UNIVERSITY OF NOVI SAD, FACULTY OF TECHNICAL SCIENCES
DEPARTMENT OF CIVIL ENGINEERING AND GEODESY
Novi Sad, Serbia

HIGHER EDUCATION TECHNICAL SCHOOL OF PROFESSIONAL STUDIES
Novi Sad, Serbia

EUROPEAN YOUTH PARLIAMENT
Belgrade, Serbia

SERBIAN NATIONAL FIRE PROTECTION ASSOCIATION
Belgrade, Serbia

BOOK OF PROCEEDINGS

1st INTERNATIONAL SYMPOSIUM
K-FORCE 2017
Knowledge **FO**r **R**esilient so**C**i**E**ty

Novi Sad, September 14, 2017

Publisher:

HIGHER EDUCATION TECHNICAL SCHOOL OF PROFESSIONAL STUDIES
21000 Novi Sad, Školska 1, Serbia

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Circulation:

80

Novi Sad, 2017

PREFACE

University of Novi Sad, Faculty of Technical Sciences from Novi Sad, in cooperation with Higher Education Technical School of Professional Studies in Novi Sad, National Fire Protection Association and European Youth Parliament, organizes first international symposium Knowledge For Resilient soCiEty - K-FORCE 2017, within Erasmus + K-FORCE project.

Climate change, fast urbanization and new technologies, in interaction with irresponsible human activities, cause the need for multidisciplinary and interdisciplinary engineering competencies, knowledge and skills. Considering these, available higher education is insufficient and unsustainable at regional level without modernizing and further development.

Numerous human causalities, significant material damages and negative environmental impact of natural and manmade disasters and fires in the Balkans are the warning calling for change of approach to these issues.

Resilient societies are based on knowledge and training, as well as preparedness. Building synchronized regional capacities in higher education in Disaster Risk Management and Fire Safety Engineering, according to regional needs and contemporary trends, is a first trend towards building resiliency of our region.

The symposium will be dedicated to current issues in education, profession, science and practice in the field of Disaster Risk Management and Fire Safety Engineering.

Editors

ORGANIZERS OF THE SYMPOSIUM

The Faculty of Technical Sciences in Novi Sad is an institution of higher education and scientific research founded in 1960. Faculty consists of 13 Departments implementing 88 study programs at the undergraduate and postgraduate level. The Department of Civil Engineering and Geodesy offers a comprehensive study programs in the field of civil engineering, geodesy and disaster and fire risk management: Disaster management and Fire Safety B.Sc. Honours and M.Sc. Qualification levels.

HIGHER EDUCATION TECHNICAL SCHOOL OF PROFESSIONAL STUDIES IN NOVI SAD

The Higher Education Technical School of Professional Studies in Novi Sad, Serbia is founded in 1959. It educates engineers at 4 Department in 20 accredited study programs of professional bachelor and specialist studies. In the Department of Protection Engineering the following areas are studied: Fire Protection, Occupational Health and Safety, Environmental Protection and Civil Protection & Emergency Rescue.

EUROPEAN YOUTH PARLIAMENT
PARLEMENT EUROPÉEN DES JEUNES

EYP is a youth non-governmental, non-partisan organization that exists in 40 European countries. EYP simulates decision making process of European Parliament and is established as a non-formal educational programme with the aim of providing the young with a possibility for education, exchange of opinions and in order to encourage them to take an active role in their societies. EYP SERBIA was established in 2006.

НУЗОПРС
SERBIAN NATIONAL FIRE PROTECTION ASSOCIATION

NUZOP RS is the unique professionals' association of active working experts. It is a regionally oriented organization and represents a wide platform for gathering of experts dealing with emergencies situations and fire safety. Programs and initiatives are designed to assist institutions and national fire authorities in creating fire safety system, as well as fire, security and safety, and other relevant professionals to achieve and maintain the very highest standards of fire safety management.

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FIRE PERFORMANCE OF FACADES IN HIGH-RISE BUILDINGS

Abstract: The need for sustainable buildings has given the construction engineer the requirements for understanding several different fields, like energy efficiency and fire engineering. However, it should be noted that the same concept and the design elements that are being used for sustainability requirements are often in conflict with the requirements for safety regulations. This especially applies to fire safety in high-rise buildings, where there is a high risk of fire spread across its façade made of combustible materials. In this paper problem related to the fire spread across facades in high-rise buildings is presented. The example of testing of three different types of ETICS system, as most used façade system in Croatia, regarding their behaviour in fire tested per the British standard BS 8414-1:2002 will be also described.

Key words: facade, fire performance, high-rise buildings, test methods

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1. INTRODUCTION

When talking about a high-rise or tall building façade then one must certainly bear in mind that there are plenty of definition for this word and different interpretation of purpose, role and characteristics of high-rise building facade. The most used definition for high rise building is that "*A 'tall building' is a multi-story structure in which most occupants depend on elevators [lifts] to reach their destinations*. Another often used definition from [1] is "*Generally, a high-rise structure is one that extends higher than the maximum reach of available fire-fighting equipment. In absolute numbers, this has been set variously between 23 meters and 30 meters," or about seven to ten stories (depending on the slab-to-slab distance between floors*). The most prominent tall buildings are called 'high-rise buildings' in most countries and 'tower blocks' in Britain and some European countries [1].

The facade is considered the building envelope remains one of the most important exterior elements for building functionality. In short, facade is the skin, or exterior sides of a building [2]. High performance facade design is an engineering science. While the façade is an elegant component that helps to define the unique architectural aesthetics of the building, it also has the critical role related to energy performance, interior function of a building and fire safety. It means that properly designed façade can help reduce the building's energy consumption and improving natural lighting and offering better airflow makes a façade-clad building both functional and modern. A well-designed façade for a sustainable building will bring energy costs down considerably, and add to the lifespan of the building. Sustainability is clearly a key issue in today's buildings with many different products being used in ways and combinations that will hopefully bring about a lower environmental impact in the future. Structural engineers can bring crucial knowledge to the architect's drafting table, including how building movement and deflection will impact the building envelope. Also, e.g. through shaping we could reduce the frame as well as facade loads, resulting in significant cost savings. Along with all the properties, events, big fire that happened in the last decade teach us, one of the most important properties for façades in high-rice buildings is the fire behaviour. Facade fires being a disastrous hazard for high rise building, as several historical and recent incidents have shown, have attracted the interests of numerous fire scientists, engineers and regulators.

This paper focuses on the problem related to the fire spread across facades in high-rise buildings. Furthermore, testing of three different types of ETICS system, as the most used energy-efficient facade system in Croatia, regarding their behaviour in fire per the BS 8414-1 standard conducted in Zagreb will be also described.

2. FACADE THERMAL INSULATION SYSTEM

Insulating buildings from the surrounding environment is an excellent way to become more energy-efficient. There are many types of components and materials for use for increased energy efficiency in buildings and it is the designers who must negotiate and incorporate the appropriate solutions put forward by the various interested parties. Although all the groups having input will agree that energy efficiency is important, there are sometimes conflicts of interest that may arise due to specific functions the facility should meet.

Generally thermal insulation technologies can be classified into four main categories namely bulk, reflective, vacuum and nanotechnology as shown in Fig.1 [3].

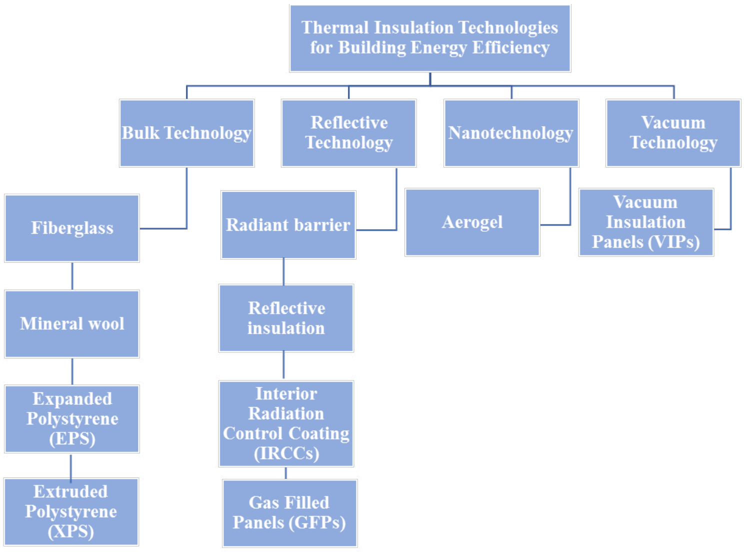

Fig.1. Classification of thermal insulation technologies for building energy efficiency [3]

One of the most commonly used ways of achieving and meeting the conditions of energy saving and building thermal protection is the use of bulk technology e.g. composite systems like external thermal insulation system (ETICS) and metal composite system e.g. aluminium composite panel (ACP).

Only in Central Europe are installed approximately 120-130 million m^2 of ETICS system annually, accounting for about 75% of the total ETICS system installation at European level. Of this amount of installed ETICS system annually, approximately 85% is performed with a layer of thermal insulation, specifically expanded polystyrene or EPS [4].

The ETICS significantly reduces the passage of heat through the outer shell and thus helps to reduce heating and cooling costs by 50% and more. It greatly improves the comfort of living - both in hot and cold climatic conditions but the widespread use of flammable thermal insulation materials in ETICS without adequate fire and barrier protection may contribute to uncontrolled fire spreading in high-rise buildings.

Despite the good thermal protection of the building, there exists the gap in engineering knowledge between thermal properties and behaviour in fire. A possible problem could be the behaviour of the façade composite system in the fire. There is a risk in fire conditions that composite panels are attacked at the joints, or the panels suddenly delaminate and the plaster or metal facing falls away, thus exposing the combustible core which then intensifies and spreads the fire. The sudden increase in fire severity can accelerate the failure of the adjacent panels, so that if a fire does take hold, it can race up across an entire facade of a building, causing a major hazard to occupants and a major property loss. Foam cores exposed through damage, fixings or penetrations will ignite sooner than intact panels. Aluminium has a much lower melting temperature than steel and aluminium facings will fail earlier.

The requirements for construction products used in high-rise buildings are different from country to country, but a summary overview for construction product requirements for some EU countries is given in the Table 1 [5].

Table 1. The requirements for construction products used in high-rise buildings [5]

Country	Requirement
Germany	A2-s1, d0
Sweden	A2-s1, d0 or system tested to [13]
Italy	B-s3, d0
Spain	B-s3, d0
The Nederland	NR (no requirements)
England	A2-s1, d0 or system tested to BS 8414-1 [11]
Czech Republic	A2-s1, d0
Slovakia	A2-s3, d2
Greece	NR (no requirements)
Serbia	A2-s1, d0
Finland	B-s1, d0
France	A2-s3, d0
Belgium	NR (no requirements)
Poland	A2-s3, d0
Denmark	A2-s1, d0
Hungary	A2-s1, d0
Croatia	*Non-combustible material (A1 or A2)*

The potential mistakes of the facade thermal insulation technologies and fire behaviour could be done at different building project stages from design, approval, procurement, construction to handover. At design stage designer, unaware or not understanding requirements, or designer asking for fire testing but not asking for the correct fire test or fire engineer not specifying façade requirements. At the approvals process it could happen that designer does not understand requirements and authority unaware of materials proposed or not understanding requirements. Procurement as the process of finding, agreeing terms and acquiring goods from an external source could have incorrect specification, engineer and contractor enforcing the specification do not understand it, supplier knowingly supplied product which does not meet the requirements, the actual material shipped to site may not match with paperwork and product supplied could not be in line with specification.

At the end of project stages in handover fazes it could happen that the handover authority unaware of material proposed or did not understand requirements. The most common mistake during construction is to change the project details and/or material. There are some examples in Croatia of changing the good project into bad construction which met the authors of these paper during the works as project reviewers.

3. CASE STUDIES OF FIRES WHOSE SPREAD IS RELETED TO THE TYPE OF FACADE

There have been many documented fire incidents but the most cited and mentioned case of fire on a high-rise building today is certainly at the 24-storey block in North Kensington, London in the early hours of Wednesday, 14 June 2017., Fig.4 [6].

Fig 2. Fire in Grenfell Tower, a west London residential tower block in June 2017 [6]

More than 200 firefighters and 40 fire engines were involved in battling the blaze. If system materials do not have a satisfactory reaction to the fire classification, they significantly increase the risk of vertical fire spreading across the building's facade. Review of fire incidents around the world indicates that although facade fires are low frequency events, the resulting consequences in terms of extent of fire spread and property loss can be potentially very high.

Table 2. USA High-Rise Fires by Occupancy 2009-2013 [8]

Occupancy	Fires	Civilian Deaths	Civilian Injuries	Direct Property Damage (in Millions)
Apartment or other multi-family housing	8970 (62 %)	26 (64 %)	387 (75 %)	$39 (25 %)
Hotel	540 (4 %)	0 (0 %)	11 (2 %)	$7 (4 %)
Dormitory	510 (4 %)	0 (0 %)	7 (1 %)	$1 (0 %)
Office buildings	290 (2 %)	0 (0 %)	6 (1 %)	$6 (4 %)
Care of the sick	260 (2 %)	0 (0 %)	7 (1 %)	$2 (1 %)
Subtotal	10570 (73 %)	27 (65 %)	418 (81 %)	$54 (25 %)
All other occupancies	3970 (27 %)	14 (35 %)	100 (19 %)	$100 (65 %)
Total	14540 (100 %)	41 (100 %)	518 (100 %)	$154 (100 %)

This has particularly been the case for incidents in countries with poor (or no) regulatory controls on combustible facade or where construction has not been accordance with regulatory controls. Combustible façade systems may present an increased fire hazard not only in building use but also during installation and construction prior to complete finishing and protection of the systems [7] Clearly every mistake represents an even risk to the building and different building risks present different costs to many different parties. From [8] in the USA 14.500,00 structure fires per year happens in high-rise buildings in 5-year period (2009-2013). These fires caused an annual average of: 40 civilian fire deaths, 520 civilian fire injuries and $154 million in direct property damage, Table 2, [8].

4. FULL-SCALE FAÇADE FIRE TEST METHODS

A recent series of fatal fire events and several documented fire incidents involving combustible facade systems, some presented in the previous chapter, indicate that a better understanding was needed of the specific scenarios leading to these incidents to analyse and improve the current test methods and potential mitigating strategies. There are many test methods used worldwide to evaluate fire safety of facades. An overview of available façade fire test methods implemented in fire safety codes in different countries was presented during the 1st and 2nd Conference of Fire Safety of Facades in 2013 and 2016 [9] in which the main parameters and principles of each test method are given. Nevertheless, in most countries, including Croatia, behaviour on façade system (including ETICS and ventilated façade systems) is assessed by reaction to fire tests and classified accordingly.

Thus, encouraged by the issue of fire spread across facades which has become more evident due to the massive inadequate energy renovation of buildings in EU, including Croatia, the Faculty of Civil Engineering, the University of Zagreb, the European association Fire Safe Europe (FSE) and Croatian fire protection associations (HUZOP) held a scientific-professional international seminar called "Facades in Fire" in 2014 [4, 10]. During seminar, the organisers conducted a public testing of behaviour of façades, with the aim to show that facades can considerably influence the fire spread and that the reaction to fire testing applied on façade systems is inadequate. In other words, with the aim to express the necessity to conduct a large-scale testing of façade behaviour. Testing was conducted in the laboratory for thermal measures (LTM) in Stubička Slatina. Apart from LTM, two other scientific partners conducted measurements: SP (Technical Research Institute of Sweden) and ZAG (Construction Institute, Slovenia). Testing was conducted according to the British standard BS 8414-1:2002 [11] simultaneously on three test samples with compositions and reaction to fire classification according to Table 3.

Table 3. Description of test specimens

Sample label	Thermal insulation material and its thickness	Plaster type	Fixing method for thermal insulation	Reaction to fire classification
Sample 1	Expanded polystyrene (EPS) – 150 mm	Mortar reinforced with glass mesh and finishing organic (acrylic) plaster – 5 mm	Glued and mechanically fixed	B-s2, d0 (barrier A2 -s1, d0)
Sample 2	Expanded polystyrene (EPS) – 150 mm + fire barrier 150 mm thick and 200 mm directly above the combustion chamber			B-s2, d0
Sample 3	Stone mineral wool – 150 mm			A2-s1, d0

Photography of the samples/ Time from the start of fire	Observations
Sample 1 Sample 2 Sample 3 	The photo shows the very beginning of the test (00:30) when the combustion chamber, simulating a fire in an apartment, ware ignited.
 **15 minutes after the start of fire**	Sample 1 is completely caught by fire and a large amount of toxic smoke and gases is emitted. Flaming droplets of burning insulation fall on the floor and increase the area affected by fire. At this point, there is no significant difference between the behaviour of Sample 2 and Sample 1.
 **19 minutes after the start of fire**	Sample 1 is still emitting a large amount of toxic smoke and gases. On Sample 2 the fire has skipped the horizontal fire barrier above the window and caught the combustible insulation (EPS) which is indicated by the black smoke on the top of the wall. On Sample 3 the insulation has not caught fire
 **28 minutes after the start of fire**	Sample 1 has burnt out, the fire in the furnace is still burning. The metal frame with sensors has prevented the falling of the finishing decorative layer. On Sample 2 the fire has completely caught the combustible insulation. On Sample 2 the situation is unchanged.
 **40 minutes after the start of fire**	Sample 2 is still burning and emitting toxic smoke, although the fire is not visible. The horizontal fire barrier above the window has delayed the fire spread for 10 minutes, but also extended the time of burning of the insulation and emission of toxic gases. The fire in the furnace of Sample 3 was extinguished by itself. Unlike Sample 1 and Sample 2, the façade on Sample 3 has not been structurally destroyed.

Fig. 3 The course of behaviour during testing of different façade systems

The time sequence of behaviour of each façade sample during testing is shown in Figure 3. The main conclusion of testing is that non-combustible fire barriers (made of stone mineral wool) can applied at Sample 2, even at a relatively small height of only 20 cm above the combustion chamber, considerably slow down the fire spread and the vertical temperature increase across the façade.

Further, according to SBI (single burning item) testing, ETICS systems with EPS and fire barriers have a fire reaction class B-s2, d0, (see Table 3) which means the absence of flaming droplets. During tests, occurrence of flaming droplets was obvious. This fact confirms the previously mentioned statement that SBI testing (namely, testing according to the reaction to fire properties) is not suitable for systems which will, when applied, be considerably higher compared to the ones required by SBI testing, which is the category facades definitely belong to.

Due to the difference in testing methods thereof, e.g. in sample size, parameters being observed and test result assessment, it has been necessary to harmonise European standards related to testing facades in fire. The project of assessing such a standard is under conduction under the title *Development of a European approach to assess the fire performance of facades*, whereby the new standard will be based on two existing standards BS 8414-1:2002 [11] and DIN 4102-20:2016 [12]. A new standard and assessment criteria will definitely contribute to the more realistic assessment of façade behaviour in fire regarding the existing reaction to fire classification.

5. CONCLUSION

Fires are the same everywhere in the world, but fire protection regulations vary widely across the globe. The goal should be to cooperate with decision-makers and regulations to ensure drastic improvement of fire protection rules across the EU.

Testing of ETICS with different thermal insulation layers, presented in this paper, proved that testing in accordance to reaction to fire properties (as used in most European countries) is not reliable for facades, especially used in high-rise buildings. Further conclusion of this testing is that engineers trained in the field of fire protection must be involved in teams designing new and/or renewing existing buildings in terms of energy efficiency.

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Miloš KNEŽEVIĆ

DISASTERS AND CIVILIZATION ARE INSEPARABLE

Abstract: With disasters, the human race has met in the past, they are shaking us now, but neither in the future we do not expect their end. We must live with disasters and try to reduce their influence on people and property, especially the disasters that we produce ourselves or that are strengthened with our activity. The paper attempted to point out the scale of the world's greatest disasters and the consequences that we have today. Of course, due to the large number of disasters, only some of them are mentioned here. They warn us that we need to make decisions how to proceed in different areas human activities, an attempt is made to make recommendations for constructions in the future.

Key words: disasters, earthquakes, floods, CO2, demography, hunger, construction

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1. INTRODUCTION

The focus of this paper is on disasters created by human activity. They are an inseparable part of civilization. We can ask for a much better response to such disasters than natural catastrophes. Natural disasters are more durable than the humanoids themselves, because they still exist from the emergence of the planet. Natural disasters transcend the temporal boundaries of human life, because our lives are much shorter than geological events on the planet. However, natural disasters and those created by human activity affect the planet, lives, human health, property, cultural and historical monuments, the environment... Always the hardest hit is to the developing countries where the acceptable risk of response to catastrophic hazards is very low due to poor material situations and low capacities of these countries. Moreover, if these countries are populous countries and also poorly developed countries, the consequences of natural and man-made hazards are even more dramatic.

Today it is very difficult to make a division into the natural and human activity disasters. According to many studies, the global change in climate-meteorological conditions, after the industrial revolution, began to inject the "fresh poison" of CO2 into the atmosphere of the planet. For this reason, I will mention only earthquakes and floods here from natural disasters, although I cannot positively answer the question: Are floods of the recent date one of the natural disasters or are they caused by the change of climate factors due to human activity? Often it is claimed that the consequences of global warming have been frequent, and large amounts of precipitation are caused by additional landslides ... Do we disturb our nature further and when do we do it?

Disasters are on the rise, natural hazards are inevitable, the elimination of all risks is impossible and there is a need to introduce measures to reduce the economic and social scope of disasters. According to the document, Disaster Risk Reduction Framework (1) states: "... during the ten-year period, disasters continued to take huge tax and affect people's well-being and security. Over 700 000 people lost their lives, 1.4 Million of people have been injured, and about 23 million have been left homeless after disasters. "

2. NATURAL DISASTERS

This cosmic moment, which we live in the evolutionary state of the planet Earth, represents for us everything we have, and for the planet, it is only a part of the evolution in continuous development and permanent changes. The geological hazards are those that, as natural hazards, most often do not leave us as tectonics, engineering-hazards, hydrogeological and geomorphologic factors.

The occurrence of natural phenomena causing disasters is most often associated with severe earthquakes, floods, volcanoes, extreme weather conditions that have not been caused by man, landslides, etc. I'll only mention some ...

Earthquakes

Among the strongest recorded earthquakes in human civilization are:

- 1556. Shaanxi China, 8 ° Richter, 850. 000 victims
- 1976. Tangshan, China, 8.2 ° Richter, 250. 000 victims
- 2004 Tsunami in the Indian Ocean Sumatra - The Andaman tsunami waves up to 15 meters that hit the shores of 11 countries, 227,898 victims

On the European soil, they were recorded as the strongest earthquakes:

- 365. Crete, tsunami, 500,000 victims
- 1755. Lisbon, 8.5° -9.0° Richter, Tsunami, 10 to 100,000 victims
- 1908. Messina in Sicily, 7.5° on Richter, 12m tsunami, 123.000 victims

In the Balkans, we record:

- 1667. Dubrovnik, the city completely destroyed, about 3,000 victims
- 1963 Skopje, 6.1o Richter, 75% of the city destroyed, over 1,000 victims
- 1979 Montenegro, 7o Richter, 136 victims (101 in Montenegro and 35 in Albania)

In addition to the described consequences of the earthquake, accentuated geological hazards must be mentioned in the form of landslides, changes in the flows of groundwater, the position of the source, the rise and lowering of the sea level.

Floods

The disturbed rivers do not choose victims, they leave a waste. History records floods in the Netherlands in 1530 year with a loss of 1.2 million people, followed by Yangcekang in 1935 with 1.5 million lives lost, Valkyao dam was destroyed in 1975 and 1.6 million people lost their lives, the Yellow River (Niargho) was poured over in 1931, killed about 2 million people in 1931, over 8 million in 1938 ... And today we are witnessing numerous floods. Every minute on the planet, 60,000 square meters of earth is flooded.

3. DISASTERS CREATED BY HUMAN ACTIVITY

The following facts are disturbing:

- Just 30 years ago, Planet counted around 3.6 billion people, today this number exceeds 7.5 billion

- Demographic explosion in the post-1950 period, which is most common in developing countries, with the conclusion that in the future demographic development will belong to the population of non-aligned origin (6). Every minute on the planet, about 158 people are born and about 100 people die (7).
- An urban revolution that is unknown in history as cities follow the development of human civilization for some 6,000 years in cities in 1975 lived 1.5 billion people or 38 percent of the world's population, and in 2010, 3.5 billion or 50.5 percent of the population. It is predicted that in 2050 will live 6.3 billion or 69% of the population. And growth is predicted mostly in poor and densely populated areas (6)
- Hungry - More than a billion people are chronically starving and more than 1.5 billion are in absolute poverty (US $ 1.5 per day). Every minute of hunger on the planet, about 40 people die.

According to reports from the World Meteorological Organization it is estimated that about 90% of all natural disasters are of hydro meteorological origin. The climate on the planet has been changing continuously. A thousand of years has been necessary for the Planet to transform from one state to another. However, we are witnessing the rapid change of climate after the industrial revolution, due to the influence of the human factor. That's what's worrying. Increasing extreme weather events, due to greenhouse gases, increasing sea levels are the effects of climate change that increase community expenses, and will be even more increased in the future. Emissions of gases in one place affect people in a wider environment.

Continuous emissions of greenhouse gases will contribute increasing temperatures on the Planet at the end of the 21st century in the range of 1.4 to 5.8^{o}C.

The development of human civilization brings us numerous harmful effects and here are some of them:

- CO2 emissions. Carbon dioxide (CO2) emissions from industrial sources are considered to be the main culprits for global warming of the Planet. Measures to reduce greenhouse gas emissions are defined at the United Nations Conference on Climate in Paris (COP21). The Conference points to the need to reduce emissions due to the impact on global warming of the planet. Every minute on the planet there is a CO2 emission of around 43 000 t (Report by the TU Joint Research Center - JRC). According to the Dutch Environmental Assessment Agency, China remains the world's largest emitter of harmful gases, but the United States emits almost three times more CO2 per capita than that Asian country.
- global warming. The heat wave that hit Europe in 2003 took 70000 lives. Even in 2010, 56,000 people lost their lives in Russia due to heat strikes, drought, and fire. Due to the global warming of the planet, the number of victims will increase.

- destruction of forest wealth. Forests are the dominant land-based eco-systems on earth and occupy about 30% of the country's surface and cover over four billion hectares. In addition to forest logging, forest fires greatly destroy the ecosystem. It is estimated that 13 million hectares of forest are lost annually due to human activity and climate change (8).
- garbage production. Demography causes an increase in waste production. It is estimated that about 60% of the waste can be recycled, and about 15,000 tons of garbage is produced on the planet every minute. In particular, there is an increasing level of electronic waste. (9)
- automotive environmental burden. Per data from 2016, 94 976 568 cars (10) have been produced worldwide, which is a huge increase compared to 2000 in which 58 375 162 cars were produced. Our environment will burden every minute over 180 cars.

The global goals of sustainable development are universal and imply the development of a community that meets the human resources with available resources, not endangering the natural and environmental environment with the condition to enable development for generations that come after us.

Recognizing the greatest impact of disasters on developing countries, the EU has recognized the main objective, and that is (2): "to contribute to sustainable development and eradication of poverty through reducing the burden of disasters for the poor and the most vulnerable countries and groups of the population ..."

4. SPACE SHIP "EARTH"

"Let's imagine that the whole earth is a spaceship of a civilization, and with all the people who live on it, this boat travels by space. Travelers must satisfy themselves with food, water, oxygen and energy reserves that remain on board. With the rise in the number of people on board, at the same time, the amount of waste and harmful substances on the ship is increasing, life is becoming more and more difficult because clean air, food and water are reducing, some of the passengers in this spacecraft are worried, they foresee a shortage due to lack of oxygen, water, food , freezing (and, therefore, they intentionally working to find solutions). Other people are wasting their supplies which comes to an end and they do not pay attention to the warnings. They rely on someone's last moment to fall into the mind, which will lead to the salvation of all. "

"To read" the text "Space Ship Earth" requires approximately one minute. For one minute on the planet "(9) the following happens:

- Number of inhabitants increased by 148
- About 40 people die of starvation

- Carbon dioxide emission is about 43,000 t
- About 24.5 ha of forest is destroyed
- Almost 1km^2 of natural surfaces are lost by construction or upgrading
- 60,000 m^2 of land is flooded
- Over 15,000 tons of garbage is produced
- Almost 180 cars additionally burden the environment

5. CONCLUSION

Disasters both natural and human activities are coming. We can not reconcile with the fact that they are catastrophes. We must act actively and preventively. Especially preventive, and we can act on all those disasters caused by the human factor. I will focus on a number of recommendations I recognize that are related to construction:

It is necessary to spend spacious resources very carefully and rationally. This is our non-renewable resource. Spatial planning and management is the first essential activity where we can fix the situation. In planning, we can define the levels of acceptable risk to hazard caused by disasters. The urban chaos lead to construction in unacceptable areas along river valleys that flow, on potentially unstable and unstable slopes, in protected biological areas, the construction of industrial buildings with outdated technology in inadequate locations ... We need to plan and design intelligently.

It is necessary to build according to ecological principles. The recycling of construction materials and the use of waste as components in new materials must be part of the builders' awareness. If we do not recognize it, we will carry out self-destruction with the increase of the population on the planet.

Energy efficiency involves stopping the use of solid fuels and CO2 emissions. Shocking is example in Montenegro in Pljevlja which is an industrial center, but where larger pollution causes burning coal in households than thermal power plants. And logically because industrial plants have at least some filters. Energy efficiency requires the use of renewable energy sources and the desire to build facilities that will consume as little energy as possible.

