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Geospatial Crisis Index – Developing Geospatial Analysis System to Support the Hungarian Defence Forces[2]

Security geography examines the military geography factors influencing the security system and environment of an area, and its investigation method is rooted in geography. The data set related to this, mainly open source databases, is a rapidly changing data set, so its analysis only shows the current state, but if the data set is large enough and considered mass data, it may be suitable for drawing new connections and conclusions for the future. A geospatial analysis system applicable to security geographic analysis is under development, which is continuously collecting data by taking predefined variables into account for a specific area of interest. The geospatial crisis index can be obtained from these local data following a professional analysis procedure based on predefined algorithms. This new index is a unitless numerical value issued by the geospatial evaluation and analysis system used to analyse crisis zones. It is a benchmark allowing areas to be compared in terms of a fixed risk factor or factors to be ranked in a hierarchy by fixing the area. This helps shape the order of the analysis, speeds up the actual text and map evaluation, reduces the need for human resources, and supports commanders in decision-making.

Keywords: *security geography, crisis, geospatial information, mass data, analysis, open source reconnaissance (OSINT)*

Introduction

Geospatial support activity includes the production and acquisition of cartographic and military geography materials and data. This geospatial dataset is analysed to support the security geography analysis of Hungary – or any other area of interest of the Hungarian Defence Forces. Most of the geo-related data can be obtained from open sources. The geospatial analysis system under development is an automatised tool of collecting, cleaning and organising the raw data, (making) turning them into useful information after the process of analysing and determining the related geospatial crisis index.

During my research, I examined the following: Can military geography factors and their methodology be used for security geography analysis as part of a geospatial analysis system? Is the mass data, the available quantity of spatial data suitable for such a geospatial

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analysis system? How should we plan the geospatial analysis to support military personnel? How can we delaminate the area to be analysed? In this paper, I present the answers to the questions above.

Security geography

According to one possible definition, security is the absence of a threat.[3] Security geography examines those military-related geographic factors that affect the security system and environment of a country or region.[4] Therefore, we must first examine what are the factors that can pose a threat to the security of the given area from the point of view of military geography. The military geographic analysis uses territorial-based division in its analysis at tactical, operational and strategic levels. Although there are Regional Security Complexes based on geographical proximity, which Buzan and Wæver say is a group of states whose security-related problems are closely related, and security threats are examined in a composite way, thus security complexes are developing.[5]

Marton introduces another approach, the concept of a question-specific security complex, where security complexes are based on causal events, not on territorial bases.[6] According to him, spatiality cannot be drawn on all security complexes, but he does not question the role of geography or maps, their role in the representation of certain geographical sources is still preserved. He says the definition of a threat within a security complex can be geographically or causally arguable and can exist from multiple valid perspectives.[7] It does not deny the geographically-based relationship, it just does not content with it. This idea is also based on the opinion that certain elements of a threat form boundaries with each other, so there is a geographically displayable connection between them.

Both security geography and military geography are rooted in geography. It can be concluded that the security geography analysis also includes military geography factors only the approach to the analysis is different. These factors are the following: geographical location of countries, physical geography, socio-political conditions, economy, transport characteristics, military, national security information, history, and ethnic and armed conflicts in the country.[8] It is important to mention here that some of the threats are not necessarily limited to a country, such as armed and, especially, ethnic conflicts. For these kinds of analyses, we need to use other kinds of delimitation than administrative boundaries. The military geography approach helps us to delimit the crisis area, the National

[3] Gazdag, Ferenc – Remek, Éva (2018): *A biztonsági tanulmányok alapjai.* Budapest: Dialóg Campus. 17.

[4] Siposné Kecskeméthy, Klára (2019): Biztonságföldrajz. In Krajnc, Zoltán (ed.): *Hadtudományi lexikon. Új kötet.* Budapest: Dialóg Campus. 102.

[5] Buzan, Barry – Wæver, Ole (2003): *Regions and Powers. The Structure of International Security.* Cambridge: Cambridge University Press. 44.

