AUTHOR'S DESCRIPTION OF A THESIS (PhD)

NATIONAL
UNIVERSITY OF PUBLIC SERVICE
Doctoral Committee

ÖRS ANTAL

The theoretical and technical issues of effective protection in the period of prevention against the harmful effects of disasters caused by floods and earthquakes

author's description of a doctoral thesis (PhD) and

its official evaluations

Budapest

December 14, 2017

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DOCTORAL SCHOOL OF MILITARY ENGINEERING

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Doctoral thesis (PhD)

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Budapest, 2017

FORMULATION OF THE SCIENTIFIC PROBLEM

In ancient times and in the Middle Ages, the population of the Earth was exposed to natural disasters, as in these historical epochs, only the primitive forms of preventative activities were known. It was typical of people's lifestyles that they rather lived together with different disasters or migrated from vulnerable areas than making serious efforts to prevent them. Parallel with technological advances and industrialization, also the protection against disasters became more and more organized and effective. The accelerating growth of the population and the significant expansion of infrastructures and urbanization were taking place at an ever-increasing pace, coupled with a combination of increased risk and potential adverse impacts as well as increasing security challenges.

The devastating natural disasters meant and still mean enormous, in many cases, unbearable burdens on the economy of some countries, cities, communities and the population as well. Disasters, in addition to causing massive deaths over a very short period, can cause significant financial, ecological, and health problems. The elimination of damages and the restoration of the damaged areas may be a long process, lasting for several decades.

In recent years and decades, the global increase of the occurrence of disasters and global climate change further increased the degree of risk and, with this, the role and importance of preventative measures as well. To reduce the devastating effects of natural phenomena that threaten the lives of people and property innovational technical solutions and measures spread throughout the world to meet the technological development level of the 21st century. With regard to Hungary, it can be said that, in the fight against threatening factors, technological solutions and procedures proven in other parts of the world are receiving more and more attention, furthermore, Hungarian engineers and researchers are also engaged in upgrading these methods and measures and widening their utilization possibilities.

The lessons learnt from natural disasters at the present reveal that, despite the tremendous international efforts, high technological advances and scientific achievements, in the field of prevention of damages by natural disasters, significant deficiencies are still to be witnessed to date. The urbanization processes greatly contribute to this and play an increasingly dominant role in the functioning of societies. In place of the optimal use of advanced technologies, in many cases, the utilization of less effective methods against the challenges of today has been in practice, or in terms of the proportion of prevention/response, the balance tilts to the latter. We could write a long list of incidents occurred during the past decades, in the case of which a phenomenon triggering a disaster, or in relation to the effect and extent of the disaster, the extent of damage was disproportionately high. The cause of this

can be traced back to, primarily, the shortcomings in the response capabilities and technological processes. The absence of preventative measures or improvements, and occasionally the problems originating from unpreparedness, response forces also contributed to this. With regard to Hungary, in the recent past (fortunately), we cannot recall incidents demanding human lives in massive numbers, but at the same time, the tendency of the occurrence of threatening natural phenomena, the degree of risk and material damages raise the question, which are the technical systems and solutions, by the practical application or further upgrade in wider circles of which, one can take significant steps, in the long term, in the field of preventing certain natural disasters threatening Hungary, or significantly reducing their adverse effects.

RESEARCH HYPOTHESES

In the dissertation, I intend to justify the following hypotheses:

1.) ***I assume*** that, in view of their occurrence, the consequences and global trends of natural disasters like earthquakes and floods may be most destructive and damaging ones, affecting most people in the coming period and that these global trends are also significantly present in terms Hungary's vulnerability.

2.) With regard to tracked flood-relief prevention facilities, ***I assume*** that, with the help of a new technical solution based on the joint management of problems arising from ensuring water closure and ground backwater, facilities can eventually be operated more efficiently.