Rational use of water is an imperative.

Finally, the making of decisions on construction must be multidisciplinary. For a long time, construction is very closely related to the area of environment, economy and sustainability. The decision to build our facilities in the future will be multidisciplinary in order to leave as little harmful consequences as possible in nature. Our decisions must restrain the power of businesses and oppose this power by rationality and professionalism.

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FLOOD PROTECTION OF HUNGARY IN THE INTEGRATED WATER MANAGEMENT

Abstract: In the recent decades Hungarian rivers', particularly the Tisza River's, flood carrying capacity has been gradually decreasing. Human management actions and natural processes resulted in increased flood duration and elevation. The ever increasing flood levels of the rivers threaten the communities and agricultural areas located in the flood plain and impact people's livelihood. River system hydrological and hydrodynamic modelling and scientific research had a significant role in evaluating flood damage reduction and prevention options. This article focuses on the flood waves characteristics and causes of the Danube and Tisza over the last two decades, with particular regard to the 100-140 centimetres increase of peak flood levels in some river reaches. These flood events in effect forced the review and re-evaluation of the Hungarian rivers' flood elevations, re-calculation of flood risks, and formulation of plans for improving and managing the river channels.

Key words: Flood peak increase, flood duration increase, river channel management plans, flood risk calculations, settlement floodplain, flood control reservoirs, hydrological and hydrodynamic modelling.

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1. INTRODUCTION

In the Carpathian Basin, throughout the Hungary's history, developments and improvement would have been inconceivable without the ability to coexist with the waterways of the region. The Hungarian people developed a successful water management culture in the Pannonian Basin from the historical flood fighting experiences. Living together with water became a natural part of the Hungarian social culture.

Hungary is entirely located in the Danube River Basin. Based on geographical characteristics and climatic conditions, Hungary's flood vulnerability is one of the most severe in Europe. Flood-protected areas cover 23% of the country. A quarter of the population is living in flood prone areas. The terrain gradient in most of the country is very low, so the uncontrolled flooding would cause problems in large areas. The protection from the approximate 100-year flood events are provided by a complex flood control system that includes over 4,200 km levees, number of reservoirs, pumping stations and other facilities.

Out of necessity, Hungary has been practicing integrated water management way before the concept got recognized. Flood management actions historically integrated many other uses of the river. The protection of the large low lying levee-protected area provided an additional challenge to remove the excess interior runoff from floodplains.

It seems like nowadays we are coming up with fancy new descriptions to technics commonly used for centuries by our ancestors. The conservation of nature has always been a part of water development projects. Looking back on our flood control history, we find that flood control of all major cities was based on sound technical solution available at the time. Systematically organized and focused flood protection - which is mainly started by the regulation of Tisza - has more than one and a half centuries tradition.

Our success is based on a national approach that has been fostered more than 60 years. This approach has unified a spectrum of water resource management services and divided into 12 units based on drainage basins and not political/administrative boundaries.

Specific legal requirements were not developed yet when we developed the first Tisza River International Basin Management Plan. During the Plan development it was obvious that we cannot separate water quantity and quality considerations. This concept was further reinforced when Hungary joined the European Union and adapted their directives (Water Framework Directive, Flood Directive etc.).

Hungary's water management in some respects is very vulnerable since it relies on runoff that mostly (almost 96%) generated abroad J. Varadi [20]. This vulnerability is highlighted by the fact that way our neighbours manage and operates the reservoirs on the rivers and their watersheds, significantly impacts the amount of sediment and pollution carried by the rivers into Hungary.

2. DANUBE

The Danube basin is located at the edge of the European continent that was annexed by the mountain-forming process during the Tertiary period. The final formation, due to internal geological forces, was virtually complete by the end of the third period of the Miocene, and achieved the present state during the fourth period [13].

In the Hungarian section of the Danube mainly two types of floods occurs. The first type occurs at the end of winter - early spring, when melting snow in central and lower parts of the basin and runoff from rain coincide. The ice-caused floods (that nowadays more and more rare) had a distinct role in the history of domestic flooding (e.g. 1876, 1891, 1893, 1940, 1941, and 1956) [22]. The second type is the summer flooding, which is the result of intensive rainfall that starts in the higher elevation watersheds of the Alps. The ice-free summer floods generated high waters in terms of rate of flow, (2002, 2013) are particularly dangerous.

2.1. Hungary's position on the Danube river basin, flood characteristics

Preparation for floods and flood protection creates a challenge for all Danubian Countries. The impact of climate change increased the level of interdependence between these countries. As a result of acceptance of the river basin approach for flood damage reduction and the recognition of the interdependence of the neighbouring countries, several international groups have been created, where the flood issues play a major role, such as the ICPDR - International Commission for the Protection of the Danube River (1998) and the Danube Region Strategy (2011). In the ICPDR, Hungary is chairing Flood Protection Expert Group (FP EG), and in the Duna Region Strategy, the Hungarian delegate co-chairs the environmental risks management Priority (PA5) group. Hungary's commitment and activity in the field of international cooperation is exemplary and well recognized, based on the high-quality hydraulic/flood control engineering knowledge and beyond, including international engagements with experts in the field. Our country's fresh water is about 96% come from abroad (Figure 1, 2), so it is not surprising that we have trans boundary water resources agreements with each of the seven neighbouring countries, that governs and addresses water resource management issues.

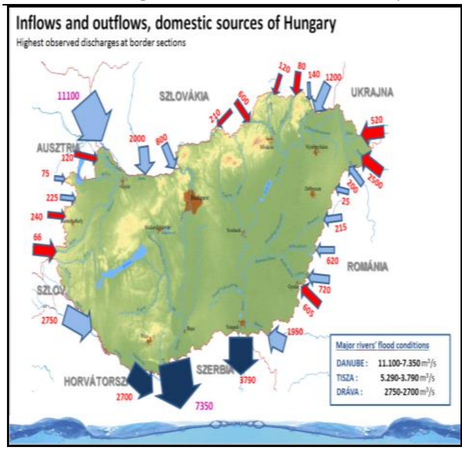

Figure 1 - Typical values of the discharges cross the borders

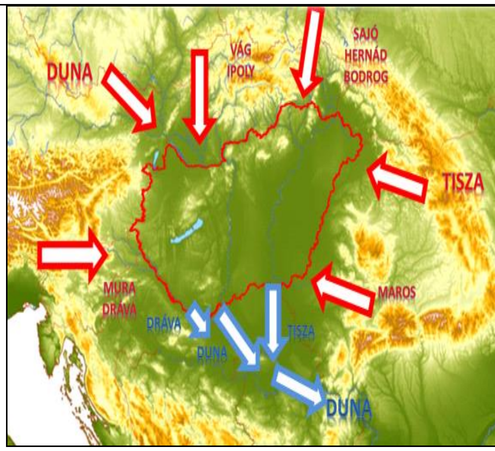

Figure 2 – Direction of the surface water in Hungary

2.2. Domestic flood damage risk reduction on the Danube

The Danube meanders 417 km through Hungary mostly within controlled, defined channels. A 142 km long portion of the river is the common border with Slovakia.

The first flood event on the Danube of which we have historical record has occurred in 1267. Through the XIII-XVI Century, we have knowledge of fourteen major floods that probably included a number of ice flood. During the XVII Century, five major floods were recorded [17]. The monograph published by Zawadowski A. [21] describes twenty-four floods that happened within the XVIII century. He also described seven floods during the beginning of the XIX Century. We have more detailed information available for the flood devastated Budapest in 1838. During the XX Century, 1954 and 1965 were years when catastrophic spring and summer floods occurred. However, not only the large volume of flows, but also extreme temperatures can carry enormous risks, as ice induced floods caused damage in 1862, 1876, 1941 and in 1956. These floods caused major damages due to levee breaks. Following the millennium, in 2002 never seen before flood levels developed, that followed by an even greater flood in 2006 that broke all previous records at almost every sections of the river. However, the 2013 Danube flood determined the highest water level observed, i.e. the "LNV" values on all –except one- staff gauge located within the country. During this flood, the great cooperation of the governmental agencies and the local population through heroic flood fight was able to prevent any inundation and casualties from this unprecedented event.

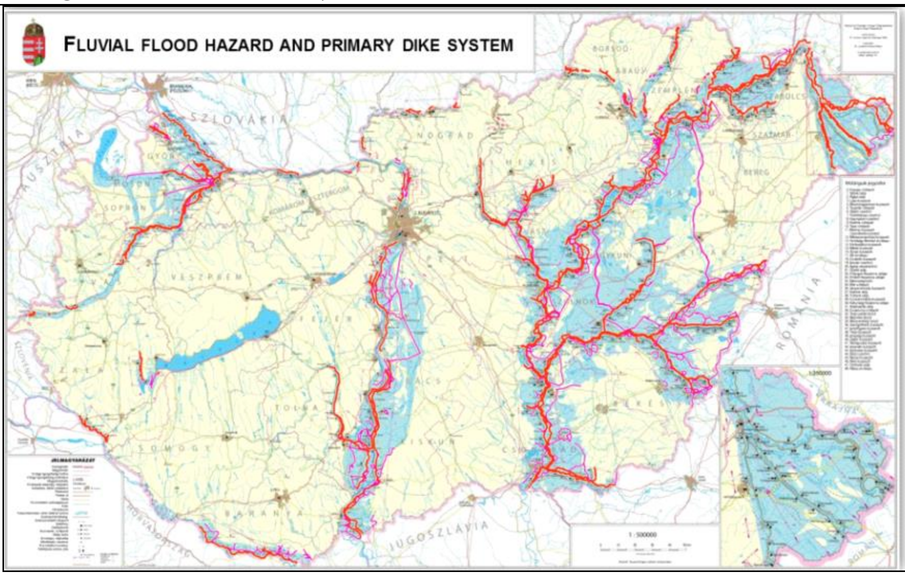

Figure 3 – Fluvial Flood hazard and primary levee system

Establishment of the levee system in the country had continued in recent centuries (Figure 3). After joining the EU in 2004, additional founding become available that we successfully incorporated into the improvement of our flood protection system and increasing overall flood safety. Furthermore, national and regional water agencies were able to apply for and secure funding for cross -border projects that further promotes the development of international cooperation.

3. TISZA

3.1. Tisza Geography, brief description of Geology

A new landscape was born out of the struggle between the Tisza and the people who settled there. At the present time the characteristics of the Tisza River is not only determined by geology, but also the skilful changes by people. There are no other rivers in Europe that contain larger reclaimed floodplain area than the one from Tisza. The reclamation was achieved by implementing a major channelization project by cutting off meander belts, and thereby shortening the river length.

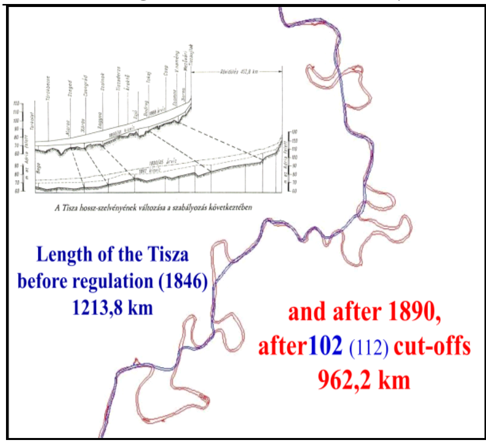

Figure 4 - Changing of the length of Tisza after cut-offs

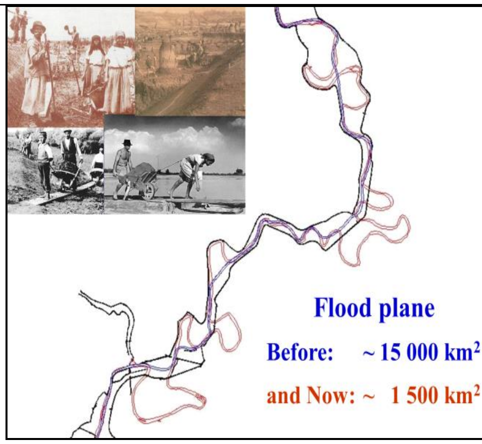

Figure 5 - Decreasing of the Tisza floodplain after cut-of

Reclaiming the floodplain from the river was achieved by constructing a levee system for the Tisza and its tributaries that become the longest levee system in Europe. The construction of levees reclaimed almost 90% of the ancient river floodplain that changed the available in-stream flood storage, as well as the water and sediment conveyance (Figure 5) [8].

The large flood control project provided for the economic development of the Tisza valley floodplain. Construction and operation of flood control and other flood damage reduction facilities allowed rural development programs in the country's history during 1860-1915, thus created the most significant economic achievements in the Great Plains of Hungary [12].

The Tisza and its tributaries have been squeezed between levees and for this reason, people have to consider the river’s present "vision and mood" in their decisions regarding any improvements. The flood-control program (VTT - Vasarhelyi-Plan), adopted in 2003, aimed to improve the most critical sections of the Tisza, requiring the development of a complex improvement program [11].

The increase in flood peaks of the River Tisza, during the period after 1888 is illustrated in Table 1.

Table 1 - Increasing of the peak levels on the Tisza after 1888.

ÉVEK	TIVA-DAR	VÁSÁROS-NAMÉNY	ZÁ-HONY	TOKAJ	TISZA-FÜRED	KISKÖRE (Taskony)	TISZA-BŐ	SZOL-NOK	CSONG-RÁD	SZEGED
1772.										630
1830.				715	631			684	599	
1855.		770		768	675			739	671	691
1876.		817		784	686			753	757	786
1877.										793
1879.								763	805	806
1881.		866	747					764	820	845
1888.	753	900	751	872	742			818	834	847
1895.						841	866	827	867	884
1912.	790									
1919.						882	919	882	929	916
1932.					750		921	894		923
1947.	848									
1967.					765					
1970.	964	912			773	887	935	909	935	961
1979.				880	788	912	949			
1998.		923								
1999.				894	835	978	1023	974		
2000.				928	881	1030	1080	1041	994	
2001.	1014	941	758							
2006.									1033	1009
Number of the new peaks after 1887.	6	4	2	4	7	6	7	7	6	6

3.2. Effects of 1998 and 2010 Tisza flood waves on our view to flood protection

There is significant rise in flood elevation on the Tisza River and on its tributaries (especially in the main channel) caused by natural processes and human management practices.

Is it possible to have a higher flood elevation in the future in the Middle Tisza region than the flood levels evolved in the last decade? The answer is definitely yes. During the history of the Tisza we could find periods with less favorable meteorological condition than the past few years. One of the hydro meteorological aspects of the standard floods is the one happened in 1888, when the water level of the Tisza in Vásárosnamény exceeded 790 cm for 16 days while the tributaries water levels were also extremely high. At the same section in Vásárosnamény, during the past decades the duration of floods over 790 cm have not exceeded 3.5 days. We need to consider, that the way the peak flood level of 900 cm at Vásárosnamény in 1888 developed, the tributaries barely had any levees and even those were washed it away by the flood.

After 1970 the reduction of conveyance capacity of several sections of the Tisza reached 3-4 cm. (Figure 6).

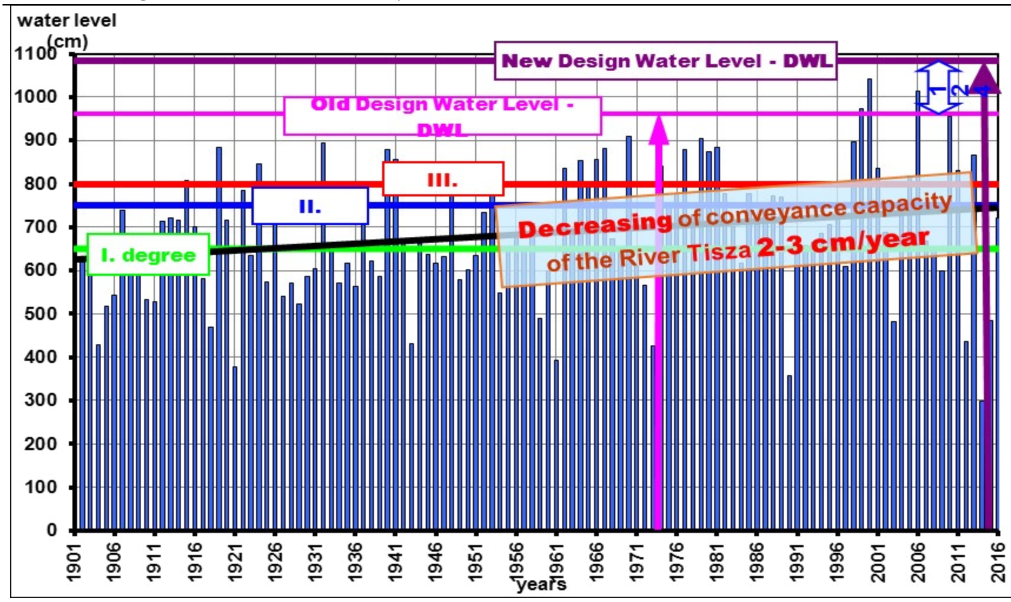

Figure 6 – Annual maximum water level of Tisza, in Szolnok

This suggests that if the flood of 1970 would happen again, then it would raise flood level in the Middle-Tisza by approximately 130-140 cm. If the hydro meteorological conditions that caused the flood in 2000 would occur again, then we would expect 40-50 cm higher flood levels (assuming the completion of the levees). The recurrence of the 2001 flood would similarly create higher flood stages on the Upper-Tisza region.

Beside the increase in the flood levels, the increased length of the flood duration would cause an even more problems. During the period between 1881 and 1910 the flood duration above 650 cm was 5.4 days per a year on average in the Middle-Tisza. Currently this value rose to 25 days, nearly five times of the past duration (Table 2).

Table 2. Annual flood wave duration on the Middle-Tisza

Period	650 cm above	700 cm above	750 cm above	800 cm above	850 cm above	900 cm above	950 cm above	1000 cm above
1881 - 1910.	5.4	2.9	1.2	0.6	0.0	0.0	0.0	0.0
1911 - 1940.	14.0	7.1	3.6	1.9	0.8	0.0	0.0	0.0
1941 - 1970.	21.1	14.7	9.6	5.2	1.2	0.2	0.0	0.0
1971 - 2000.	25.8	17.4	10.5	5.7	3.4	1.3	0.8	0.4
2001 - 2016.	**23.3**	**18.3**	**11.5**	**8.9**	**4.1**	**2.5**	**1.4**	**0.5**

The main reasons of the increases in water levels on the Tisza and its tributaries can be summarized as follows:

The rivers arrive to our country with a steep gradient from foreign watersheds. The gradient of the rivers decreases at the border (Figure 7) and the same time the water velocity is significantly reduces. As the water velocity decreases, the sediment carried by the river is dropping out from suspension. The sediment settled from the floods is constantly increasing the height of the floodplain. The continually decreasing water velocity causes the increase of sedimentation process that will create further rise of flood levels. The condition of floodplain also slows the flow of water, fostering the continuous strengthening of this process.

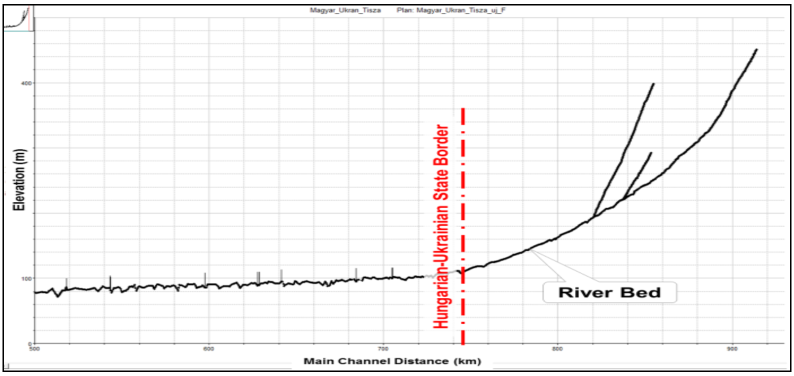

Figure 7 - Longitudinal profile of the Tisza between Rahó and Tiszadob

As the flood wave proceed toward to the middle and lower section of the Tisza, the water velocity further decreases, and the sedimentation process is further increases. The volume of significant floods exceeds 10 km^3 on the Middle-Tisza and 15 km3 on the Lower-Tisza. The result of decreasing water velocity is the reduction of kinetic energy of the river. The reduction of kinetic energy decreases also cause the increase of the potential energy and the water level.

The increase of flood level also causes the increase of flood duration, which creates additional pressure on the aged levees. The duration of the first degree of flood control preparedness exceeds 90 days in the Middle-Tisza. During the flood event in 2000, the flood stage stayed above 1000cm for 11 days. If a similar flood like in 1888 would occur on the Tisza, then the flood duration over 1000 cm would be 24 days for the middle section of the river [10]. Our levees could not endure such extended flood event. For this reason, our main tasks should not only concentrate on the reduction of flood level, but also on the decrease of flood durations. As we mentioned it before, it is possible to achieve this goal by increasing the kinetic energy of the load wave and increase the velocity of the river, and by cleaning the way in for the water.

In the development of water velocity, the condition of the floodplain plays a major role, the density of vegetation, the height of the berms/river banks and summer dike, and other different (Figure 8 and 9).

Figure 8 – Height of the berms/ river banks by the link-channel of the Nagykunság reservoir in the floodplain (own photo)

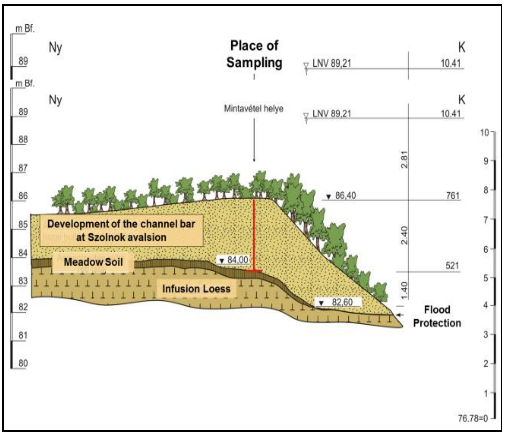

Figure 9 – Development of the berms/river banks next to the Tisza, in the edge of the bank

In the second half of the XX Century the grass in the floodplain areas were slowly replaced by field crops and forest expansion that degraded the conveyance of the area. Following the political regime change, many unfavorable changes (neglected summer dikes, sediment deposition along drainage channels, abandoned fields, weeding, heavy underbrush, invasive species proliferation, establishment of fenced gardens, construction of buildings, etc.) deteriorated the water runoff conditions. Even the former agricultural fields on the floodplain now mostly give the impression of neglect (Figure 10).

Figure 10 – Current Floodplain of the Tisza (own photo)

Due to the extreme floods on the Middle Tisza region, in the fall of 2000 recommendation was made for the creation of a new flood protection concept (New Vásárhelyi Plan). This concept emphasized the flood level reduction measures. Following the review of the findings and recommendations in the Plan, an external governmental meeting was held in Szolnok in 2003, where the new flood protection program concept was adopted [11].

4. WATER SCIENCES, RECALCULATE OF DESIGN FLOOD LEVELS

The last two decades of record floods made it necessary to review of the design flood levels of the Hungarian rivers, as the calculated flood level increases of certain river sections exceeded the 100-140 centimetres. The pre-2014 levee freeboard requirements of 1.0-1.5 m would not guarantee safety from flooding.

The calculations completed in 2014 included the revised design flood levels for each river section of Hungary, considering the current and the design flood level and the regulated data of 11/2010 (IV.28.) by the KvVM (Ministry of Environment and Water) regarding the design flood levels, with the amended regulations 41/2014. (VIII. 5.) by BM (Ministry of Interior) advertised and promulgated in August 2014.

The current numerical models are now accepted as suitable to estimate higher as previously seen or measured flood levels and extending it to the river sections between stream gauges.

The design flood level (MÁSZ) is the 1% probability (i.e., 100-year return time) annual flood, as it was used in the past. The accuracy of the calculation depends on the quality and the length of the observed data. Today we have a more accurate, and significantly longer hydrological data series than they were available during calculations in the 1970s.

Based on data availability for different rivers, we are using basically the combination of two methodologies:

1) By analyzing the historical time series of the annual maximum flood levels using hydrological statistic, for each stream gage, with theoretical distribution functions, the 1% probability exceeded the thresholds (NV1%) can be determined. This is the method of determining design flood level since the 1970s, but the extended time series data set already include the recent floods, thus also reflect the changed runoff conditions. The past water levels are adjusted for the present values by correcting for the long-term trends, taking into account the sedimentation of the floodplain, riverbed cutting, the changes of the hydro-meteorological conditions, and the changes in the river basins.

We have used two fundamentally different samplings and probabilistic computation methods (Figure 11).The first method is approximating a three-parameter distribution curve using the pattern of the annual maximum water level distribution. The second method, the so-called intercept method, is developing an above a certain water level (in our case the 1st degree of flood protection level), pattern of independent flood peaks that are fitted to these data series distribution with logarithmic functions.

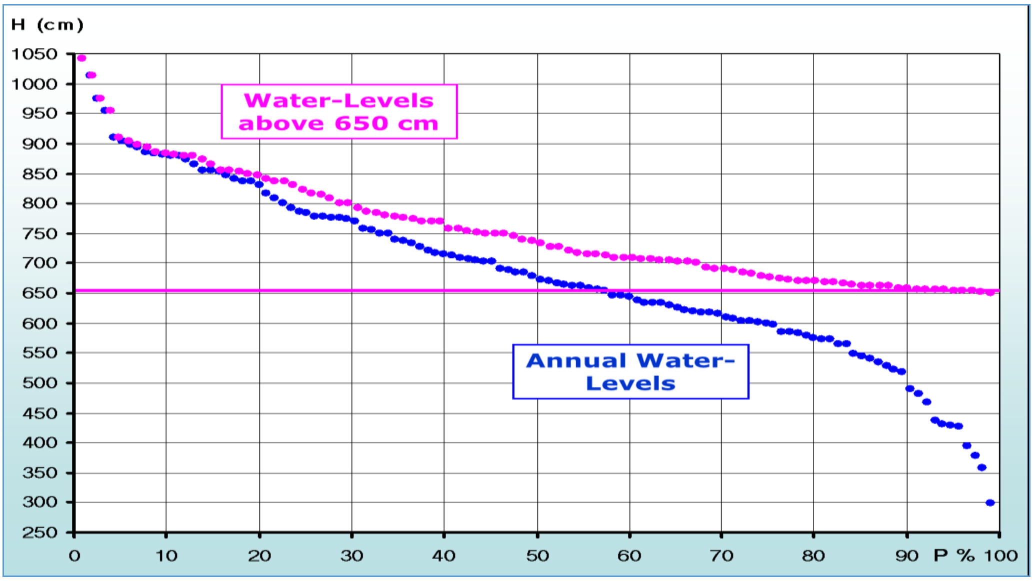

Figure 11 – Distribution of the Annual flood level and floods with peaks above 650 cm

According to the second method, the design flood level is calculated by a 1% probability of annual rate of discharge (NQ1%) and preparing a large number of hydrodynamic models using synthetic boundary conditions. From the thousands of models prepared, the ones where the maximum discharge has not exceeded NQ1% value were selected. The new design flood level is determined by selecting sections to sections the highest flood levels. This method will automatically take account of floods coincidence from tributaries, flood wave flattening, and variability of river reaches. The hydrodynamic modelling based procedure has three main elements:

- Determining the flood NQ1% discharge, by using the annual maximum discharge hydrological statistical process for all Hungarian rivers where historical flow records are available.
- Simulating the hydrological discharge from the available time series that produced the hydrodynamic model boundary condition input data at six-hour intervals, which included the thousands of years of tributary coincidental discharge information. These time series are artificial, but based on observed statistics and provide an opportunity to take into account a wide range of the coincidental tributary floods by appropriately weighting their probability.

- Calculating the flood water levels and discharges for the full length of the river system from the artificial time series generated large number of flood water levels and discharges are calculated by quick hydrodynamic models, typically 1 hour time intervals and between 0.1 to 1 km cross-section locations. These numerical results are analyzed to determine the profile of the maximum flood levels of the NQ1% less than the annual maximum discharge,i.e. the new design flood level.

5. FORWARD-LOOKING DEVELOPMENTS FOR FLOOD DAMAGE REDUCTION

The Tisza and the Danube flood events of the XXI. Century highlighted important changes. Due to the change of modern concept of national land use (e.g. floodplain afforestation 1950s), as well as natural floodplain processes, the conveyance capacity in the designated flood overflow areas ability to pass flood flows are drastically reduced. The non-protected areas without levees, so-called open floodplains, with high extended banks believed to be safe from flooding have been inundated and large flood volume created new flood ways.

The state prepared flood damage reduction and response plans and updated the plans for levee breach preparedness (localization plan) for open floodplain communities. Meanwhile preparation of the hazard-and risk maps and risk management plans took place in accordance with EU Flood Directive, which required forward looking methodology, including the expected climatic changes, their impacts, and expected flood level variations.

The primary function of the floodplain is floodwater conveyance. During flooding, the flood water moves through the conveyance corridor of the floodplain. The floodplain can only accomplish this function if the designated corridor has appropriate width and it is clear to allow free passage of the flow.

It is an important tool in creating a regional flood protection to ensure that the flood corridor allow only for activities with low surface roughness that does not hinder the passage of flood waters.