[6] Marton, Péter (2019): *Biztonsági komplexumok. A biztonság empirikus elemzésének alapjai.* Budapest: Budapesti Corvinus Egyetem.

[7] Marton 2019: 121.

[8] Siposné Kecskeméthy, Klára (2019): Katonaföldrajzi értékelés. In Krajnc, Zoltán (ed.): *Hadtudományi lexikon. Új kötet.* Budapest: Dialóg Campus. 524.

Security Strategy[9] is the source for identifying threats, and geospatial analyses provide the results of expert work.

Dimensions of security geography

There are social, environmental, political, economic, military and IT dimensions of security, so these are examined and analysed by the respective sub-science of geography dealing with them.[10] It is hard to define nowadays where the battlefield ends and where the area that is no longer part of the battlefield begins. Geographically relevant, mainly natural areas (terrestrial, marine, aerial and cosmic), social spaces (military, political, economic, cultural and psychological) have become operational dimensions as well during the age of unrestricted warfare – forming more dimensions, so it is considered more like battlespace than a battlefield. Respectively, the cyberspace connecting geo and social spaces has all become an operational dimension.[11] Attacks that threaten security can no longer be characterised simply by occupying or retaining territory.

The information and data used for security geographic analyses can be linked to both the Earth and its immediate environment. It refers to its immediate environment, according to our current concepts these are all geospatial data. There is no difference between security geography and geospatial analysis in the location of the examined area, only in its size and delimitation. Similarly, there is no difference in the available data, only in the processing methodology.

Security geography and geospatial information

Geospatial information is "a set of spatial data and information about the Earth and its immediate surroundings".[12] All factors that have a geographically relevant security dimension or have an impact on geographical and social relations and that can influence the outcome of a possible crisis, the possible course of an armed conflict, should be part of modern geospatial analyses. Different dimensions of security examine different sub-areas, yet together they affect the security of an area. That crisis area needs to be delineated and studied locally, regionally, or globally, depending on the nature of the effect.[13] This effect can vary, as mentioned above, social, environmental, political, economic, military and IT dimensions of security can be distinguished.

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[9] Government of Hungary: Government Resolution 1393/2021 (VI.24.) on the National Military Strategy of Hungary. [online], Hungarian Gazette, 2021. Source: defence.hu [04.12.2022].

[10] Gazdag–Remek 2018: 21–24.

[11] Szenes, Zoltán (2017): Katonai biztonság napjainkban. Új fenyegetések, új háborúk, új elméletek. In Finszter, Géza – Sabjanics, István (eds.): *Biztonsági kihívások a 21. Században.* Budapest: Dialóg Campus. 90.

[12] Kállai, Attila (2019a): Geoinformáció. In Krajnc, Zoltán (ed.): *Hadtudományi lexikon. Új kötet.* Budapest: Dialóg Campus. 314.

[13] Gerencsér, Árpád (2016): *A Kaukázus térség biztonságföldrajzi értékelése.* PhD thesis. Budapest: Nemzeti Közszolgálati Egyetem. 21.

We need a large data set to collect for this study. All data from publications intended for wider use should be obtained from open sources to avoid classification. In addition to the use of printed sources, the Internet and open source information collection provide an excellent opportunity.

Open source reconnaissance

Open source reconnaissance (OSINT) is an intelligence using open, non-secret, freely accessible, usable and downloadable public, accessible resources.[14] The point is that the data is publicly available to all individuals through legal means, possibly with limited dissemination, but not classified information. The discovery, collection, selection, analysis and evaluation of the use of this data for professional purposes is covered by open source discovery. This has several advantages and disadvantages.

Advantages and disadvantages

The advantage of OSINT is that this amount of information, especially spatial data, has never been available before,[15] so a large amount of information can be obtained in a relatively cost-effective way.[16]

Disadvantages can be that it is not enough to collect this data, the information must be filtered, selected, organised, analysed and evaluated, always according to the defined purpose. It slows down the process and requires professional qualifications and experience, which requires continuous training and organisation. Likewise, too much information can be a disadvantage if not handled properly. The need to know everything about everyone may be an expectation, however, an unachievable one.