3.) ***I assume*** that, according to best practice abroad, subsurface emergency flood reservoirs can be adapted in a sustainable manner even in the case of major cities of Hungary - especially Budapest - to effectively reduce the risk of fast-onset floods.

4.) ***I assume*** that earthquake risk is underestimated in major cities of the country, especially in Budapest, therefore, the emergence of programs on conscious, preventative technological solutions and decision support systems is missing, through which, by increasing response capabilities, the reduction of risks can be more effective.

5.) ***I assume*** that the inhabitants of Hungary judge the level of their vulnerability by disasters generally low. They are only willing to sacrifice little efforts, on their own, to enhance protection; and disaster risk is not considered an important consideration when choosing a residential property. ***I furthermore assume*** that through the

introduction of state subsidies and programs, through the involvement of the population, possible damages, also in Hungary, can be significantly reduced.

RESEARCH OBJECTIVES

During my research I have set the following objectives:

1.) I ***analyse*** the disaster threat and future tendencies - primarily the risk of earthquake and flood damages - can be measured at global and national level in Hungary. On the basis of this, I draw conclusions by making statements about response activities. In the possession of these knowledge, I intend to research and propose scientifically justified methods and technical solutions for the mitigation of earthquake and flood risk, the protection of human life, and the prevention of damages.

2.) Based on the national strategic environment, directives and national regulations, I ***examine*** the tasks related to prevention and their criteria ***by comparative analysis.***

3.) Through the ***analysis*** of directives, concepts and policy strategies related to flood prevention, I draw conclusions for the role of preventive tasks, the necessary developments and enhancements, as well as the necessity of self-defence capability of the population.

4.) With the help of a questionnaire survey, I ***examine*** the level of preparation of the population, and their attitude and willingness regarding the application and introduction of preventive technical solutions.

5.) Through the examination of earthquake events occurred in Europe, I ***present*** the potential effects on different types of building constructions, and by means of this, I draw conclusions about the level of earthquake risk regarding Hungary. Furthermore, I intend to ***reveal*** those critical points, which require intervention in order to create the conditions for long-term safety.

6.) Exploring innovative technical solutions and the possibility of their adaption, I ***intend*** to promote the enhancement of technical innovation and the strengthening of international knowledge-based systems in accordance with the National Research, Development and Innovation Strategy.

RESEARCH METHODS

In my research, I put a high emphasis on presenting and analyzing each solution with a scientifically well-established technical approach. During my studies, I applied both quantitative and qualitative methods. Given the topic, my conclusions were mainly based on

analyzes, comparisons and inductive arguments through the following methods and procedures:

- Through international literature, professional forums and case studies, I have been monitoring and analyzing the recent disasters and emergencies worldwide, drawing conclusions from their experiences with the focus on prevention.
- I have prepared my own reports on the features and impacts of flood and earthquake catastrophes through a targeted analysis of the most relevant international databases and information systems related to disasters. The data collected from the databases and collections were filtered and sorted by different aspects, then conclusions were drawn from the correlation, significant deviation or extraordinarily high values of the numbers.
- In addition to the elaboration of written and digital domestic literature, and international publications – the latter serving as the main basis for my research – the most recent solutions and latest research results have also been examined through the foreign conference publications related to the technical prevention of disasters.
- During the analysis of flood water discharge facilities, I used digital modeling in order to study leakage conditions.
- Regarding the operation of certain technical alternatives, I have based my findings partly on existing design documentation and on-site surveys.
- I conducted a survey focusing on the disaster risk awareness of the population as well as the alternatives that motivate people to enhance their own security. The primary results collected from the survey were compared with the results of previous research and were directly linked to my conclusions and suggestions.
- I participated in domestic conferences and lectures on the issue of disaster prevention and applied these experiences during my research work.