In Hungary during the 1960s, great attention was paid to the condition of the main rive channels and the floodplains to ensure the free conveyance of floods. The document titled “Regulation of the Tisza River” that was submitted by the National Water and Soil Building Repair Office in 1891, it describes implementation of the previous regulations in details.

In 1960 three planting, along with the construction of summer dikes and summer homes, and fallowing of agricultural grass grazing lands started in the floodplain areas. All these activities contributed significantly to the rapid rise in water levels and increased sediment deposition. It can also be stated that, due to the established conditions, our country has abandoned the maintenance of the floodplains and shifted the emphasis to the proper construction of levees.

According to our calculations during a mid-Tisza levee breach, the volume of water from a levee breach would exceed 1.5 km3. Note: in 2001 at Tarpa, approximately 120 million m3 of water flooded Hungarian lands [2]. The filling of the large basins with flood waters could take up to several weeks. Hundreds of km2 area could be under water that could be almost impossible to dewater. The large volume of water inundating for months, years would make the entire region uninhabitable.

Therefore, the potential for flood duration due to levee breach must be considered and evaluated everywhere. Preparation to these events, the risk management plans also include localization plans.

In accordance with the New Vásrhelyi Plan, flood risk reduction need to have higher priority than the environmental protection and regional economic interests. The solution to land-use planning and changes should include stakeholder involvement, various legal requirements, technical considerations, taking into account the coordination of the comprehensive development of the Tisza framework and find the way to maintain or preferably improve flood safety and the area ecological potential, and ensure the preservation of biodiversity.

Parallel to the river basin management planning required by the European Union, the JenőKvassay Plan's was prepared to establish overall strategy for the Hungarian water management. The strategy describes beyond the technical tasks, the tasks necessary to obtain public support for water management. For gaining public support, water professionals must carry out their tasks with the best available tools in a highly professional manner. That is why the strategy puts high emphasis on education, professional training, and advancement of scientific knowledge.

6. SUMMARY

We humans love predictability, ability to plan and security. We do not want our daily lives disrupted by floods, not having drinking water from the tap and droughts. However, nature itself is non-permanent, it's ever changing, and we must adapt to that. The projected and already experienced climate change will increases the extreme natural events. If we want to maintain our water security, on the one hand we need to adapt better to changes, on the other hand, we need to develop systems that will reduce the impacts of extreme events on our daily lives that occur with increasing frequency.

The internationally active Hungarian water sector is renewing its current structure based on the historical traditions and knowledge. Environmental protection and satisfaction of the needs of residents challenges the water resource profession. It is the responsibility of water management to adopt the XXI Century tools that enable us to reduce the harmful effects of extreme events, while providing balanced water management to the public, where and when it is needed.

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PHD STUDIES AT THE DOCTORAL SCHOOL OF SAFETY AND SECURITY SCIENCES, OBUDA UNIVERSITY, HUNGARY

Abstract: In this paper the PhD study at the Doctoral School of Safety and Security Sciences at Obuda University in Hungary is presented. The procedure and rules for obtaining of the PhD degree in Hungary is explained. The study is divided into two parts: first part is 'education and investigation' and the second 'investigation and dissertation'. During eight semester studies 240 credits have to be achieved and the Complex Exam has to be passed. After passing the exam in three years the dissertation has to be finished. The PhD is obtained after passing the final exam. The Doctoral School is open for dissertations in any topic connected with safety or security in engineering, techniques, economics, management, etc., and even juridical aspects of the problem.

Keywords: PhD study, credits, exams, complex exam, final exam

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1. INTRODUCTION

The Óbuda University is a technical university in Budapest, Hungary. It was founded in 2000 with the merging of three polytechnical institutes: *Bánki Donát Technical College*, *Kandó Kálmán Technical College* and *Light Industry Technical College*. Having complied with the requirements, the institution was promoted to university status on 1 January 2010 under the name of *Óbuda University* [1]. The university with the merger of former polytechnic institutions has founded the following faculties

- Alba Regia Technical Faculty (Székesfehérvár)
- Bánki Donát Faculty of Mechanical and Safety Engineering
- Kandó Kálmán Faculty of Electrical Engineering
- Keleti Károly Faculty of Business and Management
- John von Neumann Faculty of Informatics
- Rejtő Sándor Faculty of Light Industry and Environmental Engineering

Recently, with nearly 13,000 students it is one of the largest technical universities in the country.

At the University there are three Doctoral schools:

- Doctoral School of Applied Informatics and Applied Mathematics
- Doctoral School of Safety and Security Sciences
- Doctoral School of Materials Sciences and Technologies

The objective of the Doctoral School on Safety and Security Sciences (DSSSS) accredited in 2012 and reaccredited in 2017 [2], is the training of technical scientific researchers who are able to go beyond the traditional disciplinary approach and to solve real research and development tasks based on real industrial needs independently by applying the skills in a synergistic and creative manner. In this way the sharp borderline between the separate disciplines is disappearing and the project-oriented approach necessary for practical tasks is going to generate synergies between the disciplines and a new science of safety knowledge is going to develop.

The research topics of the Doctoral School on Safety and Security are the following: safety science, human-machine-environment analysis techniques and scientific research on issues affecting the activities of critical infrastructure. In the doctoral school, we apply the methods of scientific research to clarify the issues, to seek new security solutions and to ensure the successful implementation of complex security.

The activities of the Doctoral School are supported by a tender entitled “Critical infrastructure protection research” accepted by the National Development Agency within the topic of “Improving the quality of Higher Education trough development of research-innovation-education”, which was won jointly by the Óbuda University and the National University of Public Service.

2. PROCEDURE FOR THE PHD DEGREE

The state authority of Hungary gives the law and rules for obtaining the PhD studies in 2011 (CCIV Law of High Education [3]) and modified it in 2015 (see [4] and [5]). Since that time the PhD studies are arranged in eight semesters with minimal 240 credits. In general the studies are divided into two parts. The first part of studies relates to 'education and investigation' and is in the interval from the first to the fourth semester. The second part of studies, during the fifth up to the eight semester, involves 'investigation and dissertation'. At the end of the forth semester and before the beginning of the fifth semester the so called 'Complex Exam' has to be passed. It is an obligatory exam which reviews the level of scientific knowledge and resuts of investigation of the candidate. After passing this exam the dissertation has to be finished up to three years.

At the Doctoral School of Safety and Security Sciences credits are achieved for:

- Passed Exams
- Reports
- Publications
- Research projects
- Teaching activity

2.1. Courses

The minimal number of courses which have to be passed is 8: half of them (4 courses) are obligatory and prescribed by the Doctoral school and half of them (4 courses) are optional (prescribed by the supervisor of the dissertation). Obligatory courses are of general type: two of them are with topic of scientific work, and other two dealing with safety and security sciences. For every passed exam 6 credits are obtained. Finally, maximal credits for 8 passed exams are

8 courses x 6 credits/course = 48 credits.

2.2. Publications

Depending on the type of publications, various number of credits is obtained. In the Table 1. the list of publications and corresponding credits are shown.

Table 1- Credits for publications

	Published abroad on foreign language	Domestic publication on foreign language	In Hungarian language
Book	100	80	40
Book Chapter (for each 20 pages	12	8	4
Publication in journal with impact factor	24	24	24
Publication in journal with review	16	12	8
Publication in journal without review	12	8	4
Editor of journal with review	12	8	4
Editor of journal without review	6	4	2
Proceeding with review	16	12	4
Proceeding witout review	8	8	2
Conference poster	8	4	4
Conference presentation	8	4	4

Remarks:

1. *It has to be mention that the credits for publication are divided with the number of authors. For example, for the paper published in the journal with impact factor (24) and by three authors (3), the number of credits obtained by the author is the one third of the whole amount, i.e., 24/3 = 8 credits.*

2. *Every candidate must publish not less than two papers in the journal with the impact factor before finishing the dissertation.*

2.3. Lecture activity

For the lecture activity the candidate gets 2 credits/1 lecture for week. However, the number of lectures is limited to 30. It means that the maximal number of credits for lecture is 60.

2.4. Activity in research projects

For the activity on the Research project the candidate obtiaonally gets 6-10 credits. The manager of the project gives the recommandation for credits.

2.5. Reports

At the end of each semester a Report has to be written in which working results for that semester have to be summarized (exams, publications, teaching activity, work on project, investigation results). After oral presentation the candidate gets 8 credits/1-4 semesters, and 15 credits/5-8 semesters.

3. CREDITS IN SEMESTERS

The schedule of courses at the Doctoral School is shown in Table 2.

According to the scheduled courses and reports, the fixed credits for semesters are:

1-4 semester: 8 for report + 12 for exams = 20 (10 is missing)

5-8 semester: 15 for report = 15 (15 is missing)

Finally, it is Σ=140 credits. If the candidate is active in lecture, additional 30 credits are available. For the acrivity in Resarch project the available credits are 48-60.

Table 2- Schedule of courses

Course	Semester							
	1	2	3	4	5	6	7	**8**
Obligatory course in Scientific Work -I.	X							
Obligatory course in Scientific Work -II.	X							
Basic course in topics of research-I.		X						
Basic course in topics of research-II.		X						
Optional course-1.			X					
Optional course -2.			X					
Optional course-3.				X				
Optional course -4.				X				
Research presentation – Reports	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**

4. COMPLEX EXAM

After the fourth semester, the candidate can attend the so called 'Complex Exam', if he/she achieves minimal 90 credits. Some additional credits to those obtained for passed exams and reports (Σ=48+32=80) are necessary.

What is the Complex Exam?

The exam has two parts: a) Theoretical part which is the exam in 2 or 3 courses/topics and b) Presentation of directions of investigation on the dissertation topic. A commission of 3-5 members is formed. The supervisor of the dissertation is not the member of the Board. The members of the Board evaluate the theoretical knowledge with marks from 1 to 5. Candidate passes the theoretical exam if he/she achieves 60% of maximal value. After presenting the investigation on the dissertation the exam is passed if more than 50% give the answer Yes. If the candidate fales on the exam, he/she can repeat the exam once more. Only students who pass the Complex Exam can continue their studies.

5. FINAL EXAM

After achieving the 240 credits and publishing two papers in the journals with impact factor the first version of the dissertation can be given for consideration. Two reviewers are denominated for reviewing of the dissertation. Reviewers have to be two professors: one from the Obuda University and the other from another university. (The supervisor can not be the reviewer). The workshop about dissertation is organized. Reviewers give their opinion about dissertation and the candidate gives answers on the questions and explanation to comments. Based on the review the first version of dissertation has to be corrected or additionally treated. Sometimes additional investigation are necessary. The final version of the dissertation has to be corrected according to the reviewers comments and suggestions. The final version of dissertation is also reviewed by two revievers: one of the Obuda University and the other from another University. The reviewers give their opinion in the written form. If the opinion is positive, the Obuda University forms the Board for the final exam which has 3 – 5 members: president, secretary and one ore three members. At the exam the candidate gives the oral presentation, the reviewers give their opinion, the candidate answers on the comments of the reviewers, the Board members give two or three questions on which the candidate has to reply. Members of Board estimate the final exam with marks 1 - 5. If the sum of marks is higher than 60% of maximal sum of marks (15 or 25, depending on the number of members), i.e., the averaged mark is 3.50-4.0, the candidate passes the exam. If the averaged mark is more than 4.0 and up to 4.5 the candidate obtaines the notation Good, while for >4.5 to 5 it is Excellent.

6. CONCLUSION

Comparing the PhD studies at the Doctoral School of Safety and Security Sciences at the Obuda University in Budapest, Hungary, with those at the other Universities it is concluded:

1. The organization structure of the Obuda University gives a special position of the Doctoral School as a unique system directly connected to the University. Due to this fact, many limitations to doctoral studies, which are evident for the PhD studies connected to faculties, are eliminated.

2. Doctoral School gives dissertation in all technical but also non-technical areas connected with safety and security. Interdisciplinary and multiscience dissertation are available. If PhD studies are connected to faculty the topic of dissertation is limited only to certain technical sciences. For example, at the Faculty of Civil Engineering the topic is in Risk and Safety in Civil Engineering.

3. Doctoral School has a significant number of students from Hungary and abroad whose basic education is not in Safety and security sciences, but in mechanical engineering, civil engineering, traffic engineering, energetics, IT technologies, physics, environmental engineering, economics, mathematics, etc., and even in juridic aspects of safety and security.

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FLOOD RISK MANAGEMENT AT A MUNICIPALITY LEVEL – CASE STUDY

Abstract: The ongoing climate change is a reason of a number of emergencies resulting from the extreme weather. The floods are most represented in Slovakia in the last twenty years. Having the information on such a situation, knowing the specific localities, where the flood should be expected, and the specific level of public awareness itself, is the primary prerequisite to save the lives and protect the property of the communities living in those areas. This paper deals with an issue of the flood hazard areas identification, assessing the vulnerability of the area, i.e. modelling the potential flood impacts, and according to the modelling results evaluating the existing preventive measures as well as the measures used to mitigate the flood risk. The experimental area is represented by the cadastre of Zvolen town, which is situated in the centre of Slovakia.

Key words: flood, hazard, vulnerability, resilience, Zvolen

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1. FLOOD MANAGEMENT AT ZVOLEN MUNICIPALITY LEVEL

The flood management in general is divided to three principal parts – flood prevention, flood rescue works and reconstruction of the area affected by a flood.

All the activities, which are related to the specific phase of flood situation and flood management phase are managed and provided by relevannt institutional bodies.

The flood prevention activities are provided mostly by the employees of the Slovak Water Management Enterprise, S.E. In Zvolen, there exist a branch of this enterprise, which manages the middle part of Hron river catchment.

The flood rescue works are managed and provided by the members of the District Directorate of the Fire and Rescue Service, the members of the municiplity voluntary fire brigade and Police forces. The tasks of civil protection in flood time provide the Civil Protection forces, which are composed from the employees of the Municipality Office and the District Office which is settled directly in Zvolen town.

The reconstructionm works are provided by the Municipality, Slovak Water Management Enterprise branch, Regional Road Administration branch settled in Zvolen and the owners or users of flood damaged structures.

2. FLOOD RISK

In this chapter of the paper is introduced the theory of risk and the procedures to assess it, as well as its components based on application of DSS tool, i.e. GIS, geodata, risk assessment methodologies based on GIS application.

2.1. Risk Theory

The risk can be defined as the probability of occurrence of an emergency / phenomenon, which is calculated most often based on the frequency of occurrence (relative frequency) of the given type of an emergency / phenomenon in the past, and potential negative impacts of such an emergency / phenomenon [1].

According to this definition, the risk can be calculated as the probability of a specific emergency occurrence multiplied by the impacts (damage) value (express as the loss in e.g. euros or like a number of injured or dead persons).

Another way how to determine the risk value is to use the methods for quantitative risk assessment (FTA, FMEA, ETA and other).

For the emergencies of the disaster type is better to used the methods which are based on the analysis of the function among the hazard, exposure, vulnerability and resilience, the particular components used to express the risk. Except those components, there is also susceptibility, which belongs among the most often assessed risk components, while this one is also siutable to be applied in flood danger analysis, which is a part of many flood alerting systems.

Here we introduce the meaning of the particular risk components.

Hazard is a phenomena of varying spatial extent with the potential to lead to damaging events or disaster that "may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources." [2]. The aim of a hazard assessment is to characterize hazards according to their most important characteristics such as the probability of occurrence or frequency of hazard events, the intensity and the affected area [3].

In accordance to the [2], the exposure can be defined "as the presence (location) of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected by physical events and which, thereby, are subject to potential future harm, loss, or damage". Exposure refers to the physical space upon which a hazard may act and

The susceptibility [2] refers to the potential for the hazard to affect people and/or property which is linked to the fragility of exposed elements or their predisposition to be adversely affected.

The vulnerability describes a condition or a potential condition arising from a system's "exposure, susceptibility, and coping capacity, shaped by dynamic historical processes, differential entitlements, political economy, and power relations" [4]. Vulnerability may comprise certain factors, such as poverty, and the lack of social networks and social support mechanisms, which make a system vulnerable irrespective of the type of hazard [2].

The resilience can be, in accordance to the [5], defined comprehensively as "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation".

As a part of resilience, there are also assessed the existing coping capacities to cope with the emergency.

According to [6], the coping and coping capacity in the vulnerability literature refer to measures that provide for the "protection of the here and now" [7]. If a system copes successfully with a hazard, it returns to its "pre-hazard state" [8]. Coping capacity, sometimes used synonymously with capacity of response [9], is influenced by currently available resources and their usage and determines whether a SES can survive the hazardous impacts relatively intact [2] and captures actions that aim at the "conservation of the current system and institutional settings" [10].

Present risk theory involves into the assessment also the uncertainty assessment, to correctly set the accurracy of the risk assessment results.

3. FLOOD RISK AT ZVOLEN TOWN LEVEL

3.1. Risk Assessment Methods Applied

In this paper are briefly introduced the methodological approaches to flood risk assessment, which are strongly dependent on the application of the environment and the tools of the geographical information system (GIS).

All the analyses were processed in the ArcGIS for Desktop 10.2.1 environment.

3.1.1. Experimental area

The experimental area is the cadastre of Zvolen town. It has the extent of 98.73 km^2. The number of inhabitants is 42 688 (situation to 31. 12. 2016).

There are four rivers flowing through Zvolen: Hron, Slatina, Neresnica and Hucava (Zolna).

3.1.2. Flood Susceptibility Assessment and Flood Hazard Areas Identification

The susceptibility to flood was assessed based on the combination of the geographical data in spatial scale of 1 : 10,000, representing the terrain slope, erosion factor of torrential rain, land use type, position of water courses and dams (see [11]). There were identified the areas which are more susceptible to flood occurrence. Those represent the flood hazard areas, too.

3.1.3. Flood Vulnerability Assessment

The vulnerability to flood was assessed based on the data obtained from modelling the 100-years flood in the territorry of Zvolen town cadastre. The flood modelling was processed in HEC-RAS environment. The input data represented the ortho photo images of the Zvolen town territory, digital terrain model and technical data on the water courses flowing through the town cadastre and dams existing in this territory. The methodological approach to assessment of vulnerability to flood can also be find in [11].

3.1.4. Flood Resilience Assessment

To assess the resilence to flood, there were assessed several factors: preparedness and personal and technical capacities of institutions responsible flood management (flood preventive and also flood rescue work), preparedness of institutions responsible to provide the evacuated citizens with emergency accommodation and emergency supplies, as well as the preparedness of the municipality and the relevant organisations to cope with the flood damages and reconstruction of the territory to restore all the systems existing in it.

4. RESULTS OF FLOOD RISK ASSESSMENT

In the area of Zvolen town territory, there were assessed the susceptibility, vulnerability, exposure and resilience to flood in accodance to the GIS based methodological approaches mentioned above.

In Figure 1 we introduce the results of flood susceptibility assessment for the Zvolen municipality.

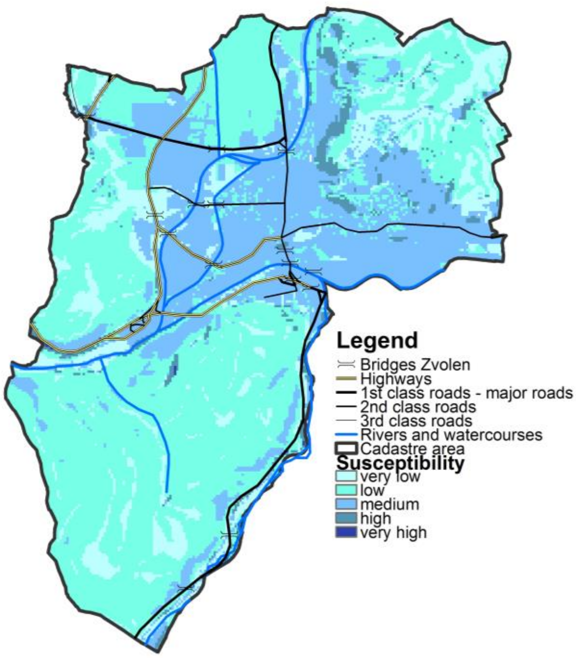

Figure 1 − Flood susceptibility assessment results

The results of the assessment showed the following parcentage share of the particular flood susceptibilty degrees: very low degree was found on 13.90 % of the area, low degree on 51.00 % of the area, medium degree on 31.74 % of the area, high degree on 3.30 % of the area and very high on the 0.06 % of the area.

Figure 2 documents the results of flood vulnerability for 100-years flood.

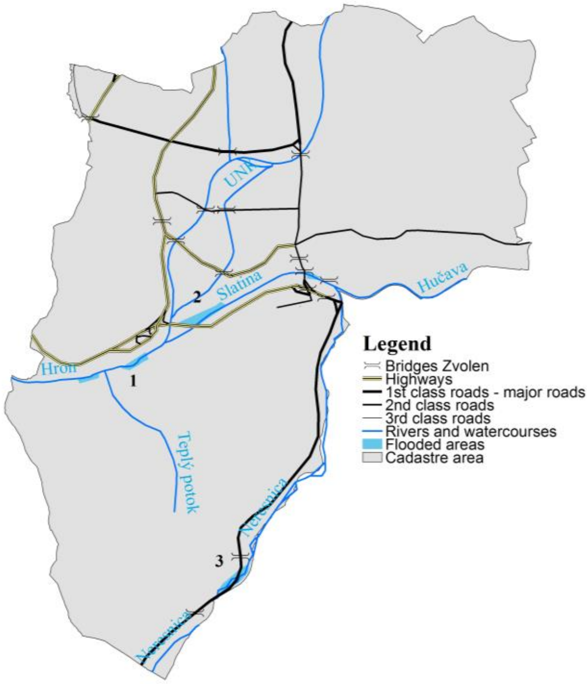

Figure 2 – Flood vulnerability assessment results

From the flood vulnerability assessment is evident that the most vulnerable areas on the Hron river are below the inflow of Slatina river into the Hron river (1). The vulnerable localities were also found on the Slatina river. The most vulnerable area was found in "Balkan" (2), where potential flooding threaten the community of persons in poverty (gypsies), who built their wooden houses on the right bank of the Slatina river. Another flood vulnerable locality was found also on Neresnica watercourse (3).

In general, the floods in Zvolen cadastre are caused mostly by the long-lasting heavy rainfalls, but also short-term local heavy rainfalls. Those situations are characteristic by the rise in water levels of rivers and local watercourses and to their subsequent spillage. Flooding is also caused by the increased drainage of water as the drains and the gutters are unable to discharge the enormous amount of fallen water. Soaked soil leads to a landslides. Torrential water carries silt, branches, trees that block the culverts across the roads, then rises also the water level of minor streams. There is also flooding of houses, cellars, courtyards, wells, local communications, submergence of bridges, flooding and damage to roads of the 1st., 2nd and 3rd class or even railway lined. The most frequent occurrence of floods in Zvolen was after 1974, in July 1999, December 2009, October 2010, mostly on Neresnica watercourse.

Based on evaluation of the assessment results, there are described the strengths and weaknesses of current flood management on the municipality level.

The strengths of the flood prevention measures which were implemented on the Zvolen municipality level in the past, are the artificial dams which were built on the Neresnica watercourse near Dobra Niva village, then the technical equipment, which the District Directorate of the Fire and Rescue Service in Zvolen has in disposal to cope with the flood impacts and saving the lives of persons during the flood situation. This equipment was obtained from the financial budget of the national project "Active anti-flood protection measures", which was implemememented at national level in the Slovak Republic in 2015. The last important measure, which was implemented in last years, was establishment of the municipality voluntary fire brigade, which members are trained to cope not only with fire situations, but also the flood situations and have also technical equipment to support the rescue activities of the Fire and Rescue Service members. Those measures strongly enhance the prepardness of the municipality to cope with flood situations and increase the level of its flood resilience.

As the weakness of the current flood management is the fact, that the responsible water management and crisis management bodies do not have and work with information on 500-years and 1,000-years flood for Zvolen municipality. This is quite hazardous. The ongoing climate change causes many extreme weather situation, which could cause heavy rainfalls anywhere also in localities where such flood were not noticed before. It is necessary to have such flood scenarios and plan and realise the measures to be able to cope with such situations in the future. Those plans is required to implement into the municipality development plan to avoid the emergencies in industry plants as a consequence of flood situations or the losses of human lives and damage of the living constructions built in flooding areas.

There is also lack of training the crises managers in this field (flood management), but not only at the municipality level, but also at the national level. There is also a problem legislation area. There are two laws to be used to cope with the flood situation (Law on Civil Protection and Law on Flood Protection), which do not correspond. There is specified different order of procedures, which could cause the lated warning of the citizens.

5. CONCLUSIONS

Flood risk management is an integrated part of the integrated flood management except the management of the water cycle as a whole, integrated land and water management and adoption of the best strategies. In general, the integrated flood management seems to be the right way to cope with the flood prevention issue as well as the issue of planning the coping capacities to be deployed during the flood situation.

This paper is focusing the issues of flood risk analyses, which are important as for the flood prevention area to know the most flood susceptible localities, to plan and realise the flood prevention features there or to concentrate the flood monitoring to those localities, as for the flooding impacts minimising to enhance the decision making process of crisis managers as well as commanders of rescue services deployed to cope with flood situation.

In the analyses the geographical information systems tools and function were deployed to process the analyses based on the methodologies developed at the Department of Fire Protection of the Technical University in Zvolen in the last years.

This paper presents the results of a case study provided for the Zvolen municipality.

The results of the analyses showed that the Zvolen municipality area belons mostly to the low or medium susceptibility degree of flood. The most flood vulnerable areas were found on the Hron river below the inflow of Slatina river into the Hron, near the Slatina flow ("Balkan" locality) and also on Neresnica watercourse.

The previously implemented flood protection measures increased the level of municipality flood resilence, but with them is possible to manage only the 100-years flood. There absent the plans to manage the 500-years and 1,000-years flood, which could be formed by the heavy rainfalls as a consequence of the ongoing climate change. Therefore, we can state that the municipality resilience to 500-years and 1,000-years flood is ignored and threaten the Zvolen municipality citizens.

6. ACKNOWLEDGEMENT

This paper is the result of the implementation of the project Centre of Excellence "Decision support in forest and country", ITMS: 26220120069, supported by the Research & Development Operational Programme (30 %) and project "Industrial R & D Center of technologies in critical infrastructure and nature conservation sectors", ITMS: 313011B649, supported by the Research and Innovations Operational Programme (70 %), both funded by the ERDF.

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INFORMATION ON IMPLEMENTED ACTIVE FLOOD PROTECTION MEASURES IN SLOVAKIA TO INCREASE THE RESILIENCE OF SOCIETY TO FLOOD

Abstract: The floods belong among the most occurring disasters which in Slovakia. It is confirmed also by the flood statistics data which provide the Slovak Water Management Enterprise, S.E. In the paper, in the theoretical part, we describe the issue of flood risk and integrated flood management in Slovakia. In the practical part, we introduce the measures and equipment which was implemented in the practice of the integrated flood management in Slovakia in last 10 years to increase the resilience of the society to flood. In the conclusions we summarize the current state and the future situation in terms of flood occurrence and flood protection, in particular in relation to impacts of ongoing climate change.

Key words: fire-fighting equipment, flood risk, resilience, Slovakia

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1. FLOOD RISK IN SLOVAKIA

Flood management practice is aimed at providing a sustainable mix of solutions to reduce flood risk. Flood risk is defined as flood probability x flood consequences. Good practice in flood risk management is to find the right balance in measures aimed at prevention, protection, preparedness, emergency response and recovery. Depending on the circumstances in a given area this balance may shift, however generally measures aimed at prevention and protection will provide a more sustainable protection than those with a more responsive nature (i.e. during or after an event). However the costs of such measures should be realistic and in some cases it may be more sustainable to use emergency response measures instead [1].

In this part of the paper we introduce the information on flood types in Slovakia, flood statistic provided by the Slovak Water Management Enterprise, S.E., and the principals of current aproach to integrated management of floods in Slovakia.

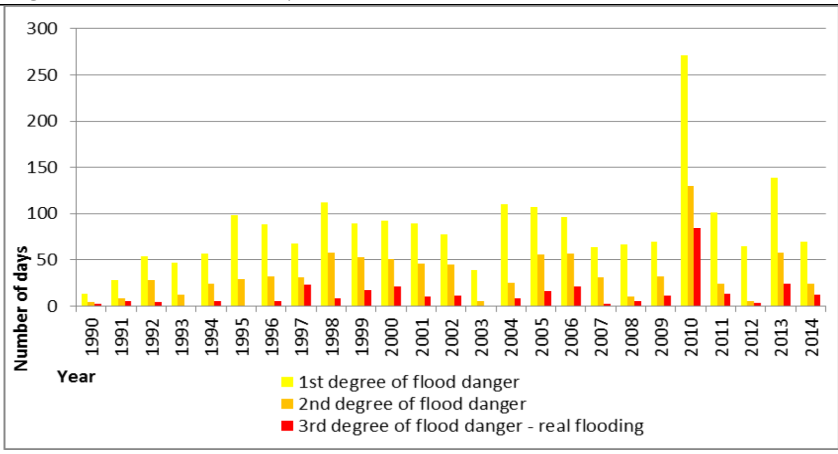
1.1. Floods in Slovakia

Flooding is usually named after the source of the flooding: coastal, fluvial or pluvial. A fluvial flood is caused by water coming from a river where the water levels are getting higher than the surrounding areas. A pluvial flood is caused by excessive amounts of rain, that cannot drain into the ground or into a drainage system. Sometimes a pluvial flood in a built up area is called an urban flood. In steep terrain a pluvial flood is called a flash flood. The flash flood is the most often occurring and the most dangerous flood, which is typical for many regions in Slovakia and which caused enormous material damage and damage to the environment in recent years [1].