As Karcsai demonstrates the problem: "It is like a pizza: basic information, as topographic background, as the pizza dough, and technical data as the tomato sauce, are musts. But all other information, just as all kinds of toppings, cannot, or hardly can be placed on the pizza itself, nor can all the information represented on a map."[17] However, it is a rational need to collect all this information, analyse it after appropriate professional selection and display it to the extent necessary.

Types of open source data

There are different types of open source data that shall clearly be distinguished. There are open source data, which mean a raw document or knowledge that can be provided by primary sources. It can turn to open source information, which means the data is

[14] Kovács, László (2019): Nyílt forrású felderítés. In Krajnc, Zoltán (ed.): *Hadtudományi lexikon. Új kötet.* Budapest: Dialóg Campus. 846.

[15] Olasz, Angéla (2017): Big Data és térbeliség. *Geodézia és Kartográfia,* 69(5), 12.

[16] Dobák, Imre (2019): OSINT – Gondolatok a kérdéskörhöz. *Nemzetbiztonsági Szemle,* 7(2), 87.

[17] Karcsai, András (2021): *The Usage of Geospatial Related NATO STANAGs.* Presentation at the Geoinformation Service HDF, 23 June 2021.

processed, collected, selected, and evaluated according to a given approach. Then comes open source information acquisition, which is the procedure itself, when information is obtained from openly available sources, in order to achieve a specific goal. It is necessary to prioritise, to be able to determine which of the available data should and can be used for the given task, which is relevant, and filter what we know, and might be useful to us later, but we need not consider it at the time being. This requires both experience and training. The availability of metadata, the secondary information assigned during processing, is essential, potentially for anything we consider important to assign them, and provides data retrieval.

Following the above concept, we will carry out the process of searching, collecting, selecting, evaluating and using data within the OSINT activity. It is worth mentioning that we do this with open source so that the publications made from them are not classified and are available to the target audience (Hungarian Defence Forces). Of course, OSINT does not replace the collection of secret information but complements and guides it, and even, depending on the target task, can replace it in the preparation of geospatial-related publications. At the same time, the time factor has become one of the most important elements of OSINT, which, in addition to credibility and control, is an essential factor for quick decision-making.[18]

Ever-changing geographical space

The interpretation of space is constantly changing, becoming multidimensional; in English terminology, the term "battlespace" is used much more than "battlefield". The military science approach and definition of space are also changing. Anything that has a spatial or geographical relevance can be interpreted as space – geography is an inescapable factor for warring parties since the way of warfare, the forms and methods of applying the armed forces, mainly depend on the factors influencing its implementation.[19] These factors are realised in space, so in all five dimensions of the new battlefield concept – land, air, sea, cosmic and information.[20] Time also has an increasing role: the significance of having immediate access to real-time information has become more vital than ever. We need information about everything, and we need it now. The task of geospatial evaluation is to analyse the typical, defining and essential properties, components, and relationships of space, and to analyse the data collected with the investigation methods of military geography.[21] After data collection, the totality of military geographic factors is examined by security geography, which determines the security system of a given area and its surroundings.

[18] Dobák 2019: 87.

[19] Szendy, István (2017): A hadviselés, mint tudományelméleti és tudomány-rendszertani kategória. *Hadtudomány,* 27(3–4), 106.

[20] Szenes 2017: 97.

[21] Kállai, Attila (2019b): Geoinformációs támogatás. In Krajnc, Zoltán (ed.): *Hadtudományi lexikon. Új kötet.* Budapest: Dialóg Campus. 315.

Geospatial information of operational space

"However, the network-centric operation does not replace the professional (military) knowledge and preparedness of the commanders and soldiers. In other words, we can only provide the decision-makers with enough information to accurately see the situation, and nothing more."[22] The space thus recognised is the operational space, which, in contrast to 'traditional' battlefields, has no size limitations but rather technical ones. The operational space is, therefore, the cognitive space of the geographical space that decision-makers and managers have especially learnt about and processed to the extent necessary for a given activity. This operational space and military activity mutually affect and shape each other dynamically, since the operational space is where planned and ongoing military activities have an effect. Geospatial analysis is a tool for learning and processing them.