CONCISE DESCRIPTION OF THE STUDY CARRIED OUT

Chapter I of the dissertation provides, on the one hand, a brief overview of the general classification of disasters and the categorization of threatening effects, on the other hand, it examines what significance practice has from the view of their grouping. In this chapter, by analyzing the relevant international databases, I investigate the occurrence and effects of certain disasters, based on which, at international level and in Hungary, I define and prioritize the threats of vulnerability due to natural disasters (in particular, floods and earthquakes) with regard to their triggers and influencing factors.

I also present the theoretical bases for the prevention of disasters and where the preventative activities may be placed in the system of international and Hungarian disaster management.

In ***Chapter II***, I examine the technical possibilities of reducing and preventing damages caused by floods, the problems related to individual systems or developments, and the factors influencing applicability. Taking into account international and Hungarian strategies affecting flood response and protection, I propose areas and technical development possibilities, through the implementation of which complex water management approach and the increase of the long-term effectiveness of prevention can be enforced, bearing in mind the enhancement of the efficiency to forecast them and the increase of the role of self-care and adaptation to the effects of climate change. As part of this, based on the drawbacks revealed, I present a deep-ground structural solution suggested based on my own concept, through which the effectiveness of tracked flood-relief facilities can be boosted, decisively determining the flood protection of Hungary. The chapter, with a conceptual approach, presents a long-term upgrade solution to address the increasing risk of urban floods and presents multipurpose application options.

Chapter III deals with the details of the geophysical background of the emergence of earthquakes, their expected impacts, as well as the features of earthquake-damage areas, with particular reference to the damage of buildings. Based on international practice and case studies, this chapter discusses the possibilities of real-time earthquake forecasting in Hungary and the modern technological solutions in the field of damage prevention and population protection to enhance the protection capabilities of buildings with the highest risk. In this chapter, I examine the programs and strategies that can be implemented through central coordination, whereby the most critical points of our cities can be cost-effectively reinforced to be protected against potential seismic damages, even by actively involving the population.

In the last ***Chapter IV*** of my dissertation, building on the results of a questionnaire survey, conducted among the Hungarian population, I survey the viewpoint of people, primarily by quantitative evaluation methodology and their perception of vulnerability by disasters and on the improvement of the protection capability of the dwellings. Based on this, I propose measures, based on the cooperation between the population and the state, and affecting mainly preparedness and facilitating the effectiveness of the prevention phase

SUMMARIZED CONCLUSIONS

By examining the occurrence, consequences and spatial distribution of natural disasters globally, **I have proved** that, besides tropical cyclones, earthquakes and floods, inter

alia, may be made responsible mainly for the emergence of incidents of natural origin. Based on the geographic and climatic conditions related to the area of the Carpathian Basin and Hungary, **I have** also **examined** the risks and the vulnerabilities associated with the occurrence of floods and earthquakes, during which I have concluded that **no** clear increase in the tendency of seismic activities **can be detected**, however, based on risks examined, the probability of occurrence and the expected damages are certainly significant. In the context of the flooding of our rivers, analyzing meteorological and hydrographical data in the river basins in Hungary, **I have not found a direct correlation** between the evolving trends of flooding and the climatic processes, while, at the same time, the increase of the flood risk and the flood levels **are clearly detectable**, based on these data. In addition to river floods, there is an increasing risk of local, fast-onset (flash floods and urban) floods as well, which, in contrast to the above, are closely associated with the more frequent occurrence of extreme meteorological phenomena. Nevertheless, considering the strategic environment in Hungary and the nature of water damage vulnerability, I have presented innovative flood-relief technical options, based on local prevention, through which long-term flood protection efforts can be made more efficient and cost-effective.

With the help of SWOT analysis, widely used in Hungary in connection with flood-relief facilities, based on disadvantages, negative impacts and development opportunities, **I have explored and demonstrated** a deep-ground engineering structural solution, resulting from my own idea, providing water-closure functions in a special way, which can greatly facilitate the efficient use of tracked flood-relief facilities without adverse consequences, with special regard to mobile structural systems or parapet walls, affecting built-in areas. In addition, **I have shown** reservoir facilities built subsurface, based on the temporary storage of rainwater, which may be an adequate response, in the long run, to risks against urban floods**. I put forward** specific **suggestions** on the possibilities of a multipurpose function, and I have prepared a description assisting decision-making to select them.