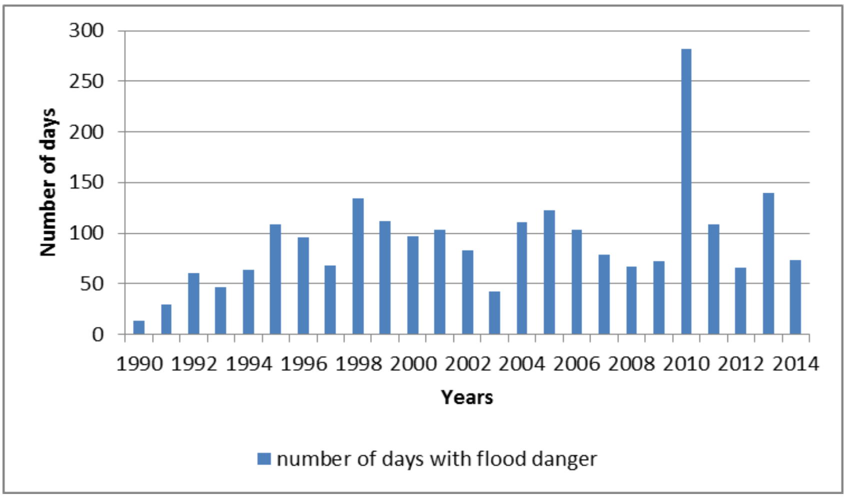
It should be noted that the above mentioned plans are mainly aimed at fluvial floods. In practice other types of flooding (pluvial, groundwater) also occur in the Slovak Republic.

1.1.1. Flood Statistics

In the graphs 1 and 2 we introduce the basic statistical data on flood situation occurrence in period 1990 – 2014. The basic statistical data are represented by the number of the days with the 1st, 2nd and 3rd degree of flood danger and number of days with flood danger at all.



Graph 1 – Number of the days with the 1st, 2nd and 3rd degree of flood danger in Slovakia in period 1990 – 2014



Graph 2 –Number of days with flood danger in Slovakia in period1990 – 2014

The 1st degree of flood danger occurs, in terms of the Law on Flood Protection [2], when reaching water level or flow rate (discharge) specified in the Flood Plan, and with the rising trend of water level; at the beginning of snowmelt, when runoff is assumed to increase according to meteorological forecasts and hydrological forecasts; upon the occurrence of internal waters (e.g. tributaries), where the water level in the adjacent watercourses is above the level of internal waters..

The 2nd degree of flood danger is declared [2]: when reaching water level or flow rate (discharge) specified in the Flood Plan, and with the rising trend of water level; on a watercourse without embankments/dikes when the water level in the watercourse reaches the bank line and tends to increase; during snowmelt, when according to information provided by the flood forecasting service a rapid rise in the levels of watercourses can be expected; when drifting objects create a barrier in the riverbed of the watercourse, at a bridge or a sluice, with the risk of obstructed flow profile and water spilling from the riverbed of the watercourse; in the occurrence of internal waters when the maximum level of internal waters is maintained by water pumping, as specified in the water structure's Operational Regulations.

The 3rd degree of flood danger is declared [2]: when reaching water level or flow rate (discharge) specified in the Flood Plan; on a watercourse without embankments/dikes when the flow rate exceeds the riverbed capacity of the watercourse, if water floods the adjacent area and can cause flood damage; when drifting objects create a barrier in the riverbed of the watercourse, at a bridge or a sluice, and water spills from the riverbed of the watercourse and can cause flood damage; in the occurrence of internal waters if, with full utilization of the water pumping station capacity and with its continuous operation, water rises above the maximum level specified in the water structure's Operational Regulations; in the occurrence of torrential rains of extreme intensity; when an area is flooded by water from the riverbed of the watercourse downstream (below) the water structure, if this flooding was caused by a malfunction of or an accident at the water structure installations or equipment.

1.2. Integrated Management of Floods in Slovakia

The Integrated Management of floods in Slovakia covers both areas of flood management: preventive and repressive, which is focusing more the activities oriented to minimizing the flood impacts.

Current preventive measures for flood protection represent the implementation of technical measures and adjustments made directly to watercourses, and also non-technical measures (e.g. the use of green infrastructure in landscape) in the river basins aimed at slowing water runoff from basin into watercourses. The measures are implemented in accordance with the Act on Flood Protection, which is transposed Directive 2007/60/EC. According to the Directive, preliminary flood risk assessment was carried out, based on which flood maps were elaborated, identifying regions with significant flood risk presence. In those territories preventive measures for flood protection are to be subsequently implemented in line with the flood risk management plans, which shall determine the necessary measures to eliminate this risk.

The measures to mitigate the impacts of flood / flooding focus more the technical equipment of responsible bodies for flood prevention and coping, i.e. Slovak Water Management Enterprise, Fire and Rescue Service and Voluntary Fire Brigades. These measures are introduced in the next chapter of this paper.

The institutional setting of flood risk management in the Slovak Republic is directly related to the governmental structure in general, then to Slovak Water

Management Enterprise, S.E., Fire and Rescue Service and Voluntary Fire Brigades existing in Slovakia.

The governmental structure of the Slovak Republic consists of 8 regions, 79 districts and 2891 municipalities. On average a municipality in the Slovak Republic has less than 2.000 inhabitants, but there are great differences between cities and rural areas.

Slovak Water Management Enterprise (SWME) performs the flood safeguarding works. This organization is governed by Ministry of Environment of the Slovak Republic. The SWME Corporate Directorate is located in Banská Štiavnica and directly coordinates the activities of its four branch enterprises. Operations of the SWME branches in the context of flood protection include: activities of managerial, administrative and coordinating nature, i.e. mainly the preparation of Flood Plans, flood risk assessment, preparation of anti-flood structures, comment procedures under the capital (investment) construction, data collection and monitoring, preventive measures, management of maintenance work on flood-protection structures, methodological management – in the period before the flood; operation of flood control rooms (centers) and technical staffs, carrying out patrol services, participation in flood commissions meetings, data collection and evaluation, coordination of security operations and of procurement of equipment and materials in the event of major floods, proposal of necessary measures, decision-making activities, provision of exceptional measurements and observations, production of monitoring reports – in the period during the flood; evaluation of flood situations, incorporation of experience gained into the land-use planning, programming and planning documents, proposal of necessary measures, related administration, evaluation of flood damage, processing of reports – after the flood. The SWME organization includes 20 sub-branches which administer individual river basins. They are able to provide, in their administered territory due to the composition of their staff and technology/equipment, comprehensive performance of security operations of in-the-field nature as part of flood protection. The sub-branches are mutually coordinated by a higher organizational unit, i.e. a SWME Branch Enterprise.

The Fire and Rescue Service (FRS) is responsible for carrying out the flood rescue works. Generally it is governed by Ministry of Interior of the Slovak Republic. The tasks and responsibilities of the FRS are stated in Act No. 315/2001 Coll. on the Fire and Rescue Service as amended by later regulations. It states as specific tasks of FRS, there are introduced some of them: executes tasks during firefighting, providing of help and performing rescue operations during accidents, natural disasters and other emergencies and during environmental protection; provides help during threat to life and health of persons, property of persons in law and natural persons; performs rescue operations during emergency removal of constructions and ice barriers; executes tasks in the field of material equipment and technical provision relative to the activities of FRS. FRS also participates in provision of emergency medical treatment and transportation of injured and diseased mainly during fires, accidents, natural disasters and other emergencies; emergency supply and emergency shelter for inhabitants and in provision of humanitarian aid; in liquidation of animal infection center; in execution of tasks of the Integrated Rescue System, civil protection, preparation of state defense and tasks relative with mobilization preparation too.

In a great number of municipalities there is a varied group of volunteers (fire fighters, rescuers, Red Cross, etc.) who provide assistance for the professionals when called upon by the mayor. Until this year, the volunteers did not have a role to play in emergency response to floods. The government of the Slovak Republic has noted that the coverage of FRS is insufficient and that a new approach will be applied wherein the voluntary fire service participates.

Voluntary Fire Brigades (VFB) were established by municipalities according to the law No. 314/2001 with respect to achieve even distribution of fire and rescue forces in Slovakia, primarily in municipalities where the FRS is not fulfilling requested service level. The Voluntary Fire Brigade is an organization in Slovakia, where in 2927 sites (towns, town districts and villages) it is recognized 2357 organizations of fire rescue volunteers, 1622 of them achieved classification (A1-A-B-C-D) which is related to the readiness be deployed for different level of tasks. An act Nr.37/2014 about Voluntary Fire Protection of Slovak Republic, adopted in parliament by January 29th, 2014, resulted in a formal role of Voluntary Fire Brigade also addressing floods.

2. IMPLEMENTED "ACTIVE ANTI – FLOOD MEASURES" IN SLOVAKIA

With the Decision from 23.03.2015 the European Commission approved a financial contribution from the Cohesion Fund for the project entitled "Active anti-flood measures." The beneficiary of this contribution is the Ministry of Interior of the Slovak Republic. The project is a part of the Operational Programme "Environment", under the Priority Axis 2 "Flood protection" and its total budget amounts to 159,719,101 euros.

The main ambition of the project was to enhance the country's preparedness for floods and to mitigate their consequences by streamlining the work of rescue services and improving their technical equipment. As the total amount of damage caused by floods in the last decade exceeded the amount of 707 million euros, the Ministry of Interior through the project Active anti-flood protection measures supported effective protection of life and health of citizens, their property, protection of social and economic infrastructure and environmental protection at the time of flooding. The project also contributes to enhancing the protection of members of intervening units and more efficient and faster performance of rescue works during the flood and after the flood.

The aid in the form of special flood equipment was distributed to the Fire and Rescue Service, Slovak Water Management Enterprise, S.E. and to 771 municipalities. At the local level, the anti-floods action pack, completed with the technical equipment for the each municipality voluntary fire brigade, which facilitates the management of emergencies at this level. Also 150 municipalities were equipped with the CAS 15 Iveco Daily vehicle.

In Table 1, we introduce the technical equipment implemented into the practice of the rescue services.

Table 1 – New technical equipment to cope with the floods in Slovakia [3]

Equipment Group	Equipment	Pcs	Organization
Automobiles	CAS 15 Iveco Daily	150	VFB
	Transport vehicle with stretcher and trailer for containers and container systems 6x6 on MB Arocs chassis	8 + 3	FRS + SWME
	Transport vehicle with stretcher and trailer for containers and container systems 8x8 on TATRA chassis	8	FRS
	Platform container belonging to the Tatra Phoenix 8x8	8	FRS
	Universal multipurpose loader- JCB 4 CX with trailer	8 + 4	FRS + SWME
	Polaris IPS XP 900 RANGER 4 x 4	194	FRS
	Polaris IPS XP 900 RANGER 6 x 6	30	FRS
	Bus for evacuation of victims and transportation of rescuers	8	FRS
	Command post vehicle	2	FRS
	Walking mobile spider excavator with trailer	5	SWME
Technical and material equipment	Anti-floods action pack	771	VFB
	Anti-flood mobile barriers	10 km	FRS + SWME

Equipment Group	Equipment	Pcs	Organization
	Container for long-lasting interventions completed with a trailer with a power generator and accessories to the container for long-lasting interventions	13	FRS
	Separator of oil agents with accessories	4	FRS
	Mobile purification device/ preparation of drinkable water	2	FRS
	Sewage (sludge) pumps with accessories	18 + 61	FRS + SWME
	Sewage (sludge) pumps for pumping in exterior	40 + 19	FRS + SWME
	Boat with solid frame for operation in the big watercourse with trailer and accessories	60 + 30	FRS + SWME
	Personal protective equipment for water rescue on the water	500	FRS
	Personal protective equipment for water rescue under the water	60	FRS
	Rescue evacuative net under helicopter (escape platform)	3	FRS
	Helicopter under-slung floating stretcher for water rescue	6	FRS
	Mobile pressure decompression chamber for divers	1	FRS
	High capacity pumping system	8 + 3	FRS + SWME
	Container for volunteers during floods with the basic personal protective equipment and basic tools	8	FRS + VFB
	Mobile container power generator	1	FRS
	Dozer with stoker for filling of sand bags	8	FRS

Except the technical equipment modernisation, there were established two new national flood rescue modules (National Flood Rescue Module Using the Boats and National Water Purification Module) and another two specialized flood modules to be involved to cope with flood situations also in abroad, e.g. the High Capacity Pumping Module and Module Using the Anti-Flood Mobile Barriers. In addition to it, there were also realised the theoretical and practical trainings of fire-fighters related to the issue of flood management and practical operation with the flood technique and material equipment.

3. CONCLUSIONS

In this part of the paper we would like to highlight the situation of further development of climate change and its impact on the territory of the Slovak Republic, in terms of flood occurrence in particular, as well as description of current state and problem in the area of flood protection.

The national reports of the Slovak Republic on climate change indicate that climate change will bring along more frequent occurrence of extreme weather, more frequent occurrence and longer duration of dry periods, alternating with episodes of high rainfall. Mitigation of adverse social, economic and environmental consequences can be achieved only by the appropriate proactive adaptation measures.

The Slovak Republic Adaptation Strategy to the adverse effects of climate change is the first comprehensive document of the Slovak Republic in this area. Based on the scenarios and analysis of adverse effects of climate change, it provides information about how to reduce vulnerability and on proactive adaptation.

One of the most negative impacts of climate change is occurrence of a few day episodes with high rainfall and also more frequent occurrence of very strong local storms. The national reports of the Slovak Republic on climate change show that the major problem in Slovakia is the violation of water retention ability of the landscape and more and more frequent occurrence of flood conditions on river flows threatening adjacent areas. Floods occur mainly due to protracted precipitation caused by regional rainfalls intervening large areas, but also due to torrential rains affecting smaller areas, especially in the spring months, with short duration times, but with large, highly variable intensity. Preventive measures for flood protection significantly contribute towards prevention of flood resulting damage, resp. mitigation of the damage scale.

To prevent the flood occurrence mostly on a municipality level it necessary to study the factors which caused the flood. A big problem of the last years is the management activity in the forest, especially the timber logging process, which destroys the soil structure, firms it, drains the forest ecosystem and this way increases not only flood, but also fire and landslides risk. This situation alerts many experts world around, but also in Slovak condition, however the situation is instead of implementation of environment more friendly technologies in this process not getting better.

The active flood prevention measures are originally provided by the Slovak Water Management Enterprise employees. The only problem is the underfunding of this enterprise and also those activities.

The Active Flood Protection Measures project, which was implemented in Slovakia during the year 2015, has efficiently increased the level of flood resilience of the country in terms of reaction of competent water management and rescue forces to existing flood. Now, the technical equipment for the performance of floods prevention and flood rescue works corresponds to the required state and technical level, either quantity and deployment at local, regional and national level, however mostly with 100-years floods. Still, there is a problem with the adaptation to 500-years and 1000-years floods. Those scenarios are not included in the crisis management and civil protection documentation, except the municipalities, where such flood occurred in the recent years.

The aim of this paper was to introduce the current state of flood situation in Slovakia and the measures which were adopted in the recent years to increase the level of resilience of the country, and this way also population of the Slovak republic to flood situation, which occurrence seems to be more and more frequent in the future as an impact of the ongoing climate change.

4. ACKNOWLEDGEMENT

This paper is the result of the implementation of the project Centre of Excellence “Decision support in forest and country”, ITMS: 26220120069, supported by the Research & Development Operational Programme (30 %) and project “Industrial R & D Center of technologies in critical infrastructure and nature conservation sectors”, ITMS: 313011B649, supported by the Research and Innovations Operational Programme (70 %), both funded by the ERDF.

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FINANCING MEANS FOR DISASTER RISK MANAGEMENT - THE CASE OF ALBANIA

Abstract: The aim of this paper is the provision of a comprehensive report on the possible and available means for financing the disaster losses in case of disaster events. This will be discussed in the framework of disaster management techniques, which include also the issue of financing. In addition, the paper will focus on the implementation of different means of financing in Albania. While discussing this case study, an overview of Albania's disaster governance and policy landscape will be offered. The paper will offer several recommendations, especially in the light of introducing some means of innovative financing sources that could be adopted in the future to achieve the goal of sustainable environmental financing in general and disaster losses financing in particular. The methodology used includes the revision of the main literature in the field, review of public data from national and international institutions, expert consultation and interviews; laws and draft-laws revision.

Key words: disaster risk management, financing, insurance, financial resilience, Albania

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1. INTRODUCTION

Responsibility for financing disaster risk reduction and civil protection is a contested topic among governments, multilateral organizations, development banks and commentators. Albanian population has experienced numerous man-made and natural disasters such as flood, droughts and even earthquakes. They have had a serious effect on Albanian economy and country development. Despite the controversy, in Albania there has been some progress in implementing financing mechanisms. Specific disaster risk management projects and programs are new to public policies, but their role is increasing as the issue is obtaining more and more public interest.

The aim of this paper is the provision of a comprehensive report on the possible and available means of financing economic and social recovery measures in case of disaster events. This will be discussed in the framework of disaster management techniques, an outline of which is offered in the first part of the paper. In addition, the paper will focus on the implementation of different means of financing in Albania. This is preceded by an overview of Albania's disaster governance and policy landscape. At the end the paper will offer several recommendations, especially in the light of introducing some financing means that could be adopted in the future to achieve the goal of sustainable financial resilience.

2. AN OVERVIEW ON DISASTER RISK MANAGEMENT AND FINANCIAL RESILIENCE

Disaster losses have been increasing all over the world. This have been principally conditioned by the increases in population and assets exposed to adverse natural events, a trend likely to worsen with growing urbanization, environmental degradation and expected increase in the number and intensity of hydro meteorological events resulting from climate change [4]. It is recognized that disasters can have widespread impacts, causing not only harm and damage to lives, buildings and infrastructure, but also impairing economic activity, with potential cascading and global effects. These impacts generate losses for households, businesses and governments as damages need to be repaired, homes and businesses rebuilt, and activities resumed. These financial costs may be catastrophic in nature, aggravating economic and social impacts. While disasters impact the macroeconomic indicators in any country they occur, their impact is much serious in developing countries and emerging economies [5]. This is due to many factors, including the infrastructure conditions, lower building standards, absent or poor incentives for mitigation, and underdevelopment of private markets which do not provide catastrophe insurance for homeowners and small businesses, and greater constraints on government resources available to cope with disasters. Although capital losses might be smaller in absolute terms when compared to those in developed countries, their relative weight and overall impact tend to be very significant, even affecting sustainability [4]. Of the 40 worst catastrophes in terms of the number of victims in 1970- 2001, 39 occurred in developing countries [5]. A 2013 study states that disaster losses in developing nations amount to $862 billion, which is considered under-estimate [8]. These devastating events affect millions of people around the world, destroying homes and livelihoods. With countries facing more frequent and severe disasters and increasingly constrained public finances, the development of disaster risk management strategies has become indispensable for enhancing the resilience of societies against disasters and reducing their long-term social and economic costs and this become quite a challenge to governments. In addition, in these countries often the mentality imposes a further burden to the implementation of disaster risk management practices. This includes the mentality of governments which often develop short run strategies corresponding to the election cycle, the mentality of private sector which develop its activity focused on short term profit, without taking into account any damages imposed to the environment and infrastructure, and the mentality of the population which do not consider insurance as a risk protection technique ([9]; [5]; [2]).

The public sector has in most of the cases the responsibility to bear the cost of damages caused by a disaster, acting as insurers of last resort [1]. The analysis of financial exposure of a country to disasters is an important part of disaster risk management strategies. This analysis is a subset of the overall macroeconomic analysis [4].

Governments generally have access to various sources of financing following a disaster. These sources can be categorized as ex post and ex ante financing instruments. Ex post instruments are sources that do not require advance planning. This includes budget reallocation, domestic credit, external credit, tax increase, and donor assistance. Often the public sector relies on such ex post financial means, where international assistance has been especially important. Even though funding from donors and international development banks can be an important part of government catastrophe risk management strategy, over-reliance on this approach has often been the cause of the lack of economic incentives for countries to engage in proactive disaster risk management [5]. In addition, ex post international assistance in some occasions can result inadequate, since often is offered in-kind, which has several disadvantages [7].

The emphasis on ex ante disaster risk management practices, especially in terms of financial planning is deemed crucial. Ex ante risk financing instruments require proactive advance planning and include reserves or calamity funds, budget contingencies, contingent debt facility and risk transfer mechanisms. In this respect, risk transfer instruments are of major importance and much emphasized in academic literature, financial strategies and international institutions recommendation, as a mean of risk management that should be considered and implemented in developing countries. Such means include insurance and reinsurance, parametric insurance and

Alternative Risk Transfer (ART) instruments such as catastrophe (CAT) bonds ([5]; [7]).

Financial strategies for disaster risk management are intended to ensure that individuals, businesses and governments have the resources necessary to manage the adverse financial and economic consequences of disasters, thereby enabling the critical funding of disaster response, recovery and reconstruction. These strategies depend on a comprehensive identification and accurate evaluation of natural and man-made disaster risks [13]. Relevant financial authorities play a pivotal role in disaster risk management strategies given their responsibilities for economic, financial, fiscal and budget policymaking, planning of public investment and coordinating public expenditures. These central responsibilities as confirmed by the OECD framework include[13]:

- Ensuring that financial vulnerabilities within the economy are addressed through private markets, government-backed schemes or other instruments in order to promote financial resilience, and ensuring the availability and efficiency of compensation mechanisms, whether private or public
- Ensuring proper fiscal management of disaster risks by anticipating potential budgetary impacts and planning ahead to ensure adequate financial capacity and rapid release of funds, thus enabling emergency response, reconstruction of public assets and infrastructure, and targeted financial assistance
- Ensuring that clear rules regarding post-disaster financial compensation are established to enable rapid compensation, demonstrate solidarity and clarify the allocation of disaster costs, thereby promoting public confidence in country financial strategies while aligning incentives and reducing moral hazard
- Ensuring the soundness and resilience of the financial sector with respect to disaster risks, including through proper regulation, business continuity planning, and stress testing
- Ensuring the optimal allocation of resources for disaster risk management, including assessment of the cost-effectiveness of major public financial investments in disaster risk reduction projects.

A comprehensive approach to disaster risk management should emphasize both ex ante measures (prior to a hazard) and ex post activities. [4] give a list of the instruments that can be used by governments to mobilize funding after a disaster. It also provides an assessment of the time necessary to mobilize funds through these instruments (Figure 1).

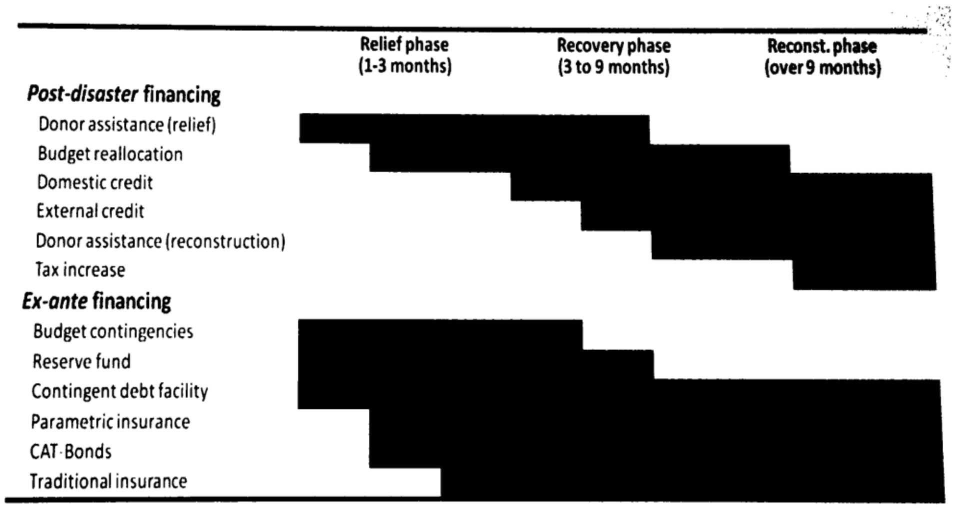

Figure 1: Sources of post disaster financing, Source: Ghesquiere and Mahul (2010)

Finally, as the frequency of disaster events is expected to increase with the increasing risk of climate change, exposure of businesses, infrastructure, assets and economies to disaster risk will be even more serious. The inexorable increase in disaster loss over the past 50 years underscores the fact that ad hoc action may no longer be adequate. The rising frequency and costs caused by natural hazards call for more action to reduce disaster risk. A more proactive approach is urgent, starting with a better understanding of the sources of risk, the systematic consideration of risks in development planning, and the development of financial protection mechanisms. Understanding how to involve the private sector in responding to these risks – or encouraging them to take advantage of the new business opportunities that may arise from changing climate conditions – is crucial to catalyze greater investment in activities that increase countries, businesses, and communities' resilience.

3. DISASTER RISK MANAGEMENT AND FINANCIAL RESILIENCE IN ALBANIA

3.1. Legal Framework for Disaster Risk Reduction and Civil Protection

In Albania, the disaster risk reduction policy, strategies and plans have often been under revision to reflect the needs of the countries and the international DRR practices. Two articles in the Albanian Constitution, article 170 and 174, refer to emergency and disaster situations and measures to be taken in case of them. The Law on Civil Emergency[1] states the measures to address the disasters. The

[1] Law Nr. 8756 dated 26/03/2001, "On Civil Emergency Services"

Government structures responsible for emergency situations in the country are in place. The Council of Ministers leads the process of the emergencies management. All the responsive steps of emergencies are coordinated by the Inter-Ministerial Committee of Civil Emergencies. The 'National Civil Emergency Plan" was developed in 2004. The plan defines the structures for disaster risk management in Albania. The General Directorate of Civil Emergency was established in the Ministry of Interior. The main structures of this Department include the Unit for Civil Emergency Planning and Coordination, the Unit for Fire-Fighting and Rescue operations and the National Operations center for Civil Emergency (NOCCE). In addition, the respective responsibilities at prefecture level and municipal level have been defined [10].

Some further steps are being adopted in the area of DRM. A five year strategy on Disaster Risk Reduction and Civil Protection from 2014-2018 has been developed [11]. In addition, the Law on Civil Emergencies is being revised. According to the new law the structure of the Department of Civil Emergency will be based on a more functional and versatile scheme that should simplify the cumbersome command and control chain of the previous, rigid and centralized, system. Moreover, the new Civil Protection structure will adopt a multi-level system, emphasizing the role of local institutions, whose competencies and responsibilities will be enhanced and enlarged to include preventative activities and planning.

3.2. Financing mechanisms for Disaster Risk Management in Albania

Figure 2 shows a diagram of Disaster Risk Reduction and Civil Protection financing in Albania, where different funds, financing mechanism, implementing agencies and respective relationships are included. Details on each are provided in the following sections.

3.3. Domestic funds for Disaster Risk Reduction and Civil Protection

The state budget, as specified in the current Albanian Law "On Civil Emergency", is the primary financial resource for civil emergency planning and crisis management. The Law also states that the Ministry of Interior (MoI) and other ministries should have an annual budget for civil emergencies. Therefore the budgetary provision consists of four types: the emergency budget of the MoI, the emergency budgets of local government, reallocated budgets of line ministries and the CoM Reserve Fund. The disaster preparedness and post-disaster recovery are the main focus of the funds allocation. However, the financial means for DRR in Albania are extremely limited, especially at the local level.

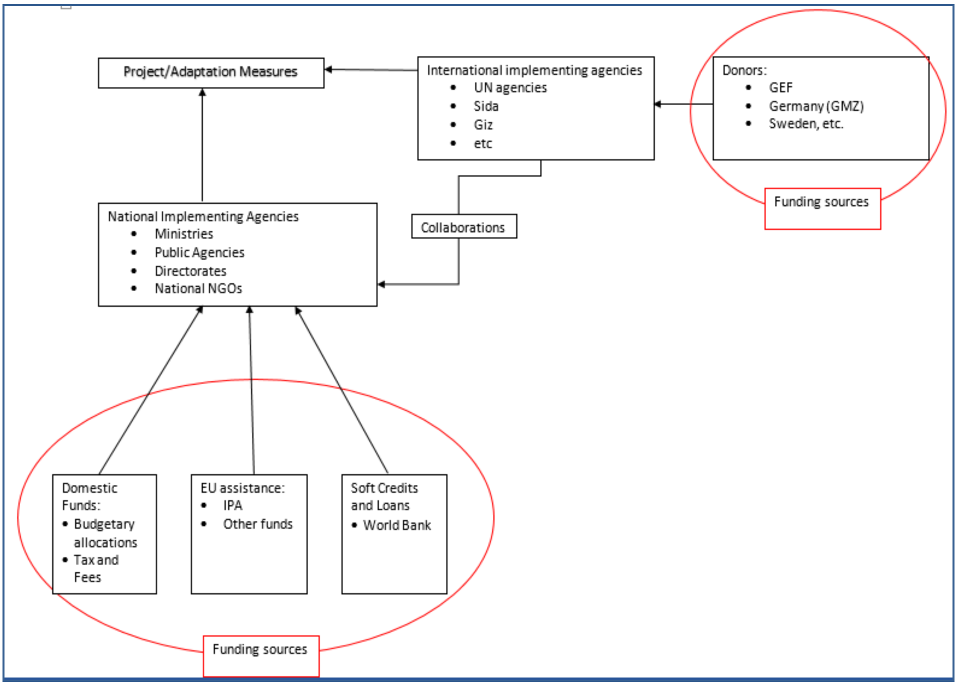

Figure 2: Disaster Risk Reduction and Civil Protection Financing Schemes in Albania, Source: Authors

The new draft law which is being developed[2], referring to this section, specifically states that the line ministries and central institutions should have a separate budget line for Civil Protection at the rate of 0.3 to 1 percent of their total budget. In addition, the draft law addresses the issue of the necessity for local governments to receive financial support from the central government for civil protection work, also mentioning their obligation to use some of their incomes. The decentralization process has led to the increase of competences of local government. So on one hand it is foreseen that they will receive funds for civil protection from the central government but on the other hand they have to obtain their own income and also raise funds through projects from other donors. So far at municipal level, only 3% of the budget is available to compensate its citizens for the DRR-related losses.