Mass data in geospatial analyses

According to Gartner[23] Big Data – in this paper I regard mass data the same in volume and nature – is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision-making and process automation.[24] This means capturing, processing, analysing, sharing and displaying unprecedented amounts of mass data from various sources.

The amount of data available exceeds the capabilities of commonly used data capture and processing software. According to the most common definition, three things characterise this kind of spatial mass data: quantity, speed and variety.[25] This means that there is a huge amount of data that is constantly and rapidly generated, and it is usually unstructured.[26]

Spatial mass data

I am studying the geospatial analysis system under development as part of my doctoral research. The analyses discussed in this article are derived from the results obtained from the system as well as from the improvements made in it. All geospatial data and specific sources of data collection had to be precisely determined before the development process with the help of the system plan. The database must be large enough to be able to draw appropriate conclusions and mass data from it, but no agreement has yet been reached

[22] Szternák, György (2008): Gondolatok a hatásalapú- és hálózatközpontú katonai műveletekről. *Hadtudományi Szemle,* 1(3), 1–7.

[23] Gartner is a global research and consulting firm that provides information, advice and tools in areas such as IT and communications.

[24] Gartner: Big data. [online], Gartner, 2021. Source: gartner.com [04.12.2022]

[25] Laney, Doug: *3D Data Management: Controlling Data Volume, Velocity and Variety*. [online], Meta Group, 2001. Source: studylib.net [20.11.2022].

[26] Szűts, Zoltán – Jinil, Yoo (2016): Big Data, az információs társadalom új paradigmája. *Információs Társadalom,* 16(1), 11.

on the definition of the term 'large'. Potentially, the entire Internet is a set of data that the developed system must analyse for the given crisis phenomena.

Spatial data in the traditional sense, such as vector and raster data, have also undergone tremendous development, encouraged by the development of data collection softwares. The time of data collection has been shortened and the amount of data surveyed at one time is increasing, largely due to new generation technologies.[27] However, only about a third of the data set created in this way is suitable or worth analysing, so most of the data we create and store is not useful in this sense.[28] The analysis of the data after its collection and the publication of the knowledge is not fast enough compared to the amount of data received, therefore pre-processing, data preparation, coordination of data and information from different sources are necessary.

One of the key elements in processing, in addition to relevance, is speed. Spatial mass data is always linked to a well-defined geographical location, furthermore, it can be originated from very different sources and in very different formats. This data needs to be cleaned, filtered, analysed and published in a very short time as expected.[29] The collection and characterisation of spatial data are not enough in themselves, the size, variety and update speed of location data sets exceed the capabilities of geospatial technologies.[30] We have reached the limit of the processing capacity in the possibility of quantitative data collection, it does not make sense to collect more data, or increase the processing volume, the pre-selection; targeted data collection needs to be improved.[31] The geoinformation analysis and evaluation system that we are developing during my doctoral research uses the latter method – targeted data collection became the key; it plays a particularly important role. A properly developed data collection method reduces the size of the currently used local database. If the types of data are systematised, the area is properly delineated and the risk factor is properly defined, the algorithm collects data in a targeted manner. It is not the processing time that is shortened in the first place but the time of data collection – of course, this shortens the whole process.

A huge data set is created when using networked devices that change rapidly, so its analysis shows only a momentary state. If the data set is large enough, it may be suitable for a level of knowledge of a given process that can be used to formulate relationships that have not been explored with good efficiency or to draw conclusions for the future.[32] The system to be developed does not work with a permanent data set but is continuously collecting data for the delimited, given area of interest, considering the variables we had defined. The data collection is essentially based on algorithms. The available database is often not a single database but a set of data that is continuously being produced from

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[27] Such technologies are Unmanned Aerial Vehicle (UAV) used for remote sensing, aerial surveying or orthophoto, the Remotely Piloted Aircraft (RPA) and laser-based remote sensing, LiDAR (Light Detection and Ranging).