With respect to earthquakes, based on international examples, **I have made suggestions** for the possibilities of the implementation of a ***real-time earthquake forecasting system*** in Budapest based on the availability and application of state-of-the-art information and telecommunication systems. By implementing this, Budapest and other larger cities of Hungary a system could be created, based on which, the time advantage originating in the perception of the initial symptoms of earthquakes, through alarm and communication channels, provides the possibility, adequately controlled and through methods, for the

population and response forces to take precautionary measures, and execute emergency protocols on time.

Analyzing earthquake vulnerability and risk involving Hungary, I have examined the critical points and the typical forms of structural damages to buildings. Analyzing international examples and examining the effectiveness of technological options aimed at each reinforcement, in my dissertation, I have searched for and **proposed** technical options to reduce the susceptibility of unreinforced masonry buildings against seismic effects.

Following the analysis of some technical intervention options, in my research, **I have made a proposal** for the creation of a digital GIS resource, through which the extent of risks can be measured on a spatial basis as well as identifying the priorities related to the necessary interventions. In detail, I have set out the objectives of the map imagery, its potential applications and aspects. Nevertheless, based on the analogy with projects and aspirations as a thriving sample program in the United States, **I have made a proposal** for the announcement of a program centrally managed, through which interventions meant to reinforce could be effectively carried out with the active participation of the population.

Given that concepts and preventative technical solutions, presented and suggested in the dissertation, require the active participation or inputs of the population, therefore, within a questionnaire survey, **I have measured** the ***attitudes and willingness*** of Hungary's population towards prevention measures as well as the target areas of incentive programs.

NEW SCIENTIFIC ACHIEVEMENTS

1.) Based on international data, by using statements ***I have proved*** that the tendencies of the occurrence and effects of natural disasters show significant correspondence regarding Hungary, since with respect to floods and earthquakes, growing risk shall be counted in Hungary, too.

2.) Regarding the application of linear flood relief establishments in built-up areas, ***I have introduced*** an underground technical structure by which both the impermeable function and the prevention of back thrusting of groundwater flow can be achieved at the same time.

3.) Regarding Hungary, ***I first introduced*** underground flood water storage solutions in a comprehensive manner for the prevention and mitigation of urban floods. These establishments provide sustainable solutions as part of the integrated urban water management, even in the Hungarian cities.

4.) ***I have made proposal*** for those measures and technical solutions that contribute to the enhancement of seismic resilience of the buildings in Hungary, too. Furthermore, ***I have proposed*** the creation of a decision support system based on digital GIS resource through which the effectiveness of the preventive interventions for seismic risk mitigation, and the level of earthquake safety can be considerably increased.

5.) ***I have determined*** the attitudes and willingness of contribution of the Hungarian population for the enhancement of the level of safety of building constructions, and ***I have made proposals*** for the implementation of concepts, programs and devices for the enhancement of self-defence capability of the population.

RECOMMENDATIONS

I recommend to use the analysis and research results revealed in the dissertation for the following aspects:

- for the elaboration of new concepts, sectoral strategies, which aim to prevent and to avoid natural disasters and harmful events, furthermore, for strengthening the existing legislative and policy framework,
- for the promotion of the basic principles and methodology for the selection and improvement of modern assets can be used for prevention or preparation purposes,
- for the integration of technical solutions, which had been proved to be effective at international level, into the Hungarian practice, and their adaption to the local conditions and circumstances in Hungary,
- for the examination of the standardization with regards to the technical solutions discussed in the dissertation, as well as the review and harmonization of legal definitions (e. g. flash floods, urban floods or mobile flood protection walls),
- for the promotion of the preparation of population and systematic approach of preventing disasters, furthermore, for the effective implementation of informing public through modern and innovative communication systems,
- for the determination of the terminology and priorities of programs aiming the protection of public and the active participation of the population.
- for designing technical solutions and laying the foundations for the prevention of natural disasters, and for the promotion of investments and projects that contribute to these goals, and
- for strengthening and improving the international scientific relations, the domestic research results and knowledge transfer.