3.3.1. International assistance for Disaster Risk Reduction and Civil Protection

In Albania, international assistance has been and remains very important for the purposes of Disaster Risk Reduction and Civil Protection in general. Instrument for Pre-Accession (IPA) has been the European Union's main mechanism for providing

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[2] http://www.mbrojtjacivile.al/?page_id=453

financial assistance to specific investments in EU candidate countries, such as Albania.

A great and effective contribution in accomplishing the DRR goal has been given by the World Bank through various projects. The Albanian Disaster Risk Mitigation and Adaptation Project (ADRMAP) [12], of about USD 10 million, is the most important one. The main coordinator of this project is the MoI. The project consists of five components: 1) Disaster Risk Management and Preparedness - USD 4.89 million; 2) strengthening of the hydro-meteorological services - USD 2.09 million; 3) development of building codes USD 0.36 million; 4) catastrophe insurance - USD 2.65 million; 5) project management – USD 0.01 million (IPA assessment – 2011, p.15).

The South Eastern Europe Disaster Risk Mitigation and Adaptation Program was initiated by the World Bank, the WMO and the UNDP in 2007. The goal of this program is to develop and build national capacities in the following directions: 1) disaster risk management, institutional capacities and governance; 2) hydro-meteorological services; and, 3) financial risk transfer mechanisms, to assist countries in reducing risks associated with natural hazards.

Since 2011, under IPA programs [6], a team from different Albanian institutions with responsibilities in DRR&CP, has frequently participated in seminars, workshops and table top exercises, as well as in several field exercises organized regionally, concerning civil emergencies of various scenarios, such as earthquakes (Slovenia) floods (Croatia) etc. [3]

Albania has regularly turned to the international community for assistance, using both the NATO Euro-Atlantic Disaster Response Coordination Centre (EADRCC) and the EU Mechanism (monitoring and information centre, MIC) as the domestic resources do not meet the international standards yet. A total of twenty-two countries, plus a number of international organizations and NGOs, provided assistance of various kinds to Albania during the wildfires of 2007, floods of January and December 2010 and winter emergency in February-March 2012. On trilateral basis, a number of other agreements have been signed for instance: the agreement between Kosovo's Emergency Management Agency, Macedonia's Crisis Management Centre and Albania's GDCE, on emergency and relief operations. As e result, with USAID support, the MoI and MoD of the above mentioned countries signed a joint declaration and a program for regional cooperation in the field of crisis and emergency management.

3.3.2. Other sources of financing in case of disasters

It is clear that other financing possibilities have to be implemented in Albania. The overreliance on international aid can impact the long run development of sustainable strategies in the area of DRR. Based on international experience, the following options can be considered:

Insurance and reinsurance payments are considered as one of the main alternatives in the literature but their implementation in Albania has several problems. First, there is a very low level of private insurance in the country. This is caused mainly by the low income per capita level of the population, especially in most risky areas, which makes the insurance payment unaffordable. Other problems, especially related to the supply side, affect the lack of private insurance in the country. Problems with property rights make also the insurance companies unwilling to sell insurance to the population.

Financial Markets. This is a very valuable tool insurance company and governments can rely on. The problem with Albanian insurance companies is that because of their size, such financial instruments may be very expensive to purchase. Moreover, the way this contract will be regulated and other related issues may pose some barriers to this finance opportunity.

New Taxes. This is a very sensitive measure, since it relies on the solidarity of those who are not directly affected by the disaster event. This mean might be particularly problematic in Albania, because the population reacts easily to new taxes. Moreover, the way the new tax revenues will be used might be put into question, since the confidence of the population on the tax system is very low.

Internal and External Credit. These are alternative financial recourses on which the state can rely in case of disaster event. However, these means have to be carefully considered, since their cost will be borne by future generations.

Budgetary relocations. This may be the most difficult issue. This possibility of financing poses a very delicate concern. Different governments, based on the importance and awareness on such problems, allocate differently the state budget to different sectors.

4. CONCLUSION AND RECCOMENDATIONS

Financing possibilities for the damages caused by disasters are becoming a very important concern in public policy. In Albania, the costs of natural disasters have been covered by public (central and local) budgets and vulnerary contributions. The insurance system is still very weak, particularly in terms of private and voluntary insurance. Other market financing options have not been introduced yet. Disaster risk reduction strategies and measures ought to be combined with financial protection instruments in a coordinated action by the government and private sector. In addition to having a national emergency plan or strategy for ex post actions, Albania and other developing countries and emerging economies ought to design a consistent national plan or strategy to manage disaster risk. Those plans should be developed jointly with input from all stakeholders. Providing effective means for ex ante financial protection is essential because it facilitates the availability of funds when they are needed most, and can reduce the ex post financial burden of recovery and reconstruction following a catastrophic event.

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INSURANCE AVAILABILITY FOR DISASTERS RISK MANAGEMENT IN ALBANIA

Abstract: Albania has high exposure against disasters. They cause several millions of Euros per year. Who pays for the losses? Where the governments find the money to indemnify the business and the individuals? The financial burden of all the losses is held by the Albanian citizens, paying higher taxes. Why? Because the commercial firms do not insure their businesses; the farmers do not insure their products, the homeowners do not insure their houses. Why? They do not have enough money to pay the premiums, they do not know anything about insurance, or they believe that the government has the duty to indemnify them in case of losses? The aim of this paper is to point out the factors that affect such behavior of individuals and firms with respect to the insurance technique and to make evident some possible alternatives to orientate them toward the insurance operators.

Key words: insurance, losses, disaster, property, indemnity, Albania

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1. INTRODUCTION

Albania is affected from the natural hazards, related to the geographic position and climatic changes. Up to now, the damages from natural disasters have been indemnified by the government. The state has no capacity to fully indemnify the injured persons and the injured persons are never satisfied. In order to mitigate the disaster risk, it is now the time to transfer the financial risks to the private insurance market. The aim of this paper is to point the possibilities that the Albanian insurance market has to manage the disaster risk and the readiness of the households and business firms to insure their properties. Referring to the literature, the second section describe the reasons why the insurance companies are not very willing to insure the disaster risks and what part of economic disaster losses is actually insured all over the world. A short overview of disaster hazards affecting Albania and the institutional management of disaster risk is presented in the third section of the paper. The fourth section presents the development of the insurance market in Albania and its capacity to manage the disaster risk. Some conclusions are presented in the final section. The analysis of the paper is based on secondary data, published by international and national institutions.

2. INSURING DISASTER LOSSES

Insurers normally insure only pure risks and not all pure risks are insurable. There are some requirements that should be fulfilled before a pure risk can be privately insured. One of these requirements is that the loss should not be catastrophic. This means that a large portion of exposure units should not incur losses at the same time. The insurance companies would ideally wish to avoid the catastrophic losses because they are unpredictable and the rate making process is very difficult. But actually the insurers provide coverage for catastrophic losses, natural catastrophes and man-made disasters. That means that insurance companies have found a way to use the resources of the financial market to meet the problem of catastrophic losses (Dorfman M., 2005). There are at least three basic approaches. First, reinsurance may be used by which insurance companies are indemnified by reinsurers for catastrophic losses. Second, distributing their coverage over a large geographical area and as a result the possibility of a catastrophic loss will be reduced. Third, catastrophic bonds are special bonds issued insurers to help them pay for natural catastrophic losses. The bonds are usually rated below investment grade (junk bonds) and pay relatively high yields.

According to the Swiss Re Sigma publication, economic losses from natural catastrophes and man-made disasters across the world were estimated USD 175 billion in 2016. Natural catastrophe-related economic losses were estimated USD 166 billion in 2016, coming mostly from earthquakes, tropical cyclones, other severe storms and droughts in Asia, North America and Europe. Insurance coverage is not universal. There was an all-peril catastrophic protection gap of USD 121 billion in 2016. Figure 1 shows the difference between insured and economic losses over time, termed the insurance protection gap. The rate of growth of economic losses has outpaced the rate of growth of insuring losses over the 25 past years. In terms of 10 rolling averages, insured losses grew by 4,6% between 1991 and 2016, and economic losses by 5,6%.

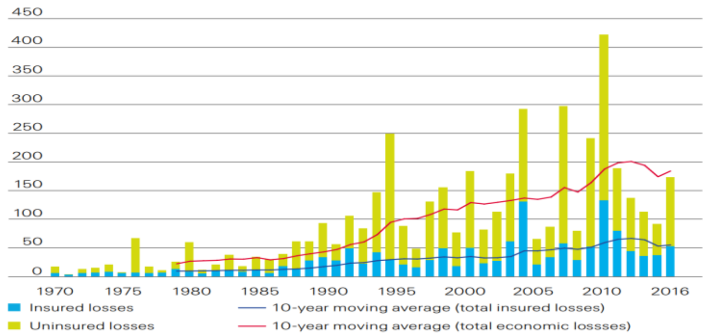

Figure 1 – Insured losses versus uninsured losses, "Sigma"

3. DISASTERS MANAGEMENT IN ALBANIA

3.1. Disaster risk in Albania

The four main hazards affecting Albania are forest fires, floods, earthquakes and snowstorms. Other hazards include landslides, drought, epidemics, avalanche, tsunami, technological hazards, the dam burst and storms. Risk to natural hazards is primarily driven by economic, social and environmental factors, as well as institutional and political context

While information on risk to natural hazards in Albania remains patchy, available data show that the risk level is increasing and is comparatively higher in Albania than in neighboring countries. According to the World Risk Index of 2014, Albania ranks 37th, Serbia ranks the 76th, and Bosnia and Herzegovina ranks the 95th in the world in terms of the risk of becoming the victim of a disaster resulting from an extreme natural event.

3.2. Institutional management of disasters in Albania

The legislation for disaster management in Albania is composed of the articles 170 (extraordinary measures) and 174 of the Constitution of the Republic of Albania (which address the issues of state of emergency and disasters, the acts issued and the measures taken under these circumstances) and the law on 'Civil Emergency Services' – Law 8756 from 2001 and Law Nr. 11/2013 "On some amendments to the Law no 8677 dated 04.05.2001.

At a national level, the Council of Ministers leads and governs the national system of civil emergency management in Albania. Each line Ministry is responsible for planning and handling civil emergencies, according to their area of expertise.

Albania developed a 'National Civil Emergency Plan' in 2004, in line with the current law.

The current law refers to the participation of civil society through volunteer services and refers to the Albanian Red Cross (ARC) as the main civil society partner. The ARC has the responsibility for local risk and capacity assessments, public education and community-level disaster planning.

Regarding financial resources, the Law on Civil Emergency Services mentions that the State budget is the "primary financial resource for civil emergency planning and crisis management" and that ministries should have an annual budget for civil emergency planning and response within their respective field of activity.

The Albanian Government is cooperating with Europa Re (shareholder, member), the World Bank and UNISDR in the context of the South Eastern Europe and Caucasus Catastrophe Risk Insurance Facility (SEEC-CRIF)) to carry out the preparatory work required to launch a regional insurance scheme. The risk context in Albania requires measures to establish incentives to increase the insurance coverage among homeowners and small and medium businesses in order to reduce the dependency on government assistance in case of disasters.

4. INSURANCE MARKET CAPACITY IN ALBANIA

4.1. Features of insurance market in Albania

Unlike the bank sector, where the state has lost its monopoly position since 1993, the Albanian government has been the sole owner of the only insurance company (INSIG) until 1999. The first private insurance companies have been licensed in 1999. Participation of the foreign capital has been too late, in 2007. In December of 2016 there were ten insurance companies operating in Albania: two were life insurance companies, seven were non-life insurance companies and one was a composite company. The insurance companies which operate in Albania should be licensed from the Albanian Financial Supervisory Authority, established in 2006.

The insurance market in Albania has been always dominated by non-life insurance products, which share was about 92,7% of the total volume of gross written premiums. The structure of the insurance market in Albania has been changed from the state monopoly (until 1999) to oligopoly (up to 2002) and then to monopolistic competition (during the last decade) (Sharku G., 2015).

Compared with other Western Balkan countries, the insurance market in Albania is less developed. In 2015, Albanian citizen has spent on average Euro 35 on insurance products (in Bosnia & Herzegovina and in Serbia the density rate in 2015 has been respectively Euro 80 and Euro 93). The insurance penetration index was 0,99 % in Albania (In Bosnia & Herzegovina and in Serbia has been respectively 2,1% and 2%). Insurance companies insure the property of business and households, against the fire and other natural perils, on a voluntary basis. In terms of gross written premiums, the share of property insurance was 14% in 2015, recording the minimum value of the last decade. The share of the motor third party liability has been 64% in 2015. Motor third party liability is provided on a compulsory basis. Voluntary insurance activity is still underdeveloped. Actually, the life insurance and the major part of property insurance are purchased due to the application for credit in commercial banks, which require the assurance of property and borrower life. Therefore, these products are indirectly provided on a compulsory basis, which means that the real share of voluntary insurance is even lower. It shows a low level of insurance culture in Albania. There are some other compulsory coverage for business and professionals, particularly in liability insurance, but their share is very small (about 2%). In many cases of these categories, the law is not applied.

4.2. Insurance market capacity for managing disaster losses

In the present the insurance market is not actively involved in the process of disaster management. Up to now, the management of disasters, especially natural ones, has been considered as a government responsibility. In Albania, people always have relied on government to provide protection and financial relief from natural disasters and they have historically been indemnified from the state budget. But when the government offers protection against the risk of natural disasters, it is not free. In other words, all the citizens have to contribute in indemnifying the damages through paying higher taxes. The funds that the government use to indemnify the disaster damages have been removed from other sectors of the economy. The experience of all developed countries over the world, provide several methods of relieving the state burden, by involving the insurance market in the disaster management process. There are at least two alternatives to be followed:

1. The government may manage by itself the disaster risk by purchasing "cat bond" in international reinsurance markets. This option is suitable especially for the countries where the domestic insurance market is not developed. But, if the government selects this alternative, the domestic insurance market will be condemned to be underdeveloped.

2. The second alternative is the collaboration of the government with the domestic insurance companies. For example, in Germany, the state collaborates with insurance companies in the disaster risk management, by not indemnifying the injured people from any natural disaster, if they have no insurance. In the context of a low level of insurance culture in Albania, the implementation of this model will not have any positive impact on the person's behavior toward insurance. Therefore the best option is that insurance against disasters should be mandatory.

According to the World Bank, in Romania, where the insurance against seismic risk is obligatory, about 60 percent of the homeowners has purchased insurance policies. Following the successful experience of Romania, this option is suggested in 2014 by the World Bank to be followed in Albania. The World Bank has given some suggestions regarding the coverage range and the premium rates. The minimum coverage should be between Euro 20.000 - Euro 40.000 and the premium should not exceed Euro 50. The draft-law has been discussed by the interested parties and the people have been very sensitive especially in the insurance price. First of all, they consider the premium very high in respect to their revenues. In Albania, the citizens spend on average Euro 35 for insurance products (with the exception of social insurance). The imposition by law of a new extra premium is considered as a large burden to them. We think that this is one of the reasons of dragging the approval of the law. Another problem related to the premium, is that not all the citizens should pay the same premium. There are many buildings, constructed after 1990, without any legal permission, in very risky areas. But actually, almost all the buildings have been provided or are going to be provided with the legal documents, and it is not fair that all homeowners pay the same premium. The bonus-malus system should be applied. The premium amount should depend on the riskiness of the area and the value of the building. But the insurance market in Albania does not implement the bonus-malus system, even for the motor third party liability which shares the largest part of the insurance market. Free of bonus-malus system, the insurance market in Albania will not provide the insured with fair premium rates and it is going to keep far away the potential customers, even in the compulsory insurance schemes.

5. CONCLUSIONS

Albania is vulnerable to natural hazards. Disaster risk needs to be considered as a political priority to ensure the required cooperation across all the interested parties and to bring about the required behavioral change in the Albanian society. Actually, the disaster damages constitute a large burden to the state budget. It is the time to share this burden with other operators in the market, such as insurance companies. Household and business firms in Albania are not willing to voluntarily insure their property and activity, due to the low confidence they have on insurance companies and due to the low level of insurance culture. We think that the lack of the bonus-malus system constitutes the most crucial problem of the insurance market. In order that a new insurance product is accepted from the Albanian citizens, such as disaster insurance, it should be necessary and fairly priced. The necessity of disaster insurance policies is actually accepted by the government, insurance companies and the citizens as well. Instead of paying higher taxes, the citizens are willing to pay the premium for insurance. But they are not willing to subsidize each-other, as they are paying for a product which is to be provided by private operators. In order that the implementation of the World Bank recommendations is successful, the Albanian government has the duty to enforce the rule of law, in order that all the homeowners be included in the compulsory disaster insurance program, and the Albanian insurance companies, on the other hand have the duty to respect the contract, in order to get the confidence of the insurers and to treat them equally and fairly.

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MULTI-CRITERIA INVENTORY OF BURNED AREAS IN LANDSCAPE SCALE: CASE OF ALBANIA

Abstract: The paper investigates the burned areas in Albania as derived from CLC data through a multi-criteria approach. The analysis criteria consist of i) Social Impact (e.g. transportation/ accessibility, distance to the closest settlement area, relation with areas of national importance) ii) Environmental (e.g. sunshine duration, wind speed/wind direction, solar radiation, outdoor temperature, precipitation, precipitation humidity) iii) Physical (e.g. surface area, perimeter, neighboring Land Cover, former Land Cover, slope, orientation, elevation). The study concludes with a proposal of multi-criteria inventory methodology for burned areas applicable to any territory. The proposed method is aimed to serve as an initial step in support of holistic Disaster Risk Management and Fire Safety (DRMFS) agendas in landscape scale.

Key words: multi-criteria evaluation, Corine Land Cover, DRMFS, landscape hazards, Albania

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1. INTRODUCTION

The paper presents a multi-criteria inventory methodology that can be used during the analysis process of burned area of the territory in landscape scale. The proposal can serve as the first stage of a multi-criteria analysis of zones affected by wild-fires, in order to develop holistic preventive approaches in Disaster Risk Management and Fire Safety (DRMFS) agendas for any territory at coarse scale. In fact, wild-fires can be investigated in a gradient of spatial and temporal scales as reviewed in previous studies [14][21]. Whereas, in this study it has been decided to proceed at the landscape scale due to the lack of similar studies at coarse scale for Albanian territory as well as due to the availability of data.

1.1. Literature Review

Referring to literature there exist disaster risk evaluation attempts based on multi-criteria analysis that may serve as multi-criteria decision making methodology in DRMFS processes [22]. This broad investigation of burned areas is very crucial to understand and mitigate the risks of wild- fires. In these issues, the efficiency of fire disaster management is very related with comprehensive analysis that include different disciplines and try to understand aspects such as population changes, economic issues, land use typologies and the ecosystems of wildland areas [7]. At the same time, there are studies that base the analysis on criteria such as topography, vegetation, climatic and socioeconomic parameters [11]. In addition, other researches focuses on components such as: spatial organization of infrastructure, patterns, vegetations, difficulty of fire management and frequencies of wildfires in the past [15].

The impact of fire hazards on socio-economic issues and landscape aspects and the mitigation of fire disasters becomes very important in intermediate zones between forest and human settlement [25]. These transitional areas-called wildland-urban interface (WUI)- consist of human settlements that are spread near or within wildlands [3][19][23]. The character of WUIs is classified based on human activity (population, dwellings, infrastructure etc.) and features of vegetation in these areas [12][13][19]. Fire in Wildland-Urban interface areas in Mediterranean region is one of the most significant problems because of the impact that it can have on daily human activity [5]. Moreover, urban development in these zones need to be done within proper planning policies that takes into consideration the high threat of fire hazards at WUIs [17].

Climate is one of the main factors in wild fire frequency and probability of occurrence since it determines the wet and dry periods. Different authors have proposed fire-weather indices as a useful tool for the provision of current and future fire danger climatological maps, as an easily interpretable and meaningful information for fire managers [4][6]. The moisture of the vegetation is affected by the weather through different processes and fire weather indices evaluate the dryness of the vegetation [10]. Different models on fire frequency and probability of occurrence are derived from many authors considering temperature, humidity, precipitation [20]. Other factors such as wind profiles (speed and direction) and conditions near earth surface are considered in fire activity [2].

1.2. The Study Area

According to seasonal severity rating evaluation by Joint Research Center on average values within the time span of 1981-2010 and about the assumptions for 2071-2100, Albanian territory is not categorized under the hottest spots of Forest fires occurrences around Mediterranean (figure 1-left). Yet, according to the same source, even during one of the lowest records such as 2014, Albania faced 4 wild fires over 50 ha, 36 % of which being forested and wooden areas [9].

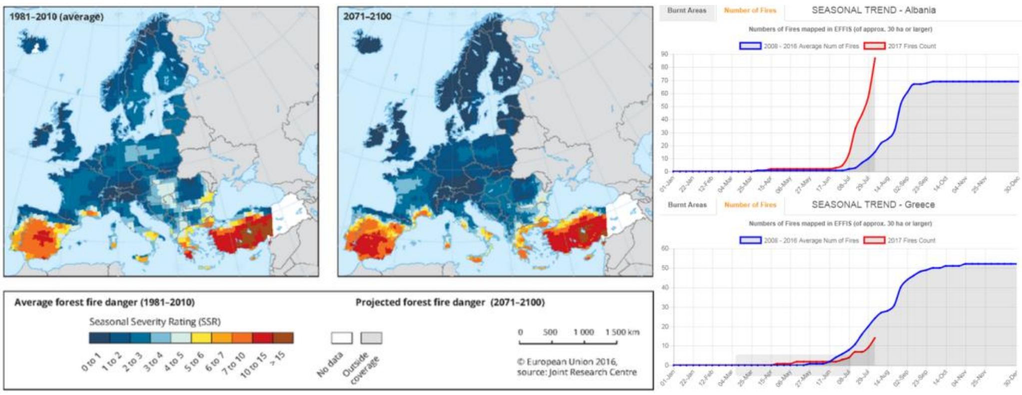

Figure 1- Current and projected state and trend of fire danger [8] (left), *Seasonal trend of Fire cases above 30 ha of Albania (left) and Greece (right)*

Surprisingly enough, referring to the online application Current Situation Viewer of European Forest Fires Information System (EFFIS) as provided by Copernicus Emergency Management Service which provides real time data on wild fire cases based on satellite monitoring, currently Albania is one of the hotspots of accruing and burned surfaces in Europe. According to the same source, Albanian territory in 2017 is facing not only an increase in wild fire cases above 30 ha as shown in figure 2 (right) compared with the average values of 2008-2016 interval, but also changes in seasonal trends of wild fire occurrences.

Referring to the same graphic, despite its smaller surface area and its favorable geographic position Albania is in much more critical situation than the territory of Greece. This is a fact that supports the idea of the need for analyzing the wild fires phenomenon not only based on physical properties but as well relying on socio-economical characteristics of the context especially in the wildland–urban interface (WUI) [5][16]. The anthropogenic factors are believed to be the major reasons of seasonal regimes changes in wild fire occurrences in the WUI [18][24].

2. MATERIALS AND METHODS

The study aims to utilize a multi-criteria inventory methodology of burned areas by investigating these zones in terms of social, physical and environmental aspects (figure 2). First, the social aspects rely on the relation of burned surfaces with the diverse types of settlements, human infrastructure, Areas of National Importance (ANI), and water resources. Further on, the workflow includes environmental criteria such as sunshine duration, precipitation humidity, precipitation, temperature, solar radiation, wind direction and wind speed. Finally, the method investigates physical properties of each burned areas under the following categories; surface area, perimeter, elevation, slope, orientation, former land cover, adjunct land cover.

The initial information about the burned surfaces by wild fires, is derived from CORINE Land Cover data as validated as an open source via EIONET[1]. There have been comparatively used the CLC data of 2006 and 2012 of Albanian territory (figure 3), leading to interesting evidences about the landscape transformation into burned areas during 6 years interval. Apart from area and perimeter of burned surfaces, two main analytical criteria derived from CLC data is former land cover and adjunct land cover. The first, informing about the land cover properties of each patch before being burned and the second presenting the neighboring land cover types.

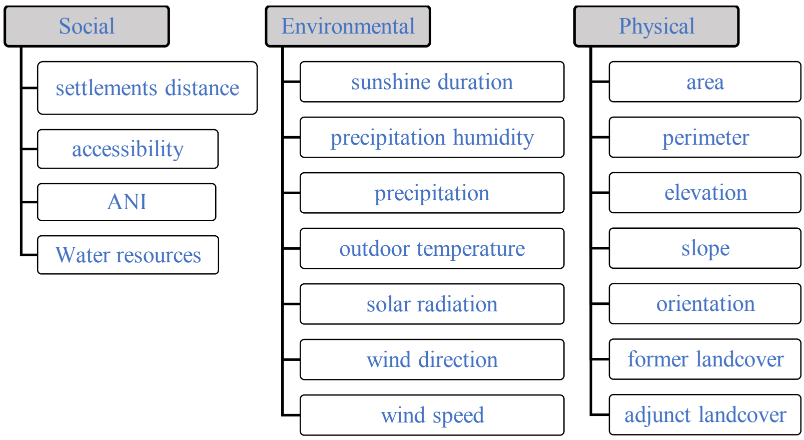

Figure 2- The components of a multi-criteria analysis in the study area

Besides CLC another important input data consists of Digital Elevation Model (DEM) as provided via EEA[2]. The source provides open source DEM data for European countries in a pixel resolution of 30 m. DEM data are utilized to derive other physical properties of burned areas under investigation such as, elevation (average, max, min, stdev), slope (average, max, min, stdev), and aspect/ orientation.

On the other hand, data for the ocial criteria inventory is received from the online Albanian geoportal where different maps that represent variable geographical information for Albanian territory is provided. The above-mentioned components (settlements, road infrastructure, ANI and water resources) are extracted and analyzed in relation with burned areas.

[1] http://rod.eionet.europa.eu/obligations/572/deliveries
[2] https://www.eea.europa.eu/data-and-maps/data/eu-dem

Whereas, the environmental criteria analysis was based on the fire-climate relationship in order to assess the potential impacts of local climate on burned areas. Identification of the most sensitive areas, where prevailing meteorological conditions are favorable for fire to spread, are analyzed. In this study, we investigate the sensitivity of fire activity (and in particular burned area) in response to the weather conditions. Meteonorm software program (Meteonorm 7.1) was used to generate one-year (2016) weather file for each 67 selected study zones including air temperature, global horizontal radiation, beam radiation, could cover, humidity, wind speed and wind direction.

The research illustrates the relationship between weather profile and burned area in the fire season and average data of the year (2016). The use of a fire season [1] significantly limits the potential sources of error, particularly when the climatic conditions that prevail during the fire season are significantly different from the entire year.

3. MULTI-CRITERIA INVENTORY OF BURNED SURFACES IN ALBANIA

As a result, the study presents a thorough multi-criteria inventory about the burned areas of Albanian territory having accured within the interval of 2006-2012. The results are included in a cumulative table of values per each criterion. Besides the numerical data, for practical reasons it has been decided to graphically represent each criterion exemplified through one burned surface. The selection process is shown in figure 3.

In the following series of graphics there are shown representative maps for each criteria of the burned areas under investigation. They are exemplified only in one representative burned surface patch. The selected patch is label number 40 according to the attribute table of burned areas of Albanian territory in 2012 (figure 3-right).

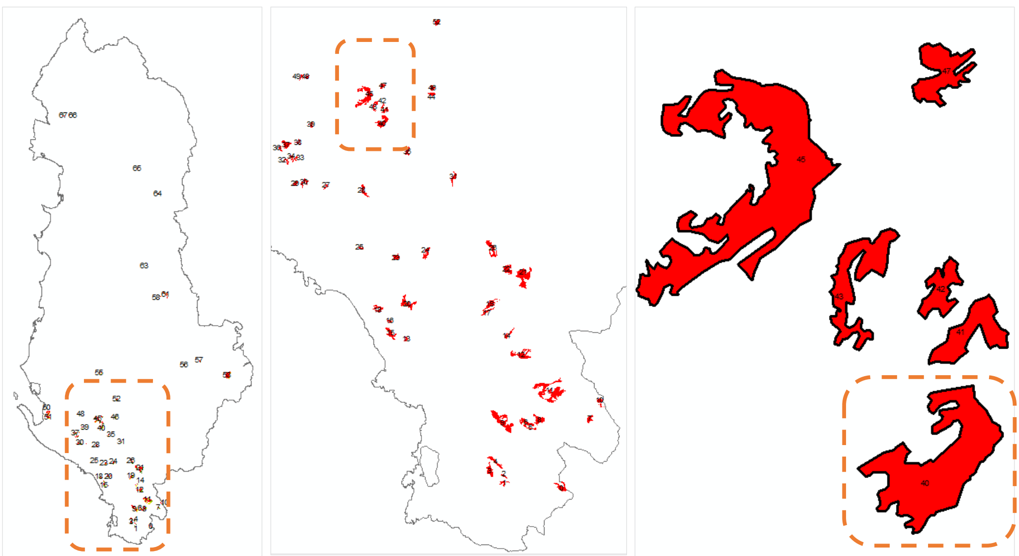

Figure 3- Burned Areas map (left), most dominant occurrences (center), patch no 40. (right)

3.1. Physical Criteria Inventory

Firs, CLC data assists in deriving a couple of physical properties of burned patches such as, area, perimeter, previous and adjacent land cover types, etc. More in detail, in this section there are presented several properties of burned areas focusing on the physical criteria. The physical measures includes the following twelve categories; Patch Area (PA), Patch Perimeter (PP), Previous Dominant CLC (PDC), Dominant Bordering CLC (DPC), Average Elevation (Eav), Maximum Elevation (Emax), Minimum Elevation (Emin), Elevation StDev (Esd) Average Slope (Sav), Max Slope (Smax), Slope StDev (Ssd), Average Orientation (Oav).