[28] Gantz, John – Reinsel, David: The Digital Universe in 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East. [online], IDC, December 2012. Source: cs.princeton.edu [04.11.2022]

[29] Olasz, Angéla (2018): *Big Data és térbeliség.* PhD thesis. Budapest: Eötvös Loránd Tudományegyetem. 33.

[30] Shekhar et al. (2012): Spatial Big-Data Challenges Intersecting Mobility and Cloud Computing. *MobiDE'12: Proceedings of the Eleventh ACM International Workshop on Data Engineering for Wireless and Mobile Access,* May 2012, 1–6.

[31] Lee, Jae-Gil – Kang, Minseo (2015): Geospatial Big Data: Challenges and Opportunities. *Big Data Research,* 2(2), 78.

[32] Szűts–Jinil 2016: 9.

a variety of sources and formats, with the continuous, fast and comprehensive analysis of which results can be obtained.[33] The delimitation of the area can be done on an administrative basis – by designating country borders, regions and groups of countries – or by defining the specific security complexes in the case of cross-border natural and social phenomena, e.g. natural and/or social disasters, such as flooding or locust infestation and, as a most likely consequence of it, migration.

Risk factors to be examined

The risk factors to be examined are determined by Hungary's National Security Strategy.[34] The key security risks that may affect Hungary, closely related to security geography, are the following:

- illegal migration
- unexpected armed attack
- financial and economic destabilisation of Hungary through diplomatic, information and intelligence operations
- cyberattacks
- an act of terrorism in Hungary or against Hungarian interests abroad
- attempts to infringe national sovereignty by depriving national decision-making powers
- sustained population decline, ageing population
- international economic crisis
- disruption of energy imports
- the establishment of a 'failed state' in the immediate vicinity of our country or in our region
- revolutionary technological developments falling into unauthorised hands
- strengthening influence of criminal organisations
- an attack or terrorist act against Hungary or the surrounding countries with weapons of mass destruction (nuclear, radiological, biological or chemical)
- industrial accidents in Hungary or neighbouring countries
- epidemic causing mass illness
- the formation of higher floods and extensive inland waters
- permanent water shortages due to global warming

This is why it is necessary to ensure the most probable results from the huge mass of openly accessible data, and the above, often multifactorial risks, as soon as possible, since the commander's decision-making process has also been shortened. I call this result the Geospatial Crisis Index. It helps to decide which area needs to be analysed in further detail, and requires a geoinformation survey with the involvement of human resources, even with the involvement of experts from other related fields. However, the system does

[33] Szűts–Jinil 2016: 11.

[34] Government of Hungary: Government Resolution 1163/2020 (IV.21.) on Hungary's National Security Strategy. [online], Magyar Közlöny, 2020. Source: honvedelem.hu [12.11.2022].

not replace but precedes the detailed, human-intensive evaluation analysis. It helps with prioritisation, so work can be more focused and, therefore, more efficient.

Geospatial Crisis Index

As part of the geoinformation analysis system, a new index is being developed. Geospatial Crisis Index is a unitless numerical value issued by the geospatial assessment and analysis system used for the geospatial analysis of crisis areas. It is created by an algorithm-based methodology based on open source data related to military geographic factors. It is a benchmark allowing areas to be compared in terms of a fixed risk factor or factors to be ranked in a hierarchy by fixing the area. This helps shape the order of the analysis, speeds up the actual text and map evaluation, reduces the need for human resources, and supports commanders in decision-making. The algorithm-based methodology for determining the crisis index based on military geographical factors is also being developed.

The target group of users of the Geospatial Crisis Index is primarily the professional staff of the Hungarian Defence Forces dealing with geospatial information, but as a result, the entire national defence can enjoy the benefits of the innovation. At the command level, the expectation is a fast, clear, essential product, accordingly, the Geospatial Crisis Index together with other specific information and data, such as thematic maps or country descriptions, are useful tools for evaluation and decision-making.

Geospatial Analysis System – System plan

The system plan of the geospatial analysis system under development is as follows.