PRACTICAL APPLICATION OF THE RESEARCH RESULTS

I recommend to use the dissertation and my research results primarily in the following fields:

- it promotes the strengthening of the role of innovation-oriented, resilient approach both in the domestic institutional system of defence management, and in legislation, too,
- it promotes and facilitates the work of professionals and decision makers occupied in defence sector,
- it may serve as a relevant and valuable basis for the education and training of students participating in specialised higher education and post-secondary studies, as well as for educational courses, vocational trainings and educational resources for defence specialists, and
- it promotes the determination and implementation of operative measures for public preparedness.

LIST OF PUBLICATIONS OF THE AUTHOR RELATED TO THE TOPIC

Publications in authoritative magazine

1.) Örs ANTAL: **The harmful effects of earthquake disasters and the experiences of the response regarding the Sichuan, L'Aquila and Haiti earthquakes**. Műszaki Katonai Közlöny, Vol. XXI., Issue 1-4. (2011) ISSN 1219-4166, pp. 267-288.

2.) Örs ANTAL: **The „animal factor" in forecasting of natural disasters**. Hadmérnök, Vol. VII., Issue 1. (2012) ISSN 1788-1919, pp. 67-77.

3.) Örs ANTAL: **Modern possibilities of earthquake resistant construction of buildings**. Hadmérnök, Vol. VIII., Issue 1. (2013) ISSN 1788-1919, pp. 305-318.

4.) Örs ANTAL: **Modern methods of protecting building constructions against improvised explosive devices**. Műszaki Katonai Közlöny, Vol. XXIV., Issue 1. (2014) ISSN 2063-4986, pp. 107-119.

5.) Örs ANTAL, Árpád MUHORAY: **The applied methods for search and rescue tasks related to structural building collisions caused by earthquakes.** Műszaki Katonai Közlöny, Vol. XXIV., Issue 1. (2014) ISSN 2063-4986, pp. 44-59.

6.) Örs ANTAL: **The assessment of the preparedness of the subway network of Budapest against chemical terror attack in the light of 1995 Tokyo attack.** Hadmérnök, Vol. IX. Issue 2. (2014) pp. 193-210.

7.) Örs ANTAL, Róbert RÉVAI: **The role of health system in the prevention of disasters.** Bolyai Szemle, Volume XXIII. Issue 1. (2014) pp. 60-69.

8.) Örs ANTAL: **Flood hazard in Hungary in the light of influencing tendencies.** Bolyai Szemle, Volume XXIV., Issue 1. (2015) pp. 55-69.

9.) Örs ANTAL, Júlia HORNYACSEK: **The role of facilities of flood relief in the prevention of flood damages.** Hadtudomány, Vol. XXV., digital issue (2015) ISSN 1588-0605, pp. 249-268.

Publications in foreign language

10.) Örs ANTAL, Júlia HORNYACSEK: **(Specialized) Technical and medical reconnaissance of disaster-affected areas.** Academic and Applied Research in Public Management Science, Volume 13, Issue 1. (2014) ISSN 1588-8789, pp. 167-182.

11.) Örs ANTAL: **The protection system of Paks Nuclear Power Plant and international best practices in light of the 2011 Fukushima Daiichi nuclear disaster.** Economics and Management, University of Defence in Brno, Vol. 2015/2. ISSN 1802-3975, pp. 6-18.