In figure 4 (a), it is shown the satellite image of the patch number 40 as provided via Basemap toolbox of ArcMAP software. The satellite image is of relatively recent state, showing the state of the burned area of at least 5 years after the wild-fire event. Whereas in figure 4 (b) it is shown the DEM map of burned patch number 40. At the first look it can be stated that the patch number 40 has a considerable range of elevation values. This fact is much more evident in figure 4 (c).

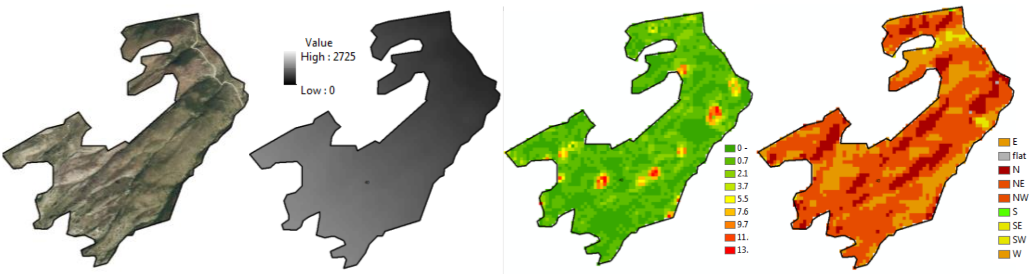

Figure 4- satellite image (a); DEM (b); Slope (c) and aspect/orientation (d) map of patch number 40

In figure 4 (c) it is shown the slope analysis based on DEM file. Each pixel is representing the value of slope (in degree) it holds. According to the map, the patch number 40 has majorly slopes up to 4 degree, with the exception of seldom cases of slope above 10 degree. According to table 2 patch number 40 has an average slope (Sav) value of 1.66 and maximum slope of 14 degree. This information can be of use during the Disaster Risk Reduction/Prevention planning. On the other hand, figure 4 (d) presents the aspect values or the orientation of each pixel. Referring to the map, it can be stated that patch number 40 is relatively oriented towards the northern side. This is preaty much on the same line with the numerical values of table 1, where the dominant orientation (Oav) of patch 40, results to be North-East. Thus, patch number 40 is 1 of 5 burned areas of Albanian territory that majorly are facing NE (table 2).

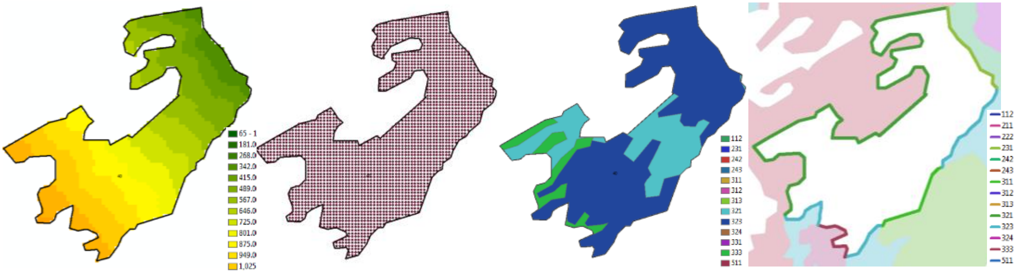

Figure 5- Elevation (a); Point Cloud (b); Previous (c) and Adjunct (d) CORINE Land Cover classes

Figure 5 (a) represents the elevation values of DEM pixels covering burned area number 40. According to the map, patch number 40 has a wide range of elevation values, between 65 and 1100 m above the sea level. Referring to table 2, patch number 40 has an average elevation (Eav) value of 784 m, being 76 m above the total average elevation of all burned areas in Albania. Besides, in figure 5 (b) it is shown the point cloud as generated from raster to points tool in ArcGIS application. The shapefile of point could is crucial in achieving the individual values of each pixel to be used in the statistical inventory as shown in table 2.

Another important physical criterion being investigated is related with the Land Cover types existing inside the burned area before it was burned. The information is dependent on the CLC data of 2006. Referring to map in figure 5 (c) and table 2, it can be inferred that the majority of the patch number 40 surface was covered by sclerophyllous vegetation (clc-323) before being burned. Besides, according to the same map there have been burned a considerable amount of natural grasslands (clc-321) and sparsely vegetated areas (clc-333).

Furthermore, figure 5 (d) represents the dominant CLC bordering the patch number 40. This is a very important information in understanding the external morphology of the burned areas. Moreover, this information is crucial in preventing agendas of DRM. According to the map and the table 2 it can be concluded that burned patch number 40 is majorly bordered by natural grasslands (clc-321).

3.2. Social Criteria Inventory

This analysis consists of exploring the issues that are related with man-made patterns or activates in relation with burned areas. The analysis is focused on four main components that can be categorized as man-made activity: Distance and typology of settlements; Accessibility (road Infrastructure); Water resources (as a potential infrastructure for fire suppression); and Distance to Areas of National Importance (ANI).

- **Distance and typology of settlements**

The distance and the characteristics of the settlements that are near wildlands is very important in fire risk management. The analysis of burned areas in relation with settlements is crucial for two main reasons: The first one is the threat that the fire can have on the different aspects of human activity that is happening on these settlements (human lives, properties etc.). Issues such as settlement distance from burned zone, typology, size, population number etc. are significant factors of this aspect. Secondly, the investigation of settlements is important for another purpose which is fire mitigation or suppression. The nearby urban zones can provide some infrastructure (human resources, services etc.) that can help in fire hazard management. Figure 6 (left) represents the burned areas (including patch number 40) in a particular zone and their relationship with the settlements that are spread around them.

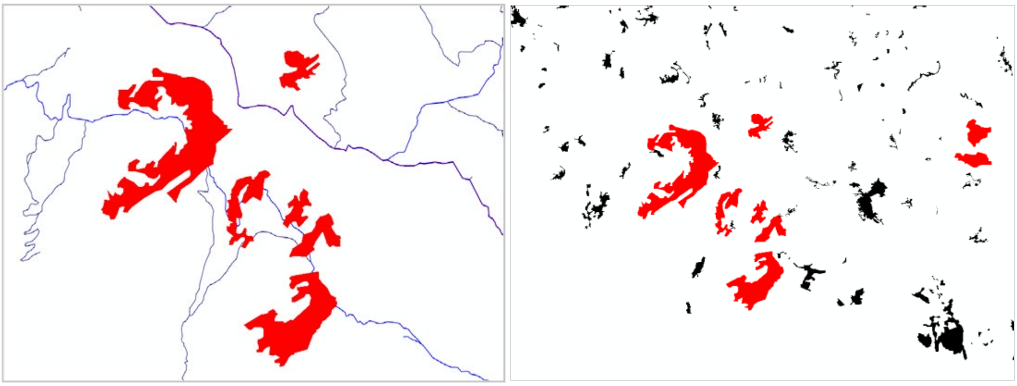

Figure 6- The relation of patch number 40 with the closest road (left) and closest settlements (right)

- **Accessibility (road Infrastructure)**

Accessibility- in all of its modes- is may be the most important factor in fire management. One of the main components of accessibility is the road infrastructure. Issues such as: the typology of the road, its characteristics, and proximity to the wildland have a direct impact on the efficiency of fire hazard management. In figure 6 (right) it is shown a region where there is a higher presence of road infrastructure near burned zones. While on the image on the right we see that the burned areas are far from main road infrastructure.

- **Water Resources**

The water resources are analyzed in the category of social criteria because it can be a useful resource for fighting and managing fires which is a human activity. Large water reserves are one of the main potentials to be used for fire suppression by taking the water with appropriate infrastructure (helicopter, water pipes etc.). In this context, figure 6 (left) presents a map that shows the burned areas and the water resources that can be used for wildland fire management.

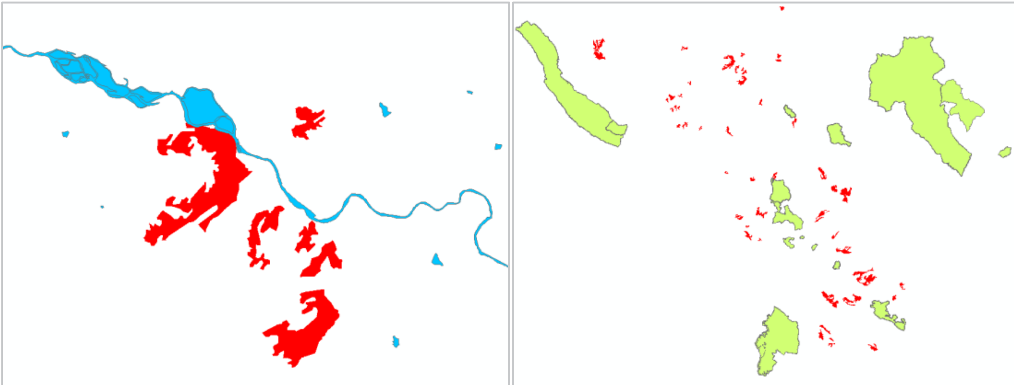

Figure 7- Burned areas in relation with water resources (left) and ANI (right)

- **Distance to Areas of National Importance (ANI)**

The final layers investigated under the social aspects of fire management are the Areas of National Importance (ANIs) and their relationship with burned zones. ANIs are zones with special natural, historic or cultural characteristics that are protected with different laws. These areas should be considered as priorities in any potential fire that can threat them. In this sense, this work tries to make an inventory burned zones and their position in the relation with Areas of National Importance. Figure 7 (right), presents a general situation of burned areas in relation to ANIs zones, where the threat of wild-fires in these areas is very visible.

3.3. Environmental Criteria Inventory

The environmental criteria inventory mainly explores the relationship between the burned areas and the weather indices for the selected locations including the Global Horizontal Irradiance, Outside Temperature, Humidity and Cloud Cover. The burned areas of the patches are grouped in 5 main categories (see table 1) and plotted based on the average of the global horizontal irradiance (figure 8- left), air temperature (figure 8- right), humidity (figure 9- left), cloud cover (figure 9- right). The period used to generate the data is the seasonal average (April, May, June, July, August, September).

Table 1- Number of patches grouped in Burned Area

Number of Patches	Burned Area
26	ha<50
18	50 <ha<100
11	100 <ha<150
3	150<ha<200
10	200<ha
68 ***(total)***	

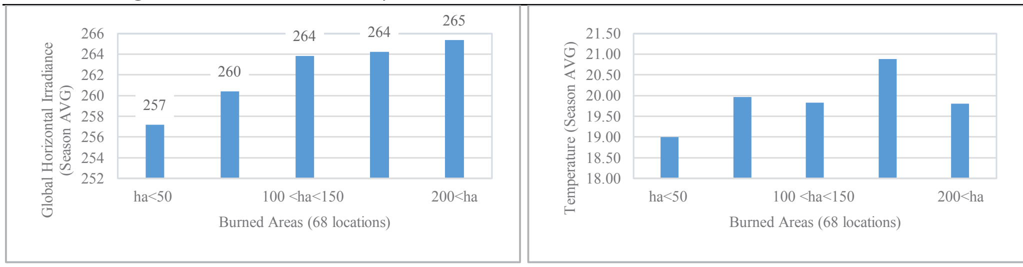

Figure 8- Burned areas (5 categories) versus seasonal average of Global Horizontal Irradiance (Wm-2) of the associated patches (left); Burned areas (5 categories) versus seasonal average of Air Temperature (°C) of the associated patches (right)

As figure 8 (left) illustrates, there is a clear relationship between the global horizontal irradiance and the size of the burned area (ha). For the patches with smaller burned areas (e.g. less than 50 ha), the average of the irradiance values is lower (e.g. 257 W.m-2), while the patches with the larger burned areas (e.g. more than 200 ha) the average of the irradiance values is higher (e.g. 265 W.m-2). In addition, the patches with the smaller burned areas (e.g. less than 50 ha), also are associated with lower temperature (figure 8- right), higher humidity (figure 9- left) and higher cloud cover (figure 9- right), as important environmental factors (in this case for areas less than 50 ha) for preventing the spreading of the fire.

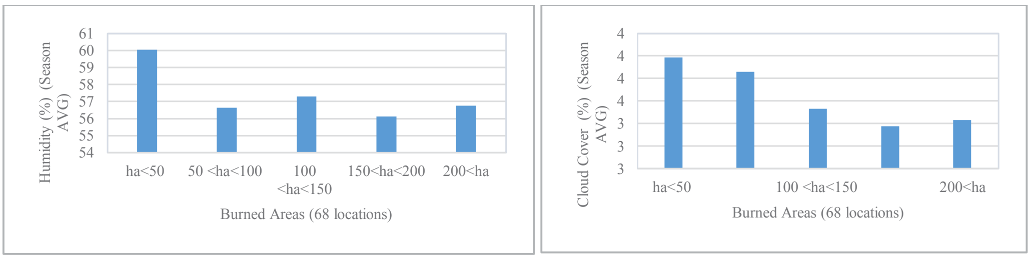

Figure 9- Burned areas (grouped in five categories) versus seasonal average of Humidity (%) of the associated patches (left); Burned areas (grouped in five categories) versus seasonal average of cloud cover of the associated patches (right)

3.4. Cumulative Numerical Inventory

Table 2 illustrates a general overview of the multi-criteria inventory approach including the physical, Social and environmental impact of all 68 patches.

Table 2- Cumulative table of all categories for all 68 burned patches under investigation

	physical							social					environmental						
no	area	perimeter	former_clc	border_clc	slope	elevation	Orientation	road	settlement	ANI	watercourse	waterbody	G_Gh	G_Bn	N	Ta	RH	DD	FF
0	146	9666	311	311	2.64	411	SW	1563	1522	6104	0	91	264	275	3	21	56	128	1
1	61	6315	324	231	4.50	106	S	468	1315	6889	0	3649	269	269	3	22	64	161	1
2	35	4054	311	231	1.69	140	NE	1256	819	7133	18	2363	267	269	3	22	64	157	1
3	150	8074	323	321	2.31	201	S	292	90	4665	522	1403	267	267	3	22	64	162	1
4	119	8815	324	311	2.13	239	S	68	0	4988	1504	320	267	279	3	22	63	153	1
5	53	6947	324	321	1.48	516	SW	101	932	3583	0	796	268	277	3	21	55	132	2
6	144	8387	321	321	1.21	925	S	658	942	4059	4657	846	269	287	4	18	57	120	2
7	80	4506	324	242	2.58	506	SE	21	0	888	3791	323	257	256	4	21	56	118	2
8	188	9941	323	323	1.48	780	SE	95	17	2489	5229	50	267	279	3	20	54	123	2
9	509	23758	324	321	1.84	889	SW	424	407	5900	2984	0	271	286	3	18	56	123	2
10	83	8844	311	311	2.27	420	SW	564	1047	4203	476	346	259	256	4	21	56	118	1
11	761	41528	323	321	3.13	737	SE	23	0	3604	2639	594	273	293	3	20	55	116	2
12	281	20225	324	321	2.69	811	E	54	0	2042	1239	1330	273	296	3	20	54	120	2
13	26	3428	311	321	4.21	217	S	1330	1533	4642	424	2234	275	292	3	22	63	179	1
14	75	6916	311	323	2.74	706	NW	1012	65	3754	1145	1662	270	285	3	20	55	125	2
15	148	9928	324	321	1.30	657	SW	413	1250	5607	1619	2975	274	292	3	20	55	167	2
16	27	3709	324	321	5.00	579	S	536	436	5550	1099	6068	277	299	3	20	55	166	2
17	66	6323	333	321	3.22	927	E	1230	1208	2763	2075	5649	268	284	4	20	54	125	2
18	107	9889	311	321	3.54	511	SE	532	789	7047	3119	8453	272	285	3	21	56	174	2
19	164	11168	323	323	2.23	635	E	0	0	3071	454	3983	266	280	4	20	55	131	2
20	217	15042	311	321	1.47	575	S	1043	1136	1757	2191	5375	268	282	3	21	56	163	2
21	479	16693	323	323	1.86	359	S	349	213	9584	633	83	262	265	3	22	62	63	1
22	164	8650	323	323	2.78	301	SW	155	146	9669	1392	825	260	260	3	22	60	75	1
23	81	4677	321	321	1.09	948	E	2641	2008	3717	7394	6522	264	278	4	20	55	150	2
24	116	10059	323	321	1.95	469	S	148	78	0	5605	3383	260	266	3	21	55	155	2
25	29	3804	311	311	1.79	311	SW	42	0	1019	4226	1148	263	263	3	22	63	186	2
26	224	14133	324	243	3.42	289	SE	252	144	6393	210	469	260	259	4	22	60	88	1
27	32	4622	311	311	1.22	715	SW	2417	3388	1703	2243	6092	259	262	4	20	54	179	2
28	106	8766	243	323	2.51	1087	SE	163	51	1358	4895	3537	261	274	4	18	57	155	2
29	48	3549	311	311	2.52	320	S	446	750	1165	320	9631	255	245	4	22	58	203	3
30	84	7915	311	311	2.59	391	SW	878	1040	1291	487	8853	255	253	3	21	55	196	3
31	102	8541	323	311	2.11	360	E	0	217	20	75	3576	261	261	4	21	55	113	2
32	41	4798	311	311	2.74	415	S	789	561	1092	1733	7770	260	261	4	21	56	200	3
33	28	3645	311	323	2.06	417	SW	1430	1376	1268	3215	8577	260	261	3	21	55	198	3
34	42	5821	311	311	2.65	377	SW	1348	1028	1196	2589	7837	261	265	3	22	56	200	3
35	61	5072	324	311	2.90	1093	SE	2102	2081	5095	1647	4202	262	276	4	17	57	137	2
36	36	4234	323	324	4.06	349	SE	645	415	1100	85	5276	262	265	3	22	56	203	3
37	117	6870	242	311	3.10	401	SW	1339	1027	1183	112	4872	262	263	3	21	56	199	2
38	33	5043	311	311	1.66	796	W	2643	2528	1396	1897	6694	262	271	4	20	54	181	2
39	38	4412	311	311	1.05	875	S	1270	1233	1764	430	7109	257	260	4	20	55	173	2
40	214	11492	323	321	1.57	784	NE	0	102	1102	1972	1727	264	275	3	20	56	128	2
41	55	4573	321	321	1.88	272	E	0	0	1182	553	2537	260	265	3	22	60	165	2
42	32	3822	323	321	4.19	240	E	0	459	1291	31	3490	261	261	3	23	56	166	2
43	76	8520	321	321	2.88	329	S	0	15	1362	268	4060	261	260	3	21	56	164	2
44	55	3902	243	323	1.00	723	W	621	264	1034	2591	2029	259	266	4	20	56	98	2
45	411	25052	323	323	3.01	504	E	0	0	1557	0	1438	259	266	4	20	54	155	2
46	58	3643	243	323	1.07	708	W	930	527	1115	3386	2490	259	265	4	20	56	100	2
47	50	5372	323	323	1.47	295	S	382	603	1527	983	1650	256	248	4	23	62	166	2
48	38	4911	313	313	3.79	521	E	0	382	2237	2159	1750	261	272	3	20	54	198	2
49	27	3029	313	313	3.93	644	NE	0	0	2194	2815	1520	263	278	3	20	55	192	2
50	99	8232	323	231	1.95	580	SW	1478	1450	8584	5070	989	270	288	3	20	57	224	3
51	561	29817	323	323	2.47	746	SW	808	992	8371	2969	139	270	288	3	19	57	209	2
52	69	4379	321	243	1.42	498	SE	2910	0	8529	2207	3421	254	253	4	20	55	107	2
53	820	19168	311	311	1.63	1379	SE	1378	1379	1185	3316	2060	255	265	4	16	58	36	2
54	39	7087	323	321	3.75	629	SE	786	647	7735	3580	1960	263	274	3	19	58	127	2
55	45	5195	323	321	3.47	714	SW	1473	1325	8018	3746	1049	263	279	3	18	64	126	2
56	54	5621	324	312	2.00	1344	SE	593	1466	1134	2913	2804	253	260	4	15	59	36	2
57	57	6047	324	243	2.42	1262	W	304	280	1657	1561	1207	259	268	4	16	59	34	2
58	31	2791	311	311	3.75	1595	SE	3136	1983	3799	7382	5895	249	255	4	13	66	51	2
59	34	3094	311	311	2.68	1507	S	2704	2010	0	3821	8465	250	254	4	13	65	49	2
60	31	2675	311	311	2.68	1602	E	3142	2832	2786	7236	7132	248	257	4	13	66	52	2
61	144	8048	311	311	1.39	1268	NE	2942	1029	0	2931	6821	249	251	4	15	64	30	2
62	37	4282	311	311	1.98	1288	NE	3771	1540	0	3716	7711	247	244	4	15	64	30	2
63	30	3246	311	311	1.20	734	SE	2758	1035	0	943	3532	248	253	4	17	69	33	2
64	38	4931	311	311	2.03	764	S	175	503	0	413	1160	245	238	4	17	67	45	2
65	30	2926	313	313	4.24	1545	SW	2506	973	176	3369	914	237	231	5	11	74	51	3
66	28	2431	311	311	1.15	323	SW	1047	689	1118	3076	1508	238	216	4	22	55	89	2
67	99	6914	311	311	3.21	186	SW	2041	1209	7135	1557	1173	241	224	4	22	55	90	2
	2.27	2.28	2.29	2.30	2.31	708	S	980	816	3170	2190	3318	261	267	3.58	20	58	132	2.07

4. CONCLUSION

The present research analyzed the burned areas in Albania via a multi-criteria approach in the landscape scale. The analysis mainly consisted of three main criteria including the social impact, environmental and physical. The typologies are studied in different scales to specifically identify and compare the driving factors of the fire hazards. The analysis mainly explores the relationship between the burned areas and the different indices for the selected locations. For the physical properties of the burned patches, different criteria were analyzed including the area, perimeter, previous and adjacent land cover types in different categories (e.g. Patch Area, Patch Perimeter, Previous Dominant CLC, Dominant Bordering CLC, Average Elevation) within the aim to understand the factors of influence. In the same way, the paper explored the relationship between the burned areas and the weather indices for the selected locations including the Global Horizontal Irradiance, Outside Temperature, Humidity and Cloud Cover.

The results showed that there is a clear relationship between the weather indices and the size of the burned area (ha). The proposed method aims to serve as an initial step in support of holistic Disaster Risk Management and Fire Safety (DRMFS) agendas in landscape scale. In addition, the study attempts to serve as a multi-criteria decision model during the DRMFS processes and to understand and mitigate the risks of wildland fires.

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HISTORY AND SURVEY ON VOLUNTEER FIRE DEPARTMENTS IN SERBIA

Abstract: Volunteer fire departments (VFD) in Serbia were established as civic associations in the 19th century. The founders and members of the first VFDs were prominent members of local communities. Today, those are volunteer organizations for preventing and extinguishing fires and rescuing people and property in various accidents. This paper presents the results of research about the number and resources of active VFDs conducted in the Autonomous Province of Vojvodina, Serbia and about the activities they perform today. The survey was done based on data provided by all registered VFDs in Vojvodina. The Firefighters Association of Vojvodina includes 35 municipal firefighting associations, 230 volunteer fire departments with 5300 active members in qualified fire units and more than 15000 supporting members.

Key words: education, prevention, rescue, volunteer fire departments

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1. INTRODUCTION

Like in many other European countries, there were no organized fire protections in Serbia for a long time. The Law of the medieval Emperor Dusan contained some provisions relating to fire protection, but until the mid-19th century there were no major fire service organizations. Fire events escalated in large numbers, which resulted in regulations being issued by the cities authorities. The regulations were binding for individual citizens and associations which were equipped properly in case of fire.

Fire regulations in Novi Sad City were adopted in 1769. The principality of Serbia issued in 1834 the first regulation on protection against fire. In this regulation, the tasks of Belgrade City Police have strictly been defined, and among others, the task to "takes care of the fire, to control that every month chimneys are cleaned, and to provide enough water reserves and tools to put the fire out quickly and with minor damage caused".

At the initiative of citizens came the humane idea of the formation of voluntary fire brigades. In 1868, a voluntary fire brigade was founded in Zrenjanin, 1870 in Zemun, and 1872 in Novi Sad and Sombor. The founder of the voluntary firefighting department in Novi Sad was our well-known writer Laza Kostić. In the period from 1872 to 1878, a large number of voluntary organizations were founded in Sremska Mitrovica, Ruma, Kikinda, and Irig as well as in Belgrade (1882) and in Kragujevac (1887).

After the formation of voluntary fire brigades, in the second half of the 19th century, due to accelerated urbanization and industrialization and the growing need for human and property protection, professional fire brigades were established. The first professional fire brigade was founded in Belgrade in 1885. After the First World War these units were founded also in Novi Sad, Subotica and Niš.

At the beginning of the 20th century, great progress was made in the area of fire protection. More attention was devoted both to the organization and to the training of personnel, as well as to the introduction of modern equipment and tools. The number of members has increased in professional and voluntary fire brigades. The start of using horse-drawn carriages to transport firefighters and firefighting equipment has contributed greatly to timely reaction to fire events. Thirty years later, firefighters got the first motor vehicles.

A significant step in firefighting was made by the adoption of the Firefighting Organization Act of 1933, when all fire brigades are integrated. The Supreme Forum was a Firefighting Union, consisting of fire-fighting organizations: voluntary-industrial, institutional and professional.

After the Second World War (1945), the Ministry of the Interior of the Democratic Federal Republic of Yugoslavia issued two acts (Instructions for the organization of the fire service and the Guide for the implementation of fire-prevention measures, the precautionary measure for fire protection and the modern way of firefighting).

All property of the alliance was taken over by the Ministry of Interior and became the basis for the establishment of state and voluntary fire brigades. National Firefighting Units were established in all cities. Unlike the Volunteer Fire Department, the Professional fire brigades consisted of "paid firefighters who worked in two shifts".

By a legal act issued in 1956, all settlements with over 15000 people should have a professional firefighting unit, and since 1982, all municipalities with over 10000 residents.

Professional fire brigades became the Municipal Fire Brigades. In addition, upon the approval of the Serbian government after 1982, the Ministry of the Interior integrated all territorial fire units in the Republic, and in 2006 a sector for Protection and Rescue was formed.

Founding of fire brigades is regulated by the Fire Protection Law. This law regulates the way and standards of establishing a fire and rescue unit in order to extinguish the fire, rescue people and property, and participate in removing the consequences of elemental disasters and other accidents.

2. VOLONTEER FIRE DEPARTMENTS

The establishment, organization, operation, rights and obligations of voluntary fire brigades, departments, and alliances are stipulated by the Minister under the Act on the Protection of Fire. Volunteer Fire Departments (VFD) are voluntary associations of citizens for preventing and extinguishing fires and rescuing people and property in various accidents. Local governments, companies and associations can establish a volunteer fire brigade. A VFD is a legal entity with rights, duties and responsibilities established by the Statute and the Law, and have their own stamp and seal, and its symbols in the form of sign and emblem. The public is informed through professional publications, through press and other media about the work of VFDs. Every citizen, under the same conditions and in the manner stipulated by the Statute, may become a member of the VFD. Members of the VFD can be: active, reserve, honorary, supporting and firefighting youth. Active members are all those who actively carry out their duties and carry out activities stipulated in the Statute of the society. Reserve members are those who have stopped with the active work in the VFD because of illness, age, etc. Honorary members are those individuals that are declared as honorary members by the Assembly of VFDs for their extraordinary contribution to the development and progress of the VFD and the fire service. Supporting members are all those who contribute in achieving the tasks of the VFD. Firefighting youth are children aged 6 to 18 years. Members of VFD's may be commended, rewarded and honored for their work.

Voluntary fire brigades have made major contributions to fighting fires throughout history. Volunteer fire services are an integral part of the system of fire protection throughout the world including our country. In developed countries, Germany, Austria, France, Denmark, the Netherlands, it is not allowed for professional units to suffocate voluntary ones, and the relationship between them is balanced. In our country today, not enough importance is given to the work and efforts of volunteer fire fighters and many departments are in great difficulties due to insufficient and sporadic sources of financing, which prevents the maintenance and modernization of equipment and resources. Objective circumstances and the consequences of social changes affected the devastation of moral and social values and other criteria, which is reflected in the institution of voluntary work in general, and particularly, voluntary engagement in this demanding and specific field, as in [1].

