data storage, to which I propose solutions, and outline the architecture of the demonstration version of the geospatial system.

In chapter five, I define the methodology for defining the geospatial crisis index. It is a dimensionless, deterministic numerical value issued by the geoinformation assessment and analysis system used to analyze crisis areas. This means that it is independent of the analyzer, thus it produces the same result when working from the same local database. The result is a so-called "benchmark", a point of reference that allows comparing areas in terms of a fixed risk factor or hierarchizing the factors by fixing the area to be examined. This helps shape the sequencing of potentially, more detailed human analyses, speeds up the actual textual and mapped evaluation, reduces the demand on specialist resources and supports commanders in decision making. I will demonstrate how this analysis can be currently performed on the web interface created in this research.

I present the methodology of each type of question defined for the algorithm. The results of translating the answers to the questions into mathematical language will be used to calculate the value of the crisis index. In the course of the research, I defined the questions and the mathematical principle that describes them. Individual questions can be disabled if they are not needed, new questions can be defined if we want to extend them.

Each of the questions can be classified into one of the following five types of questions, so I described the calculation principles for these five types, everything else can be deduced from them. The five types of questions are as follows:

1. Scalable question type. The result will be somewhere between the extremes 0 and 1, e.g. a percentage value like this.
2. Type of question to be decided. It can be answered with a yes or no answer (1;0 in programming language), this so-called boolean data type is binary, i.e. it can store logical data, the analysis can have two values, true or false.
3. Comparative question type. A question that compares data, calculates differences between data. Here, the difference is the result or some consequence of it, a conclusion drawn from it.
4. Positive-negative question type. It is similar to the type to be decided, but it is directional, it is stored vectorially, the direction of the phenomenon is not the same (-1;1).
5. Composite, weighted question type. Also gives a score between 0 and 1, but not on a scale, but weighted, e.g. whether a specific event occurred in the area during the period under study and if so, how serious the result.

After that, I present the novelty of the system and analyze the existing similar systems. The novelty of the research result is the change of approach. The main problem in the analyses with the current methodology is the lack of time. The main innovation of the system to be developed lies in the collection and processing of data. It provides a generalized assessment based on objectively collected military geography data, geospatial databases and the possibility to extract additional information through human-centered analyses. The research cover the existing methods, the analyses of the database structure, the renewal of the approach to data collection, the question of delimitation of the area to be analyzed, the criteria and the factors to be analyzed.

In the course of the research, I concluded that in practice the geospatial system, and the geospatial crisis index produced by the system is a benchmark that allows comparing certain areas in terms of a given risk factor, or sorting the factors in a hierarchy by recording the area under study. This helps to sequence potentially more detailed analyses, speeds up the actual textual and mapping evaluation, reduces the need for human resources and supports decision-making.

7. SUMMARY OF CONCLUSIONS AND SCIENTIFIC RESULTS

The results of my research provide a realistic opportunity to develop a system for the geospatial analysis of the security of a well-defined crisis zone, using a database, by revising data collection methods and approach. The command and control of military operations places demands on geospatial analyses and assessment systems that can only be met at the cost of significant trade-offs without the solution I propose. The developed geospatial geospatial system, with appropriate analysis methods, will help professionals and decision makers to provide an up-to-date evaluation, taking into account the given criteria and factors.

As a result of my current research, by delineating the geographic and operational space and introducing the geospatial crisis index, it is possible to rank the areas of interest according to a given risk factor. I have demonstrated the need to prioritize the security geography and geospatial assessment of areas of potential risk, taking into account the likelihood of a crisis occurring, which supports decision making. However, the usability of the geospatial system goes beyond the responsibilities and applications of the Hungarian Defence Forces.

The novelty of the research result lies in the transformation of the approach, in offering a new way of thinking or a new perspective. From a properly compiled, up-to-date database containing a wealth of data, an almost instant geospatial assessment or rapid report becomes realistic. Based on a metric, a geospatial crisis index for the right variable, it is possible to prioritize and provide a more in-depth analysis of the areas of real interest to the business.

The research will also provide a doctrinal basis for the development of a geospatial system that will facilitate and make more efficient the geographic analysis of the security and defence of a well-defined crisis zone. As a further research result, I introduced the concept of a geospatial crisis index as a deterministic measure of a given variable for a rapid assessment of a given area. It does not replace a detailed analysis, but it saves time, increases efficiency and facilitates the decision-making process.

The results of my research also draw attention to the inevitability of a renewal of doctrinal regulation. This is partly due to technical developments, partly due to the structural disguise of the Hungarian Defence Forces and the decentralization of the geoinformation profession

The findings and results of my research contribute to the transformation of the understanding of geographic space as a security environment, to the transformation of the methodology of geospatial data collection, and to the improvement of the efficiency of geospatial and geoinformation analysis and assessment for operational purposes.

Based on the above, I consider the scientific result of this thesis to be:

1. I have confirmed that the procedures and methods currently used by the Hungarian Defence Forces for the geospatial analysis and assessment of security and defence geography in crisis zones do not meet the increasing expectations and requirements for geospatial support in all aspects. Traditional analytical and assessment procedures no longer provide comprehensive answers to the issues involved in managing complex crises in rapid duration.

2. I have developed a new approach to the data storage methodology of the geospatial system for the geospatial assessment of security and defence geography of crisis zones, and the necessary spatial delimitation based on this new methodology.

3. I have demonstrated that military geography as a multidisciplinary science provides an appropriate methodological basis of the geospatial system developed.

4. I have demonstrated that the efficiency of preparing military geospatial assessments can be increased by developing a geospatial system and by using a deterministic measure based on given variables, the geospatial crisis index.