12.) Örs ANTAL: **The role of the Government in the field of public protection in the prevention of earthquake disasters**. Academic and Applied Research in Public Management Science, Vol. 16, Issue 2. (2017) ISSN 2498-5392, pp. 67-82.

13.) Örs ANTAL: **Green Infrastructure solutions for flood prevention – innovative investment opportunities.** Bolyai Szemle, Issue 1. (2018)

Papers in conference publication

14.) Örs ANTAL: **Earthquake hazards of Hungary and population protection tasks in case of an earthquake**. „Students in the serve of science", scientific conference on disaster management, Műszaki Katonai Közlöny, Vol. XXI. special issue (2011) ISSN 1219-4166, pp. 152-171.

15.) Örs ANTAL: **Preparing for earthquake: San Francisco**. Scientific forum for students learning defence administration, Műszaki Katonai Közlöny, Vol. XXIII. special issue (2013) pp. 61-79.

16.) Örs ANTAL: **The harmful effects on the environment of the application of mobile flood protection wall systems, the technical possibilities of prevention and mitigation,** XI. Conference on environmental science in the Carpathian Basin

conference publication, Szentágothai János Szakkolégium (2015) ISBN: 978-963-642-873-0, pp. 3-16.

17.) Örs ANTAL: **Seismic hazard in Hungary in the light of earthquake occurrences and tendencies**. Társadalom és Honvédelem, Vol. XIX. Issue 2015/2. ISSN 1417-7293, pp. 83-95.

18.) Örs ANTAL: **The prevention of flash floods and urban floods by using underground water storage reservoirs.** XXXV. Roving Conference of Hungarian Hydrological Society, conference publication, ISBN 978-963-8172-36-5

AUTHOR'S PROFESSIONAL AND SCIENTIFIC CURRICULUM VITAE

Name: Örs Antal

Place and date of birth: Kolozsvár, December 20, 1985

Professional career

After graduating from bilingual secondary school (English-Hungarian), I started my higher education studies in the Donát Bánki Faculty of Mechanical and Safety Engineering of the Óbuda University. Participating in the course of military and safety technics, I had the possibility to research and acquire skills on the basis of disaster management and civil protection besides the traditional technical subjects. Following a successful final examination, I continued my studies in the course of defence administration in the University of Public Service. Specializing in the field of disaster management, I managed to acquire theoretical and practical experiences related to the task system of the prevention of natural and industrial disasters, and designing, organizing and managing technical tasks of safety issues. During my studies, I managed to gain considerable theoretical knowledge in the field of disaster management, which laid the foundation for my specific, technical-oriented research work in the doctoral school.

I started my professional carrier in the Ministry of National Development, where I had been working on EU financed programs and projects related to water management for years. Meanwhile, as a project leader in the General Directorate of Water Management, I participated in the preparation and implementation of numerous flood control projects, whereby I gained wide ranging knowledge in the field of water management sector and flood prevention. During my work, inter alia, I acquired practical experience in the flood defence works during the extreme flooding on the river Danube, 2013, furthermore, within the

framework of a field work I gained a better understanding of the operation of flood control facilities along the river Tisza.

Scientific activities

I have already begun my research work during my University studies primarily with regards to disaster risk originating from global terrorism and natural phenomena. Besides the ongoing publishing activity, I was a frequent participant in scientific conferences in Hungary, of which I performed 10 times as a presenter focusing on the prevention of flood and earthquake disasters. Furthermore, I continuously participated also in the scientific and professional events of the Hungarian Hydrological Society. Within the framework of Concha Győző Doctoral Programme (KÖFOP-2.1.2.-VEKOP-15-2016-00001), I managed to participate in the International Conference on Disaster Management and Human Health, organized by the Wirth Institute.

Language skills

English - superlative „Type C" language exam

Spanish - intermediate „Type C" language exam

Foreign experiences

Hungarian Public Administration Internship Program - Instituto Nacional de Administración Pública, National Institute of Public Administration, Madrid, Spain (2 months)

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Örs Antal