3. VOLONTEER FIRE DEPARTMENTS IN VOJVODINA

Fire departments in Vojvodina were established in the second half of the 19th century. First one was in Veliki Bečkerek in 1868, today known as city of Zrenjanin. In the following years fire departments were founded also in many other settlements in Serbia: Zemun (1870), Pančevo (1871), Novi Sad and Sombor in 1872, Vršac, Ruma and Sremska Mitrovica in 1873; Senta (1874) and Kikinda (1875). In Vojvodina in 1893, there was the Alliance of Firefighting in Vojvodina of Bačka-Bodrog County, which on June 29, 1893 held an Assembly session in Sombor. The Alliance was joined in by 22 voluntary fire departments and one professional firefighting unit, with a total of 1328 members. Assembly of the Firefighting association Bačka-Bodrog County in Baja, was held on August 22, 1896, and in 1897 and 1898 in Kanjiža and in Bačka Topola.

The adoption of the Law on Organization of Firefighting in 1933 marked an important step in the fire service, with the integration of all firefighting organizations. The division of firefighting organizations coincided with the division according to regions. The supreme forum was the Firefighting Association, composed of the fire organizations: voluntary-industrial, institutional, obligatory and official-professional. Voluntary, formal and obligatory fire troops are considered as public fire brigades, while industrial and institutional units are considered as private entities. Reconstruction of the fire service began according to the Instructions of October 1, 1945 and continued on the basis of the Law on the organization of volunteer fire department adopted in 1947, with which fire protection systems were based on the work of the fire police and fire brigades in the industry. With the adoption of national regulations in 1947, the position and place of volunteer fire departments was specified, as well as their financial position. National committees were bound to train their volunteer fire departments for fire protection, as well as to provide them with the necessary funds for procurement of equipment. Membership could be active, reserve, and supporting, as in [2]. Thus, in 1948, fire protection services began with 264 volunteer fire departments in cities and towns with 7831 members and 4 fire units in the industry with 82 members. In Vojvodina in 1949, 123 new volunteer fire departments and 530 fire brigades in the industry were formed.

The establishment of the Fire Service Association of Vojvodina in 1950 formed the main organization, which makes efforts to improve the capacity of volunteer fire departments and contributes to the dissemination of technical and practical knowledge for fire prevention and firefighting and rescue, as well as assistance in natural disasters. Fig. 1 shows settlements in which members of the Fireman's Association of Vojvodina are operating.

Figure 1 – Territorial distribution of VFDs in Vojvodina

The Fire Service Association of Vojvodina today brings together 4 urban and 40 municipal associations with over 200 volunteer fire departments. The number of members of volunteer fire departments in Vojvodina today is between 20 and 25000, of which 5000 members are professionally trained to fight fires.

3.1. Volunteer Fire Department Petrovaradin

The Petrovaradin Volunteer Fire Department was established on June 3, 1875. The founders and prominent officials of the department were: President Josip Koher, Secretary Julius Juba and Treasurer Konstantin Nađ, and well-known names of prominent firefighters from this period include Ivan Vuksan and Đoka Živanovic. The first session of the Board was held on April 8, 1895. Founder of Josip Koherc became an honorary commander, and Secretary Julius Juba - honorary secretary. Minutes of the session was led for the first time in the Croatian language, because until then, exclusively German was in official use. A year later on March 22, the mayor of Petrovaradin and president of the department, Franja Malin, was appointed honorary president. On the eve of the first assembly, which was convened in the year 1898, the firehouse was built with social facilities. The department already had its storeroom for firefighting equipment, with a wooden tower with a height of about 6 m. The firehouse is still located in the same street now called Paul Jurišića Šturma Street in Petrovaradin.

The Volunteer Fire Department in Petrovaradin renewed after the formation of the Kingdom of Serbs, Croats and Slovenes, whose proclamation on December 1, 1918 drastically influenced the change of population structure in Petrovaradin. This proclamation shall terminate the Austro-Hungarian ban on the settlement of Serbs in the area of Petrovaradin. They changed the state symbols: the coat of arms of the Kingdom of Serbs, Croats and Slovenes gave national characteristics to firefighting helmets and insignia. Instead of German language the new administration applied Serbian language in official documents.

The 50th anniversary of the Volunteer Fire Department Petrovaradin was ceremoniously celebrated on the 15th and 16th of August, 1925, in the presence of many twinned organizations as well as Novi Sad firemen. At a ceremonial meeting on the occasion of the anniversary, it was decided that one member of every house in Petrovaradin should be an active or supporting member of this Department. This decision is one of the reasons for the huge rise in the work of the Department, as well as a large number of members which is held until today. After the commissioning and construction of a traffic and pedestrian bridge in 1927, the conditions for the administrative joining of Petrovaradin to Novi Sad were realized, and conducted in 1930. Thus, Novi Sad and Petrovaradin volunteer fire departments brought into direct contact. Since then, their cooperation in the framework of a common administrative framework became more frequent, as in [3].

Modest funds for the purchase of more sophisticated techniques were collected at events from voluntary contributions from citizens, memberships of supporting members and rare donations. Therefore Department remained at the level of hand fire techniques until the year 1939, when they purchased the first motorized nozzle and auto tank. In the same year firefighters were for the first time on-call 24/7 duty during agricultural activities. This was significant progress in the fire prevention, as in [4].

During 1951, in addition to the Fire People's Militia and Volunteer Fire Department in Petrovaradin, in Novi Sad, 43 voluntary departments have already been working, organized in factories and offices. Such an organized service, regardless of insufficient equipment, showed its good side in preventive fire protection in factories and during harvests and other seasonal agricultural work.

Since 1952, the jurisdiction of the notification of the fire with the fire siren from the tower of Petrovaradin Volunteer Fire Department was abolished. Now, departments were dealing with staff training, organizing courses and exercises, control of implementation of fire protective measures in enterprises and households. They had regular preventive service duty in theaters, public places, as well as providing fireworks. The Law on Fire Protection and the Law on volunteer fire departments, passed in 1956, led to a drastic shift in the activities of volunteer fire departments. Because of the competence of professional units in every respect, direct involvement in extinguishing the fire ceased to be the main focus of the voluntary departments. The volunteer Fire Department is decorated with many photographs and the boards from the very founding of the department, which testify about important figures of society, but also the important events: anniversaries, fire drills and parades. The year 1995 marked the 120th anniversary, and to commemorate this anniversary, in addition to the usual program of celebrations, Novi Sad City Museum hosted an exhibition at the Petrovaradin fortress, as in [3,5].

Petrovaradin Volunteer Fire Department now has 93 members, whose age structure and qualifications are given in Table 1. If to this number of members 545 supporting members are added, we get the total number of 638 members of the Voluntary Fire Department Petrovaradin.

Table 1- Age structure and qualifications of the volunteer firemen

Age	Number of members	Qualification	Number of members
6-11 years	6	Pioneer fireman	5
12-18 years	10	Fireman	27
18-60 years	56	Fire petty officer	23
Over 60 years	21	Fire officer	11
		A senior fire officer	2
		No titles	25
		Total	93

The Volunteer Fire Department achieved good results in numerous competitions and festivals of volunteer fire departments. The Department develops and fosters good relations and cooperation with the volunteer fire departments that are members of the Fire Brigade Association of Novi Sad, as well as other municipal associations.

It should be noted that members of the Volunteer Fire Department Petrovaradin demonstrated their willingness and courage especially in the bombing of Novi Sad, in the spring of 1999. Risking their lives, they were first to arrive at the building Novi Sad Television, which was burning.

The Volunteer Fire Department Petrovaradin, with its rich history, dedication and perseverance, is one of the main sources of pride of citizens of Novi Sad and Petrovaradin.

4. CONCLUSION

When the first fire departments began to be formed, the objective was to gather people around the same problems and thereby help the community.

In the first decades of the development of the fire service, when there was low level of general culture, human knowledge and economy, the most prominent people of that time (writers, doctors, merchants, priests, teachers, and others), were the founders and active members of volunteer fire departments. They recognized the importance and value of fire departments for the society even then. At that time, when the fire service was just beginning, it was a great honor and obligation of every respectable man to contribute to the improvement of fire protection. This has had a strong impact on other citizens to get involved in the volunteer fire departments. By all accounts, it seems that this useful tradition has been forgotten and abandoned in our country.

Year after year, the number of volunteer fire departments is reduced. Thus, in Vojvodina, in the period from 1950 to the present day, more than 200 volunteer fire departments ceased to exist and volunteer fire departments in the industry almost no longer exist.

The Volunteer Fire Department of Petrovaradin is just one example of how voluntary fire service in Serbia operates today. The idea of voluntary firefighting is still cherished in Serbia, so today volunteer fire departments are still "alive" in some small towns in Vojvodina. Lately, the work of these fire departments is reduced to the promotion of voluntary fire service through various forms of competition, raising awareness of preventive protection against fires among citizens, as well as the role of the voluntary fire service for our society. Today, the primary task of any volunteer fire department is increasing the number of members.

The voluntary fire service should find a place in society; ensure the financial basis of operation, stable sources of funding and favorable treatment. Voluntary contribution is expressed through the great moral values, and therefore, must be appreciated and rewarded. Better positioning of fire services would have a major impact on the formation of security culture concept and general public awareness of fire safety, and therefore, the security situation of society as a whole.

Reaffirmation of the voluntary fire service affects the responsibility we have to ourselves and to the society in which we live, and reaffirms moral and humanistic values.

5. ACKNOWLEDGEMENT

This work was partially supported by the Department of Civil Engineering and Geodesy, Faculty of Technical Sciences, University of Novi Sad within the project “Improvement of educational process and theoretical and applied research in civil engineering”.

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THERMO-VISCO-PLASTICITY AND CREEP IN STRUCTURAL-MATERIAL RESPONSE

Abstract: Many structural parts are exposed to high temperatures and loading. It is then important to have data about material inelastic behavior under such exploiting conditions. Influence of temperature on mechanical characteristics of a material may be includes via the creep coefficient in the range of visco-elasto-plastic (VEP) strains. This damage parameter is implemented in this paper in conjunction with mathematical material modeling approach named rheological-dynamical analogy (RDA) in order to address structural stiffness reduction due to inelastic material behavior. To examine the structural response, the main numerical solution method is the finite element method. This paper aims at providing a unified frame for quasi-static inelastic buckling and thermal loading of uniformly compressed prismatic shells using the finite strip method (FSM). Two sources of non-linearity (geometrical non-linearity due to large deflection and material non-linearity due to inelastic behavior) are analyzed for the problem of thermo-visco-plasticity and creep in structural-material response.

Key words: RDA, Creep coefficient, loading, high temperatures, inelastic buckling, FSM

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1. INTRODUCTION

In designing of structural element subjected to mechanical and thermal loadings it is necessary to adequately take into account material behavior under such conditions. Many national and international standards have been established for design at elevated temperatures, as a result of experience and research over many decades. Methods of analysis which include thermo-elastic-plastic and creep deformation were first of analytical type [1]. Later, with the progress of FEM, numerical procedures have been developed which can be used to realistic predict respone of very complex structures [2]. These numerical procedures have been implemented in general purpose finite element programs, like ADINA, ABAQUS, MARC, PAK, etc.

The numerical algorithm presented in this paper relies on the main idea of the RDA employed by the author for the analysis of visco-elasto-plastic (VEP) vibrations and their use for the analysis of internally damped inelastic structures [3]. The RDA is a type of inelastic analysis, which tranforms one category of very complicated material non-linear problems to simpler linear dynamical problems using modal analysis. This concept is some generalized in this paper, particularly for the thermal loading. This paper aims at providing a unified frame for quasi-static inelastic buckling and thermal loading of uniformly compressed prismatic shells using the semi-analytial FSM [3].

2. RHEOLOGICAL-DYNAMICAL ANALOGY AND THERMAL EFFECTS

Material micro cracking is accompanied by the loading of a specimen, leading to its damage and failure. Consider the case of the VEP strains of a initial imperfect column presented in Fig. 1(a). In material investigations, both stress $\sigma(t)$ and inelastic strain $\varepsilon^*(t)=\varepsilon_{ve}(t)+\varepsilon_{vp}(t)$ are functions of time. If the total VEP strain $\varepsilon(t)=\varepsilon_{el}+\varepsilon^*(t)$ is presented as a sum of elastic (instantaneous), viscoelastic (VE) and viscoplastic (VP) components, each isochronous stress-strain diagram of a long symmetrical column with a cross section A_0 can accurately be approximated by a rheological model H-K-(StV|N), consisting of five elements. The corresponding rheological model is shown in Fig. 1(b) using the following symbols: N for the Newtonian dashpot, StV for Saint-Venant's body, H for the Hookean spring, " | " for a parallel connection and "—" for a connection in a series.

Since the Hookean spring, Kelvin's body (K=H|N) and VP body (StV|N) are connected in a series, stresses $\sigma(t)$ in all the models are equal. Based on a rheological model, Milašinović [3] derived a governing differential equation

$$\ddot{\varepsilon}(t)+\dot{\varepsilon}(t)\left(\frac{E_K}{\lambda_K}+\frac{H'}{\lambda_N}\right)+\varepsilon(t)\frac{E_K H'}{\lambda_K\lambda_N}=\frac{\ddot{\sigma}(t)}{E_H}+\dot{\sigma}(t)\left(\frac{E_K}{\lambda_K E_H}+\frac{H'}{\lambda_N E_H}+\frac{1}{\lambda_K}+\frac{1}{\lambda_N}\right)+$$
$$+\sigma(t)\left(\frac{E_K}{\lambda_K\lambda_N}+\frac{H'}{\lambda_K\lambda_N}+\frac{E_K H'}{\lambda_K\lambda_N E_H}\right)-\sigma_Y\frac{E_K}{\lambda_K\lambda_N} \tag{1}$$

where E_H is the elastic modulus, σ_Y the uniaxial yield stress and $Y=\sigma_Y+H'\varepsilon_{vp}(t)$ the VEP yield criterion. The four properties at fixed step times are: extensional VE viscosity λ_K, extensional VP viscosity λ_N, VE modulus E_K and VP modulus H'. However, these constants cannot easily be determined in physical experiments, especially Trouton's viscosities λ_K and λ_N.

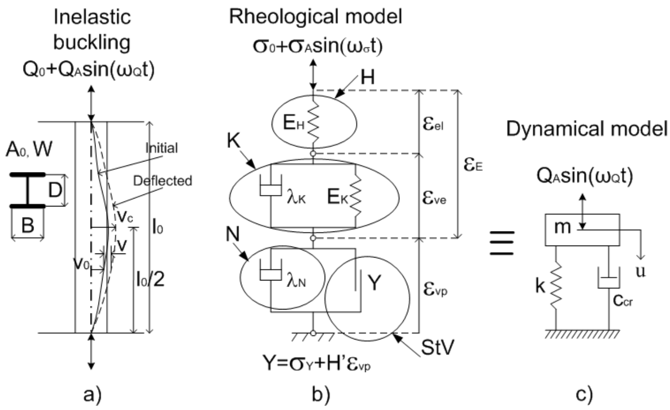

Figure 1 – RDA: a) Initial imperfect column; b) rheological model; c) dynamical model

Among the various types of time-dependent stresses, sinusoidal stresses are among the most important. Let us now define the dynamic modulus (RDA modulus) along the way required to damp the RDA model critically [3].

$$E_R=E_H\frac{1+\varphi+\delta^2}{(1+\varphi)^2+\delta^2}, \qquad \underset{\lim\delta\to 0}{E_R}=E_H\frac{1}{1+\varphi}. \tag{2}$$

where $\delta=\omega_\sigma/\omega$ is the relative frequency and ω is the natural frequency.

The total creep coefficient φ in the range of VEP strains, which includes the thermal creep coefficient φ_T may be defined as follows

$$\varphi=\varphi^*+\frac{E_H}{H'^D}+\varphi_T\ . \tag{3}$$

where φ^* is the structural creep coefficient determined based on the Euler and RDA buckling curves intersection at the elastic limit and H'^D is the dynamic VP modulus.

3. BUCKLING ANALYSIS USING FINITE STRIP METHOD

It is well-known that the total potential energy of a strip is defined as the sum of the strain energy, potential energy due to nodal line forces, as well as the additional potential energy due to the initial stress. The formulation of equilibrium equation using the principle of minimum total potential energy yield [3]

$$\hat{\mathbf{K}}\mathbf{q} + \mathbf{K}_\sigma \mathbf{q} = \mathbf{Q} \tag{4}$$

As far as linear stability is concerned, the nodal forces $\mathbf{Q}$ are zero and it is therefore possible to derive the eigenvalue equation

$$\left[\hat{\mathbf{K}} - \lambda \mathbf{K}_\sigma\right]\mathbf{q} = \mathbf{0} \tag{5}$$

where $\hat{\mathbf{K}}$ is the conventional elastic stiffness matrix, $\mathbf{K}_\sigma$ is the geometric stiffness matrix, λ is the eigenvalue (load factor is compression positive), and $\mathbf{q}$ is the eigenmode (buckling mode) vector. Hence, the critical buckling stress is

$$\sigma_{cr} = \frac{\lambda_{\min}}{2 \cdot t}\,. \tag{6}$$

4. NUMERICAL EXAMPLE

Consider the uniformly compressed rectangular steel plate (*a/b*=1) presented in Fig. 2, whose all edges are simply supported.

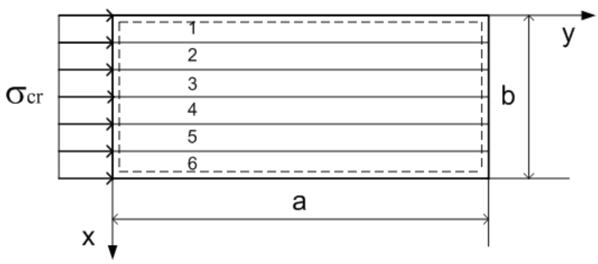

Figure 2 – Uniformly compressed rectangular steel plate and finite strip idealization

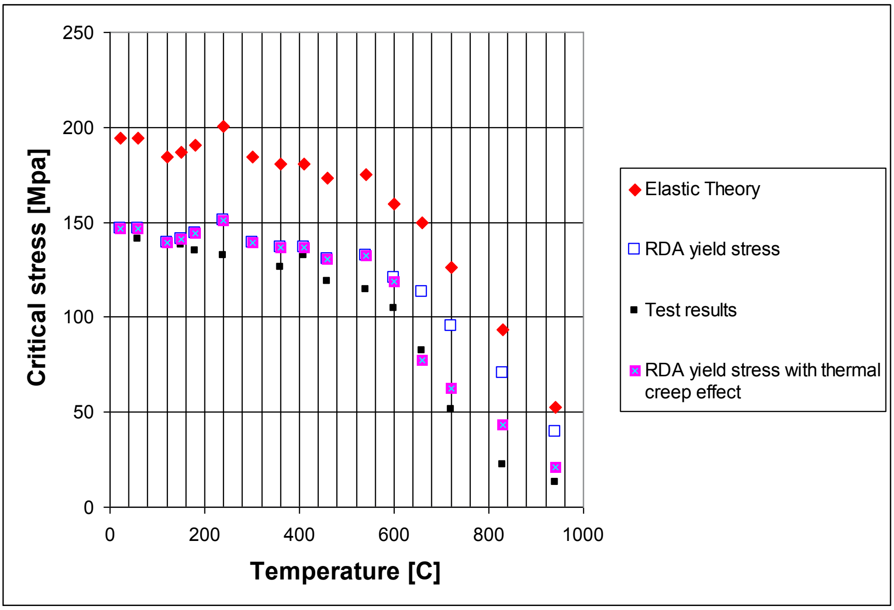

Figure 3 – Comparison of yield stresses due to high temperatures and loading of steel plate a/b=1 made of mild steel

Plate of the following geometrical and elastic properties, t=16 mm, b=1000 mm, E_H=210 GPa and $\mu = 0.3$ (Poisson's ratio), was analyzed using the test results for the reduction factors of yield strength and elastic modulus of mild steel at elevated high temperatures [4].

The RDA yield stresses are obtained using the test data given in Tab. 1 and taking into account the following RDA module [3]

$$E_{R,T,\varphi_T} = \frac{3E_T}{(5-4\mu)+2(1+\mu)\left(\varphi^* + \varphi_T\right)} \tag{7}$$

where the structural and thermal creep coefficients are respectively

$$\varphi^* = \frac{2\mu}{1-2\mu}, \qquad \varphi_T = \frac{E_H}{E_T} - 1 \, . \tag{8}$$

Table 1- Experimental and computed yield stresses due to high temperatures and loading of steel plate (a/b=1) made of mild steel

T [°C]	E_T/E_H [4]	$\sigma_{cr,E,T}$ [MPa]	$E_{R,T}$ [MPa]	$\sigma_{cr,Y,T}$ [MPa]	φ_T	E_{R,T,φ_T} [MPa]	$\sigma_{cr,Y,T,\varphi_T}$ [MPa]	D_{cr} $\delta\to0$	$f_{0.2,T}/f_{0.2,E}$ [4]	σ_{cr} [4] [MPa]
22	1	194.36	81741	146.88	0	81741	146.88	0.60	1	**146.88**
60	1	194.36	81741	146.88	0	81741	146.88	0.60	0.96	**141.00**
120	0.95	184.64	77675	139.54	0.053	77675	139.54	0.61	0.95	**139.54**
150	0.96	186.59	78492	141.01	0.042	78492	141.01	0.61	0.94	**138.07**
180	0.98	190.48	80128	143.95	0.020	80128	143.95	0.60	0.92	**135.13**
240	1.03	200.19	84216	151.29	0	84216	151.29	0.60	0.90	**132.19**
300	0.95	184.64	77675	139.54	0.053	77675	139.54	0.61	0.95	**139.54**
360	0.93	180.76	76040	136.61	0.075	76040	136.61	0.61	0.86	**126.32**
410	0.93	180.76	76040	136.61	0.075	76040	136.61	0.61	0.90	**132.19**
460	0.89	172.98	72769	130.72	0.124	72769	130.72	0.62	0.81	**118.97**
540	0.90	174.93	73587	132.20	0.111	73587	132.20	0.62	0.78	**114.57**
600	0.82	159.38	67046	120.45	0.220	62422	118.73	0.63	0.71	**104.28**
660	0.77	149.66	62957	113.10	0.299	57193	77.11	0.64	0.56	**82.25**
720	0.65	126.33	53146	95.48	0.538	44974	62.80	0.67	0.35	**51.41**
830	0.48	93.29	39246	70.51	1.083	28740	43.28	0.72	0.15	**22.03**
940	0.27	52.48	22076	39.66	2.704	11544	21.13	0.81	0.09	**13.22**

Since the development of micro cracks induces a reduction in the stiffness of materials, the damage state can also be charaterized by variation in the elastic modulus E_T. Thus, the critical damage variable D_{cr} is characterized by variation in Young's modulus $E(D)$, as follows

$$(1-D_{cr})E_T = E_{R,T,\varphi_T} = E_T\frac{1+\varphi+\delta^2}{(1+\varphi)^2+\delta^2} \Rightarrow \underset{\delta\to0}{D_{cr}} = \frac{\varphi^*+\varphi_T}{1+(\varphi^*+\varphi_T)} \tag{9}$$

Imperfection can be geometric, material or structural. Purely initial geometric imperfections are most simple, Fig. 1(a), and it implies that only the reference geometry is influenced by imperfection, not the stress state. In this case the initial imperfection may be modelled as the first buckling eigenmode $\mathbf{q}(m=1)$.

5. ACKNOWLEDGEMENTS

The work presented in this paper is a part of the investigation conducted within the research projects OI 174027 "Computational Mechanics in Structural Engineering" and TR 36017 "Utilization of by-products and recycled waste materials in concrete composites for sustainable construction development in Serbia: investigation and environmental assessment of possible applications", supported by the Ministry of Science and Technology, Republic of Serbia. This support is gratefully acknowledged.

6. CONCLUSION

Two source of non-linearity (geometrical non-linearity due to large deflection and material non-linearity due to inelastic behavior) are analyzed for the problem of thermo-visco-plasticity and creep in structural-material response. This paper shown that the critical damage variables D_{cr} due to the structural φ^* and total $(\varphi^* + \varphi_T)$ creep coefficients are quite similar for the temperature ranging from 22 to 540 $^\circ C$ and very different for temperature ranging from 600 to 940 $^\circ C$.

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ENVIRONMENTAL IMPACTS OF ABANDONED MINING OPERATIONS IN VAREŠ AREA

Abstract: There is a number of abandoned mines and mining facilities within the Vareš town area, situated in Central Bosnia. They pose a significant threat to soil, air, surface and ground waters. Consequences reflect on general environmental status in this part of Bosnia resulting from opened ore deposits exposed to intense oxidation processes. It concerns primarily abandoned surface iron mines 'Smreka' and 'Brezik', along with a polimetalic lead-zin-barite deposit exploited at surface mine 'Veovača'. A lake was formed within the abandoned 'Smreka' surface mine. Furthermore, environmental hazards are posed by an abandoned ore processing facility (lead, zink and barite), as well as a flotation dump pond, taking into account stability of the dam, along with a composition of sediments and water content in the lake. These sites have to be urgently put under control to prevent further detrimental environmental impacts. They are listed among 4 major industrial hotspots in Federation of Bosnia and Herzegovina [1].

Key words: environment, hotspots, contamination, heavy metals, surface mine

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1. ENVIRONMENTAL ISSUES RELATED TO ACTIVE AND ABANDONED MINES IN BOSNIA AND HERZEGOVINA

Environmental issues related to active and abandoned mines, as well as mine waters are serious and they should be treated as such. When analysing mine water issues, there is an obvious lack of systematic quality and quantity monitoring of mine water drainage and that is the cause of inability to define the exact kind and degree of related contamination. Almost no research has been carried out related to acid mine water drainage and its impacts on the environment, and as a result, safeguarding measures have not been defined yet. State legislation has defined control only of waste waters from processing plants, including the drainage from settling ponds of active processing plants [2].

There is no law, strategy or activities conducted related in any way to abandoned mines. Land reclamation process of the mined out areas is rarely done according to the regulations. Mines do not have legal obligation to conduct contamination control caused by mine water drainage or to decontaminate old mining areas. The dispersion of responsibilty among different ministries and sectors for control of impacts in the field of environment and water protection is an additional problem when it comes to controlling mining impacts on the environment [3].

2. CURRENT ENVIRONMETAL STATUS IN VAREŠ AREA

It is evident that there are unsettled issues in the field of abandoned surface ore exploitation. The last surface operation of Vareš mine ceased production in 1992. There are abandoned iron ore pits, namely 'Smreka' and 'Brezik' as well as semimetallic lead, zink and barite deposits in 'Veovača' pit. During the process of surface exploitation in Vareš, 'Droškovac' iron ore pit was still active. In the area of 'Smreka' pit a lake was formed after the termination of mining activities including water drainage operation. Apart from open pits, environmental hazards are posed by other remaining mining plants and facilities as well [4].

3. RESEARCH RESULTS ON ENVIRONMENTAL IMPACTS

The research of the above mentioned areas was conducted in order to test the current status of typical environment hotspots and to determine the main issues related to sites examination and remediation. The concentration of harmful substances on each researched location was compared to the environmetal standards in the Federation of Bosnia and Herzegovina, as well as to the other reference standards used in different countries. It is important to stress that there are no soil and sediment environmental standards (apart from those for agricultural soil) in the Federation of Bosnia and Herzegovina [3].

The first part of the research focuses on the broader area of Vareš town. Five locations are tested and a total of eight water samples were taken in order to determine the presence of heavy metals and to compare water quality from different locations. The second part of the research focuses on sampling and analysis of floatation pond sediment. Table 1. shows the results of chemical water analysis from the mentioned locations.

Table 1. The results of chemical water analysis

Locations	pH value	Ba (mg/l)	Fe (mg/l)	Pb (mg/l)	Zn (mg/l)	Sb (mg/l)
1. Veovača pit	7.35	0,164	0,268	0,051	1,896	0
2. Smreka open pit – lake	7.25	0,148	0,028	0	0	0
3. Smreka open pit – incline tunel	7.47	0,142	0,139	0,015	0,050	0,025
4. Brezik open pit – adit	7.62	0,148	0,073	0	0	0
5. Flotation waste – lake – end part section	8.50	0,414	0,050	0	0	0,014
6. Flotation waste – lake – a section next to the dam	8.55	0,698	0,039	0	0	0
7. Floatation pond 1	7.73	0,387	0,650	0,071	0,088	0,024
8. Floatation pond 2	8.10	0,168	0,169	0,382	48,31	0
Max Allowed Concentration in B&H	-	-	*0,200*	*0,010*	-	*0,500*

3.1. Water analysis

At the site of abandoned 'Veovača' pit, and within the locality of the ore processing plant, a very high contents of lead and iron, significantly exceeding the limit values, were registered. The amount of lead is also increased in the adit connecting 'Droškovac' underground mine with 'Brezik' open pit, from which the mine water drains into the nearby water stream. Presented numeric values for different components are not high. The reason lies in relatively long exposure period of the pits areas to wash out and dillution of mineral contents, i.e. 25 years since the ceasation of mining activities. Ph values indicate the basic character of the sampled media. Water analysis of the floatation pond included standard water quality parameters along with heavy metals which are indicators of contamination (Pb, Zn, Cu, Ni, As, Cd).

The same heavy metals are tested in the sediment. Water analysis results were compared with the limit values based on drinking water health policies. Increased blurriness of lake water is evident, along with iron contents, as well as considerable amount of organic substances expressed through potassium permanganate ($KMnO_4$) consumption. Determined Ph value of 7.9 is favorable for heavy metal precipitation, thus it can be assumed that the potentialy present heavy metals are in suspended, i.e. undissolved form.