8. RECOMMENDATION AND POSSIBLE USES OF THE RESEARCH RESULTS

The geospatial system created in my research is primarily used by analysts of crisis zones, whether in geography, security studies, military science or any other relevant discipline. But the entire Hungarian Defence Forces personnel can benefit from the system, if not indirectly, either through more thorough training, more accurate analysis, or faster and more effective decision making.

The topic of the doctoral research and its research plans fit into the medium-term plans of the Hungarian Defence Forces. Based on the demo version of the geospatial system, which is the aim of the research, I consider it justified to develop the full version, which not only allows the

analysis of a selected area, but also provides the opportunity to evaluate the whole territory of Hungary and crisis areas where Hungarian soldiers may be deployed.

The target group of the users of the geospatial crisis index is primarily the geoinformation staff of the Hungarian Defence Forces, including those whose activities include the preparation of geoinformation assessments, so that the entire Defence Forces can benefit from the innovation.

The full development of the system should be under the direction of the HDF LSC Military Geography Directorate as the organizational element comprising the military geography specialists within the HDF. Once the system has been professionally developed, it should be integrated into the workflow at the Directorare.

At the command level, the expectation is for a quick, clear and concise end product, where concrete information and data based on the geospatial crisis index, such as thematic maps, together with useful tools for evaluation, support decision-making.

By defining the data and information to be analyzed and by setting parameters appropriate to the type of analysis, it can be used in other fields - so that partner organizations involved in crisis management operations with the Hungarian Defence Forces can also benefit from the system.

Based on the results of my thesis, I propose as a further research area the possibility of including cyberspace as a geographically defined space in the definition of geospatial analyses. The new generation of warfare cannot be fully analyzed without analyzing cyberspace, but it is confirmed that the analyses of cyberspace alone is not sufficient. The analyses and integration of the newer dimension in a geographical context is certainly worthy of research.

Equally new is the application of big data methodology, artificial intelligence and machine learning in geospatial analyses and assessment. The demo version of the developed system only touches on this discipline, the full adaptation of its methodology and the use of artificial intelligence innovations could lead to further developments.

The third area of research I propose is the analyses and examination of the possibilities of using the output results of the geospatial system in the Digital Soldier Programme. The Hungarian Defence Forces are committed to the digitization of individual soldiers and their equipment, and a basic element of this could be a geospatial support element that could help the user to

geospatial support – in this sense military geography, terrain and cartography – from the combat level to the operational level.

9. PUBLICATIONS OF THE AUTHOR ON THE TOPIC

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10. Válságövezetek lehatárolása biztonságföldrajzi értelemben a 21. században In: SZELEI *Ildikó (szerk.) A hadtudomány és a 21. század 2022.* Budapest, Doktoranduszok Országos Szövetsége, Colorcom Media. 2022. 51–65.

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10. PROFESSIONAL-SCIENTIFIC CURRICULUM VITAE OF THE AUTHOR

Péter Balog was born on 7 May 1977 in Budapest. He graduated from the Madách Imre High School in Budapest in 1995. He started his university studies in 1996 at the Faculty of Natural Sciences of the Eötvös Loránd University in Budapest, majoring in cartography. In 1998 he also became a student of geography at the Faculty of Natural Sciences of Eötvös Loránd University in Budapest. In the academic year 1997-98 he participated in the African Studies Programme of Eötvös Loránd University.

He obtained his first degree as a cartographer in 2001. His thesis was on the cartographic representation of boards in board games. He continued his studies as a Defence Scholar in 1999, and after graduation he was assigned to the Mapping Service of the Hungarian Defence Forces as a professional soldier with the rank of Lieutenant. In 2002, he completed the basic training and the courses required for professional recruitment, as a result of which he was assigned to the Technical and Standardization Department of the Mapping Service HDF. In 2005, he defended his second degree in Geography at the Faculty of Natural Sciences of Eötvös Loránd University, in the field of geography, entitled General Geographical Aspects of Military Geography based on the Military Geography of Slovakia.

In 2009, he received a new position at the Military Geography and Professional Training Department of the Geoinformation Service of the Hungarian Defence Forces, which was renamed and has undergone a reorganization. He was promoted several times to the rank of Captain. In 2016, he got married and later had two children. In 2019, as a Major he started his doctoral studies at the Doctoral School of Military Science of the National University of Public

Service, his choice of topic being motivated mainly by his personal interest and the desire to innovation in order to fill the deficiencies he had encountered in his professional work.

During this time, he also worked at the Military Geography and Professional Training Department of the Geoinformation Service of the Hungarian Defence Forces, in the meantime as head of department, with the rank of Lieutenant Colonel. In 2023, the organization was abolished, and the professional tasks concerning military geography were taken over by the Reserve Training and Support Command of the Hungarian Defence Forces, and later by the Logistics Support Command of the Hungarian Defence Forces.

To date, he has published thirteen papers on his research, four of them in English. He has presented numerous papers at scientific conferences and university lectures. He has also been active as an opponent, a member of the Cartographic Section of the Hungarian Society of Surveying, Mapping and Remote Sensing and a member of the Geoinformation Section of the Hungarian Association of Military Science. He conducted his PhD research for ten months with the support of the New National Excellence Programme, obtaining an excellent distinction. He was successful in his doctoral research as a candidate of the Cooperative Doctoral Programme, in cooperation with the National University of Public Service and the Geoinformation Service of the Hungarian Defence Forces.

He has type C advanced level military language exam in English (STANAG 3.3.3.3.) and a type C basic level language exam in French.