First, we have to develop a dataset based on the obtainable data. There is a Crawler that downloads information from web pages into a Local Database. That database is a structured set of relevant data, used for algorithm-based analyses. This activity is based on existing, downloaded web pages, and it develops itself as it searches for 'similar' web pages using machine learning algorithms.

The algorithm was developed through experience, the results of many years of human experience were incorporated into the formulas. Each type of crisis as factors of military geography were examined and analysed, and shaped the formula in such a way that it gives the same result as the parallel examination of specialists. Looking for new data on the separately set, fine-tuned variables, the result also changed and became more precise, in accordance with the original analysis direction. The program is able to search for new, previously unknown sources and, after human verification, include the data in the analysis.

The processing engine extracts important information for the system from downloaded web pages. For this, it uses Natural Language Processing (NLP). NLP is a pre-processing that involves preparing the original textual data for the software to be able to analyse it and an algorithm to work on. ElasticSearch is also part of the processing engine. It is a search and analytics engine that can be used to search for any kind of document. It acts

as a stable environment during the process of storing large amounts of data and content. In addition, this technology enables data retrieval and storage extremely quickly. The theory of the engine is based on data reliability investigation and testing new data.

The third element of the system is the Administration interface (User Interface – UI). Here, one can set the search parameters, such as search terms, value limits, events to watch, or territorial distribution. It is the interface where we can manage the source data; a new source that can be added manually (typically, for example, a new web address). Moreover, existing data can be modified or deleted; new, raw data can be uploaded; and we can rank the sources (e.g. in terms of reliability).

The risk factor (Geospatial Crisis Index) calculation module weights the processed data based on the parameters specified on the administration interface and calculates the risk factor of the given area or event.

At last, there is the display component. It demonstrates the parameters specified on the administration interface and the resulting risk factor in a way that is acceptable to users on a map or in a graph. There is an external data requester planned, that produces a geo database, in a form that can be processed by a third party, e.g. ArcGIS; the software used for GIS tasks in the Hungarian Defence Forces.

Results of the research

The results of my research so far are as follows.

- The investigation method of security geography is rooted in geography, it examines the military geography factors that influence the security system and environment of an area. Publications on it must be open materials in order to reach the target audience, so we use data from open sources to create them.
- After targeted acquisition and quality processing, i.e. selection, analysis and evaluation of a sufficient amount of the available spatial data, a new opportunity will present itself for the preparation of security geography analyses based on geoinformation professional foundations.
- Algorithms can be applied to the instant analysis of the ever-expanding, huge geoinformation data set regarded as mass data. This can be used in the commander's decision-making system, prioritised by it before decision-making.
- The procedure is suitable for analysing the security geography risk of an area, even for previously undiscovered connections, or for formulating conclusions regarding the future.

The geoinformation analysis system used for security geography analysis examined in my research is continuously collecting data for a delimited area of interest, depending on specified variables – geographical factors regarding the specified crisis phenomena. The targeted data collection is the key, which is based on algorithms. A set of data is continuously being produced from diverse sources and forms, and results can be obtained through continuous, rapid, comprehensive analysis.

Conclusion

The analysis method of security geography is rooted in geography, it examines the military geography factors affecting the security system and environment of the given area. This necessary territorial delimitation is the basis for the preparation of GIS analyses and evaluations examining the same factors. These publications need to be open source to reach their target audience, so we create open source data. The risk factors to be taken into account in security geography analyses can be created on the basis of the National Security Strategy, the delimitation of the operational space is the task of security geography specialists. After defining the area of interest and the crisis factor, we can perform the analysis and evaluation, as well as the Geospatial Crisis Index.

The amount of spatial data available for this purpose today provides a new opportunity for quality processing – selection, analysis and evaluation – during the preparation of security geography analyses based on geospatial information. Relying on the system created by the experts, the data on the given variables can be collected and used according to the purpose of the task. In view of the constantly expanding geospatial mass data set, the algorithms can be used for immediate analysis. This can be used in the command-decision system to determine priorities. The procedure is suitable for analysing the geospatial security risk of an area, either for formulating undiscovered correlations or for drawing conclusions about the future.

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