3.2. Sediment analysis

Results of the sediment chemical composition indicate minimal contents of organic substances, expressed through volatile materials on 550 ˚C, that amounts to 3.58 %. This indicates that the sediments are mainly of mineral content. Apart from that, the presence of SiO_2 is significant, which is not exceptional when it comes to lake and river sediments.

A significant contamination is present in the sediment samples taken from the bottom of the lake, table 2. Maximum allowed concentration values (that are set for agricultural land), are exceeded multiple times, and this standard is used to define sediment toxicity when it comes to copper, zink and arsen as well as lead content which is likewise exceeded, but not significantly.

Table 2. Heavy metals results (Cu, Ni, Zn, Pb, Cd, As) in sediment

	Cu (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	As (mg/kg)
Sample 1	185.71	56.83	442.37	128.89	0.3333	144.01
Sample 2	223.37	51.59	442.03	164.48	0.2983	153.58
Arithmetic mean	204.54	54.21	442.20	146.68	0.3158	148.79
TEL	18.7	15.9	124	30.2	0.676	7.24
PEL	108	42.8	271	112	4.21	41.6
MAC in B&H	100	60	300	150	2	30

The heavy metal analysis of sediments shows the following:

- Copper, lead, zink and arsen exceed maximum allowed concentration values multiple times, as well as recommended toxicity sediment quality levels;
- Nickel is below maximum allowed concentration values, but is above recommended toxicity sediment quality levels;
- Cadmium does not exceed maximum allowed concentration values nor recommended toxicity sediment quality levels.

4. STATUS EVALUATION AND SUGGESTIONS FOR PROBLEM SOLUTION AT THE MOST CRITICAL SITES

Conducted research and obtained results indicate that the most significant environmental hotspots are: the lake created in 'Smreka' open pit, 'Veovača' open pit and processing plants, along with lake containing disposed flotation waste. The status of the site, key research results, suggested remediation plan and estimated cost for the targeted sites are concisely shown below.

4.1. The lake in the area of 'Smreka' pit

Upon stoppage of water pumping and drainage operations in 1992, a lake was formed within 'Smreka' open pit crater. It is estimated at volume of around 3.000.000 cubic meters (m^3) and 116 meters deep. Pit slopes are in bad shape thus erosion and landslide processes are expected.

Figure 1. A lake in 'Smreka' pit crater; Photo Abaz Velić

The water quality results: Heavy metals concentrations are sporadically high, but does not exceed the values registered in its vicinity.

Sediment quality: Some heavy metals concentration exceeds Canadian PEL values (Probable Effect Level), but the the limit values are exceeded in the vicinal soil as well.

Suggested measures: 1) detailed project development, 2) Land reclamation that includes both technical and biological reclamation 3) Regular monitoring is also suggested.

A rough remedy cost estimate is 321.000 KM (BAM).

4.2. 'Veovača' copper, zink and barite mine

Upon the stoppage of operations both in the surface pit and mineral resources preparation plants, the facilities and equipment were left unattended. Furthermore the ore at pit benches remained exposed to erosion and leaching. The facilities and equipment in 'Tisovci' plant were abandoned and no appropriate cleansing and conservation measures were carried out required for such a long period of inactivity. At the same time, a considerable amount of machinery, finished products and raw materials remained in the depot (copper, zink and barite in paper packaging).

Figure 2. 'Veovača' pit; Photo Abaz Velić

Surface ground/soil in the site of abandoned lead, zink and barite processing plant is heavily contaminated with heavy metals, such as: Pb, Cd, Ni and As, even though a major part of harmful substances were previously removed from the site.

The soil research results:

- Cd max. 27,3 mg/kg (reference limit value 10 mg/kg).
- Pb max. 3.005 mg/kg (reference limit value 500 mg/kg).
- Ni, Zn, Mn and As concentration are also higher than the reference limit values [5].

Suggested measures: 1) development of a remedy plan, 2) decommissioning and demolition (removal) of the existent buildings, 3) removal and disposal of contaminated soil (or possible neutralisation at site).

This site was recently bought by a mining company and some soil remedial measures are planned upon reconstruction of the ore processing plant. A rough remedy costs are estimated at 845.000 KM.

4.3. A lake containing tailings from processing plant

An earthen dam of lead, zink and barite factory was used to retain tailings generated in the processing plant. It concerns a lake with considerable capacity of accumulated water. After ore concentrate production ceased, it became an environmental hazard for the river Bosnia basin. The dam's crown is damaged due to water and wind erosion. Apart from surface erosion, there are traces of pitting and dredging. Repair of the dam is urgent, because in case of its collapse, the consequences could be catastrophic.

Figure 3. Waste-rock lake; Photo Abaz Velić

The water quality research results: Cd, Pb, Cu and Zn concentrations slightly exceed the surface water quality criteria set in Federation of Bosnia and Herzegovina, so it is assumed that these concentrations are caused by natural phenomena.

Soil and sediment on the dam: Cd, Pb, Cu, Zn, and As exceed reference limit values.

Suggested measures: 1) geotechnical examination, 2) detailed project, 3) construction and supporting work and other measures for dam rehabilitation and construction of two peripheral water drains. A rough remedy cost estimate is 520.000 KM.

5. CONCLUSION

The environment impacts of mining activities are present in almost any stage of the mining cycle. Contamination of the environment as a consequence of mining activities includes mine acid waters, heavy metals, chemical reagents from ore processing plants, suspended substances, and drain and overflow waters from the tailing dumps [6].

The stagnation of industrial development in Bosnia and Herzegovina has resulted in dangerous impacts on the environment. Resignation and depression among people as well as a lack of interest, and absence of adequate penalty measures in every field has contributed to a range of long-term environmental consequences, listed below:

- Aquatic ecosystem impacts as well as inability to use such water courses for water supplies and recreation purposes which is connected to change in water color as a result of iron hydroxide salts presence
- Surface and ground waters contamination with toxic substances through dust from the abandoned surface pits
- Hazards of waste-rock dam slide and collapse
- Mine waters contaminated with heavy metals endangering water courses and people living close by

Site's proprietorship has not been settled yet, nor has the jurisdiction over the site, especially for the iron ore pits since they are not so atractive to the investors. The matters are unsettled when it comes to the lake in 'Smreka' pit area, 'Tisovci' ore processing plant, earthen dam of tailing pond, etc. Consequently, not even the new owners of certain mine facilities have assumed responsibility for environmental remedial actions, which puts additional burden on the situation.

Taking into account the environmental impacts, it is necessary to implement important activities by authorities and other interest groups. Following 'the polluter pays' policy, remediation of environmental hotspots should be implemented by the responsible entities, based on the laws of the Federation of Bosnia and Herzegovina. In order for this to happen, Federation of Bosnia and Herzegovina needs to further develop its technical and administrative systems. Since the sites have been abandoned for years, it is important to minimise the risks primarily at the most hazardous sites. Approaches to the remediation of these sites can be diverse and depending on the future use of the land, time frame, funding and used technologies. These objectives require the support of experts along with other interest parties.

Therefore the prime objectives are:

- development of technical and legal frameworks for hotspots remediation,
- determining proprietorship of the abandoned mines,
- removing leftovers of the mines infrastructural facilities,
- technical and biological reclamation of 'Smreka', 'Brezik' and 'Veovača' surface pits,
- reclamation and remediation of tailing ponds and other waste disposal sites.

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DEPENDING IGNITION TEMPERATURE OF FLAMMABLE FOOD DUST ON PARTICLE SIZE

Abstract: By increasing of human need for food products the industry has shifted from the home production up to fabrications. This fact also causes increasing of the food dust amount in the spaces of silos, mills or production halls, and by that the danger of the explosion of the food dust is also increased. If the effect of explosion and pressure increase is limited, it is likely that only the device where the explosion occurred could be damaged. In worse case, sedimented flammable dust may be swollen by the pressure wave of the primary explosion, which may cause one or several other secondary explosions. The risk of explosion of flammable dust depends on several factors. One of them is the softness and particle size of dust. The article deals with its influence on the ignition temperature of flammable food dust in settled state.

Key words: flammable dust, food dust, explosion, explosion safety, ignition temperature

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1. INTRODUCTION

Inspite of the fact that food dust can appear harmless and be overlooked entirely, it is extremely dangerous because of its flammability and explosivity. Any solid material composed of distinct particles can present a fire hazard. Explosions and fires within the food industry from combustible materials are a known hazard and they can have devastating and irreversible effects. If moisture content is low and particle size is small the majority of powders can form explosible dust clouds in the food industry. Although explosible dust cloud concentrations are not normally expected to be present within processing buildings, explosible dust clouds are regularly formed inside material handling or processing equipment when bins are being filled, powders are being transferred or dust is being collected in a dust collector.

Explosibility of the dust cloud depends on the particle size of the dust. The finer the particles the greater the surface area per unit of mass and thus the more explosible a given dust is likely to be. When the cloud is composed of a series of particle sizes ranging from fine to coarse, the fine particles play a prominent part in the ignition and the explosion propagation. The presence of dusts should therefore be anticipated in the process stream, regardless of the starting particle size of the material. [1,2] The danger of fire and explosion of flammable food dust is still present in settled and raised state, too. The consequences of such fires and explosions can have a catastrophic impact on material values, technology and, of course, workers' health and lives. That´s why it is important to know the fire - technical properties of the industry food dust it has been working with.

Flammable dust can be defined as a set of pulverized particles of the solid substance which exist in the gassy environment. These dust particles have the dimensions lower than 0,5 mm. Dusts as products in the branch of industry arise in the process aimed at food production (flour, cinnamon), or can arise as secondary raw materials at the solid substance processing. [3]

In the experimental measurements particular types of food dusts were used, namely cocoa, gluten-free soya flour, dried milk and wheat smooth flour. All food dust samples were screened over sieves to the specified dust fractions.

2. STATISTICS AND OVERVIEW OF SITUATION IN THE FIELD OF EXPLOSION PROTECTION IN FOOD INDUSTRY

Nowadays, a huge number of food businesses, facilities and technological equipments are in processing within that flammable food dust is being used or generated. It is not possible to ensure their absolute safety, so it may have occurred various extraordinary events during that operation. The explosions are the most redoubtable of them, which mostly have very serious consequences, as can be fractionally seen in the following figure 1.

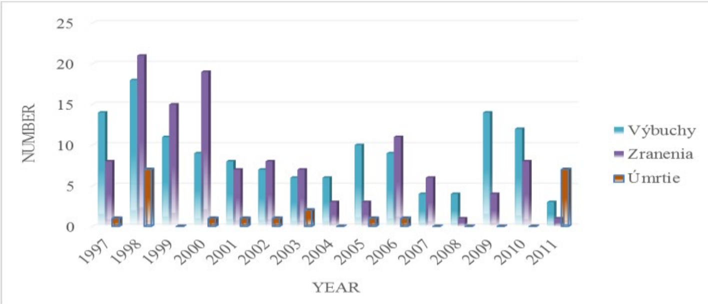

Figure 1 – Chart of grain silos explosions since 1997 till 2011 in the USA, výbuchy = explosions, zranenia = injuries, úmrtie = deaths [4]

An investigates team found there have been more than 500 grain elevator explosions from 1976 until 2011, according to documents from the Occupational Safety and Health Administration. Those explosions caused 670 injuries and 184 deaths. [5] Combustible dust has been recognized as a defined hazard for many years. But a February 2008 explosion and fire at the Imperial Sugar refinery in Savannah, Georgia, left 14 dead and 38 others seriously injured. Massive accumulations of combustible sugar dust throughout the packaging building fueled the explosion. Although similar to others in the past, this event prompted a significant movement among regulatory agencies and standards organizations to inform and educate workers and managers in such environments about the dangers of combustible dusts. [6]

Figure 2 – Imperial Sugar Refinery after explosion in February 2008, Savannah, Georgia, the USA [7]

3. FLAMMABLE FOOD DUSTS AND EXPLOSION SAFETY

3.1. Properties of flammable food dust

Flammable dust has specific properties in comparison with the compact substance which it was created from, particularly properties related to its fineness, the surface size and to decreasing particle size. Due to the fact that the dust particles have a larger surface area than the compact substance, their reactivity also increases. Dust obtained in any way is the sum of particles of different shape and size. The shape of these particles varies depending on the properties of the compact solid and the way it is obtained in. The geometric shape of the particles and their size has a significant impact on the burning process and its intensity.

Table 1- Table values of ignition temperature of chosen food dusts [8]

Food dust	Ignition temperature of food dust in settled state [°C]
Cocoa	200
Dried milk	200
Gluten free soya flour	190 - 340
Wheat flour	360 - 440

Table 2- Table values of fire – technical characteristics of chosen food dusts[8]

Food dust	Ignition temperature settled dust in °C	Ignition temperature whirled dust in °C	Minimum ignition energy of whirled dust mJ	Lower explosion limit in g/m3	Maximum explosion pressure in MPa at concentration in g/m3	Explosion constant in MPa.m.s-1 at concentration in g/m3
Cocoa	200 - 240	500 - 510	100 - 120	65 - 75	0,47 - 0,48 1000	0,89 500
Dried milk	200	440 - 610	35	60 - 125	0,66 1000	3,27 1000
Gluten free soya flour	190 - 340	500 - 620	265	60 - 140	0,91 1000	0,62 500
Wheat flour	360 - 440	380 - 440	50	40 - 50	0,67 – 0,75 1000	2,97 500

Explosion prevention is a set of measures to reduce the formation of explosive mixtures of flammable gases, vapors and industrial dusts and the possibility of initiating these explosive mixtures. It also reduces the effects of the possible fire, respectively of the explosion at the lowest possible level.

3.2. Dust explosion safety

Dust explosion protection is divided into following groups based on the way in that the environment, property, food processing facilities and people´s health and lives are protected. It is:

- Active protection
  - Primary protection (preventing or eliminating the possibility of forming explosive mixtures)
  - Secondary protection (preventing initiation and ignition of explosive mixtures)
- Passive protection (concerned to eliminate and minimise consequences of an dust explosion)

Performing passive explosion protection the dust explosion is not excluded, and therefore it is necessary to construct the hazardous parts of the equipment and facilities with the respect to the intensity of the possible explosion pressure.

Passive explosion prevention involves the use of the following measures:

- explosion resistant construction,
- explosion reducing systems,
- explosion suppression systems,
- prevention of flame and explosion propagation systems.

4. EXPERIMENT

Experimental measurements are carried out on an apparatus for determining the minimum ignition temperature in the settled state according to the procedure in Slovak technical standard STN EN 50281-2-1.

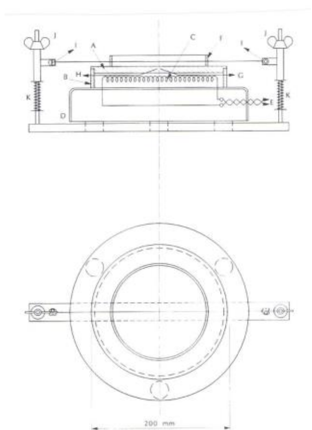

Figure 3 – Scheme of equipment for measuring ignition temperature of settled dust, A - heated board, B - hem (boarder), C - heating, D – base of heating, E - outlet for connection of heating to the power

supply and control, F – ring for the dust layer, G - thermocouple in the control board, H - thermocouple in the temperature recorder, I – thermocouple for temperature recording in the dust layer, J - thermocouple height adjustment, K - spring [9]

The first step before sampling is the sieving of selected food dusts through metal wire screens with a mesh size of 0.2 mm (200 µm),0.315 mm (315 µm) and 0.5 mm (500 µm) according to the standard ČSN 01 50 30. The measuring equipment was heated to required temperature and consequently the samples were situated on the heated surface. Particular measurements were carried out within 30 minutes. The measured samples were cocoa dust, gluten free soya flour dust, dried milk dust and wheat flour dust. The minimum ignition temperature was measured at 2 sizes of layers – 5 mm and 12,5 mm. The results are shown below in the table 3.

Table 3- Minimum ignition temperature of settled food dust measured according to the norm STN EN 50281-2-1

Minimum ignition temperature of chosen food dust in settled						
Food dust	Ignition temperature [°C] at three fractions and two layers					
	Fraction 0,20 mm		Fraction 0,315 mm		Fraction 0,50 mm	
	Layer 5 mm	Layer 12,5 mm	Layer 5 mm	Layer 12,5 mm	Layer 5 mm	Layer 12,5 mm
Cocoa	270	290	280	290	290	300
Gluten free soya flour	Negat.	Negat.	Negat.	Negat.	Negat.	Negat.
Dried milk	370	380	380	390	390	390
Wheat flour	Negat.	Negat.	Negat.	Negat.	Negat.	Negat.

As it was expected from the results of measurements of all samples, it can be said that a finer powder with a fraction of 0.20 mm was ignited faster than more coarse - grained dust with 0.315 mm and 0.50 mm fractions. This is due to the fact that the finer the dust is and the smaller the dimensions of its particles are, the larger the area is on which the reaction can occur, and thus the food dust under the given conditions is more flammable and able to ignite at lower temperatures. Wheat and gluten-free soya flour, according to the standard EN 50281-2-1, did not burst under the given conditions, but they showed smoking and also changing color of the dust (partial carbonizing).

As it can be seen from the table 3, the measured values of the minimum ignition temperature of selected food dusts compared to the ignition temperatures given in the fire - technical characteristics tables are slightly higher. This is due to the fact that each food dust has its own unique properties, including not only softness and size of the particles, but for example, moisture, structure, particle shape, composition, etc., too. Therefore, it is important to note that the existing tabulated values of fire - technical characteristics of food dusts can be considered as indicative intervals, but for adequate and proper explosion protection in a particular company, the fire - technical characteristics of the food dust must always be measured.

5. ACKNOWLEDGEMENT

This work has been supported by the Scientific Grant Agency of the Ministry of Education, Youth and Sports of the Slovak Republic under Contract No. 1/0222/16. [6] Fire-resistant thermal insulation systems based on natural materials.

6. CONCLUSION

For given food dusts in technological processes, it is important to take into account the procedure of increased cleaning in areas where dust layers may settle and it is also necessary to know the temperature of ambient objects and equipment from which the dust layer may initiate. It have been found by experimental measurements that cocoa and powdered milk have a very close composition of their products because they both can contain sugar and milk and are also mixed with similar additives.

In case if it is impossible to eliminate an explosive atmosphere or an initiating source, passive protection is required, where the HRD systems are mostly very appropriate and suitable solution for the food technologies. They are used in closed technological equipment, for example in silos, crushers, mills, powder tanks and others.

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TESTING OF SELECTIVE PROTECTIVE EQUIPMENT - REACTION ON FIRE

Abstract: Use of quality personal equipment for personal health at work is a growing trend, with which directly increases the demand for these equipment. With increasing demand has also increased it production and also the possibility of reduced quality of personal protective equipment.That was the reason why we are focus aim of our work on testing selective protective equipment's. Specifically, we focused on the behaviour of gloves exposure to flame.

Key words: working gloves, fire, reaction on fire, OHS

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1. INTRODUCTION

The achievement of increasing health and safety at work has not only social significance, but especially important influence for the actual user or for the employee. Use of quality personal equipment for personal health at work is a growing trend, with which directly increases the demand for these equipment. With increasing demand has also increased it production and also the possibility of reduced quality of personal protective equipment.That was the reason why we are focus aim of our work on testing selective protective equipment's. Specifically, we focused on the behaviour of gloves exposure to flame.

2. TESTING SAMPLES

Testing samples were gloves, we have not adjusted to predetermined dimensions, but test it on the whole, that the samples correspond to reality and variation in the results were as small as possible. See figure 1.

Fig. 1. Sample of glove num. 1

Protective gloves which have their inside side made of white nitrile and cover coating is also a nitrile. Such personal protective equipment shall be used mainly for work related to the use of paints, stains and other. Specifically they used in the brushing, spraying, dipping necessary raw materials and products. Length of the gloves is 32 cm and a thickness of 0.38 mm. The gloves are tested and certified according to EN 388, EN 374, EN 420, and EN 437. [3]

Fig. 2. Sample of gloves num. 2

Universal protective gloves for general use. Durable, good quality of bovine split in the upper part and beef cheek in the palm area. This has implications for greater comfort at work and increases the resistance of gloves to abrasion, cuts, the water absorption of oils, dirt and other contaminants in the palm area of the glove. The palm is lined with 100% cotton lining, back and cuff from cotton cloth protecting the wrist. The gloves are tested and certified according to EN 388, EN 420. [4]

Fig. 3. Sample of gloves num. 3

Seamless gloves, providing greater comfort, without silicone, made of polyester (100%), at which the fingers and palm coated with polyurethane. The advantage is good elasticity and can be handled with dirty objects. Glove thickness is 13 mm. The gloves are tested and certified according to EN 388 and EN 420. [5]

Fig. 4. Sample of gloves num. 4

Protective gloves are made from seamless knitted cotton 35% polyester and 65%. Fingers and hands are covered with a coating of natural latex. They are characterized by excellent elasticity, good tightness on the wrist, high resistance to abrasion. They are mainly used for rough work. The gloves are tested and certified according to EN 420, and EN 388, in which the mechanical tests, the abrasion tested, cut resistance, resistance to further tearing and puncture force. [3]

Fig. 5. Sample of gloves num. 5

Thin protective nitrile gloves double made Ansell Grip Technology. Nylon gloves with 15-fiber lining, excellent dexterity and longer life offer users excellent tactility and flexibility. Suitable for handling wet and slippery objects with less grip force need. The gloves are tested and certified according to EN 388, EN 420, EN EN 374-1, EN EN 374-3. [5]

Fig. 6. Sample of gloves num. 6

As the gloves of bovine split, the gloves are also this type of gloves designed for general use. Durable, good quality, easily strung the shed, whole pork splitting unlined. Gloves are breathable thanks to its porous structure, which is reflected in the wet working environment where they are more flexible and softer. They have a relatively high resistance to abrasion, cutting, absorption of the dirt and other impurities. The gloves are tested and certified according to EN 388, EN 420. [4]

3. EXPERIMENT

In experiment, we focused on the behaviour of personal protective equipment - protective gloves Flammability EN ISO 6941: 2003. A process (in which we are focused on the ignition surface of the glove).

3.1. Procedure A - surface ignition

The test specimen is placed vertically on the tip holder to the item, the centre of the lower edge. Then we attach the test sample of the clamping frame. The burner was placed vertically on the surface of the test sample so that the axis of the burner stabilizer were 20 mm above the ground and tips to intersect the vertical centre axis of the front side of the sample. The distance from the top of the burner front of the test piece had to be 17 mm ± 1 mm. [1]. We then set the burner to the vertical standby position, inflammation preheated for at least two minutes. After preheating the burner he is transferred to the horizontal standby position, and set the horizontal reach of the flame 25 ± 2 mm. We measured as the distance between the top of the stabilizer and the burner tip of the yellow part of the flame when examined against a dark background. The flame height had to be checked before testing each sample. [1,2] In the event that we have prepared the device, there is itself accompanied by the test flame for 10 seconds, during which monitors the behaviour of the flame gloves. At the same time we recorded spontaneous combustion flame test sample and whether there is a complete combustion of protective gloves and whether there is prostration and dripping flaming debris. [1, 2]

4. RESULTS AND EVALUATION

The above table and figure we can see that for only two types of protective gloves during the 10-second application of the test flame to the surface are not to avoid subsequent spontaneous of flame. It is a glove samples 2 and 6. With these gloves during and after delaying the test flame are not prevent dripping and burning parts at the same time not even to create holes. The remaining four types of protective gloves have also showed good qualities. In all of these occurred following withdrawal of test flame spontaneous of flame, accompanied by fainting and dripping of burning parts until the sample did not burn completely. Fared worst glove samples 3 and 5 which, after delaying the flame burned completely even during less than 48 seconds. Gloves at 1 and 4 was spontaneous time of flame in complete combustion of samples of 20 or 30 seconds longer than with those who fared the worst (see Table 1 and Figure 7). The flame was accompanied by fainting and dripping of burning parts.

Table 1. ***Average Times-flame ignition at the sample surface***

Mesarument	Sample					
	1	2	3	4	5	6
num.1	95,73	0,00	51,23	79,21	52,29	0,00
num.2	86,13	0,00	48,34	77,89	48,32	0,00
num.3	92,80	0,00	45,62	82,34	40,05	0,00
num.4	79,24	0,00	49,03	74,02	46,53	0,00
num.5	88,29	0,00	42,79	79,92	50,34	0,00
Average: (s)	88,44	0,00	47,41	78,68	47,51	0,00

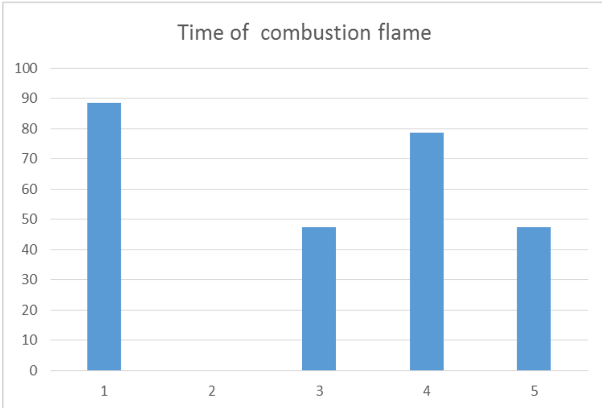

Fig. 7. Times the average spontaneous combustion flame.

5. CONCLUSION

All measurements specifically has the aimed to improve and refine information database given a standard process that, in its assessment cannot evaluate our chosen specifics. Therefore, the results of experiments, we consider the contribution of scientific disciplines in the field of fire protection, and also in the field of work in general, as well as health and safety at work affecting emergency services.

6. ACKNOWLEDGEMENT

This article was supported by the Grant Agency Ministry of Education SR KEGA - project no. 014UKF-4/2016

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A MATHEMATICAL MODEL FOR EVALUATING THE LEVEL OF POLLUTION IN THE PROCESS OF SCREEN PRINTING

Abstract: Herein we create a mathematical model for evaluating the level of pollution of the environment caused by various factors used during screen printing in printing offices. Among these factors, chemicals used in the process of printing plate preparation and printing are significant pollutants. Their impact on the environment and human health is depending on the printing technology and available equipment in the printing office. We use Fuzzy mathematics for creating a model for evaluating the level pollution of the environment according to the analyzed factors. This model can easily be generalized to include other printing techniques and more factors, in order to evaluate the level of hazards of a certain printing office.

Key words: Environment, hazards, pollutants, screen printing, mathematical model, Fuzzy mathematics

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1. INTRODUCTION

Every printing technique is a very complex process: machines of different construction, speed and printing plates are used. The main materials used in the printing process are different printing surfaces and appropriate printing colors, [5]. The composition of the components can vary, depending on the type of printing technique. Colors with different components and characteristics are used for the offset printing technique, high press, deep print, flex printing and screen printing, [5]. Considering a specific printing office, one can realize a large quantity of waste material which can be harmful to human health and the environment. Thereby, according to [4] we must respect the following protection schedule:

- A modification of the printing process using cleaner technologies,
- Using ecological friendly materials,
- Requiring a circular flow and recycling in the printing process,
- Purification measures

In the graphical industry, we can make a rough classification of polluting substances: Solid waste, liquid waste, gaseous waste. Solid waste includes: Empty packaging, materials with exceeded expire date, damaged boards, developed films, poorly printed specimens, damaged specimens, waste paper, etc. Liquid waste includes: Lubricating oils, waste paint, cleaning solutions, chemicals for the development of films, acids, bases, etc. The use of printing colors and solutions for the cleaning of colors, alcohols and other means during the printing process causes the creation of harmful organic components and their emitting into the atmosphere. Big printing offices can be sources of emissions of gases that have a very negative impact on human health and the environment, [5].

Herein, we present a mathematical model based on Fuzzy logics (see next section 3 for explanation) for measuring the rate of pollution in the process of screen printing. We consider the main two factors of pollution in screen printing: solvent consumption per kilogram of color and the number of used colors. The amount of solvent used in the screen printing process depends strongly on the printing material and on the duration of the process. On the other hand, the duration of the process depends on the type of the printing machine and the circulation (workload). In this paper we consider three different cases of jobs which include two printing surfaces: PVC and cardboard, and two different durations of work (manual work and semiautomatic machines). We use a scale for pollution measuring on the interval [1,10]. We have organized this paper as follows: A short overview on the influence of graphical colors to the environment is given in section 2. Essential information about ecological colors is provided in subsection 2.1. In section 3 we give basic information about Fuzzy logics, and introduce our mathematical model for measuring the rate of pollution in the process of screen printing. We also provide three valuable numerical examples of the use of our model.

2. THE INFLUENCE OF GRAPHICAL COLORS TO THE ENVIRONMENT

Besides the influence on the environment of the waste, a negative influence on the environment comes from colors used in the graphical industry. This devotes mainly to the so called solvent colors, i.e. colors with a high content of solvents (for example, ethyl benzene, ethylene glycol, glycol ether, toluene). Graphic colors are dispersing systems composed of a number of different components that, together, in a homogeneous mixture provide the color with the required printing properties. The most important part of a graphical color is the pigment which binds to the substrate on which it is printed. The color components during production are mutually well-homogenized into a paste of required consistency, in which the composition comprises the pigments, solvent, binding agent and excipients, [6]. The presence of heavy metals makes graphic colors dangerous. By the mid-seventies of the twentieth century, most of the graphical colors contained metals, whose maximum permissible concentrations were prescribed by law. Metals such as silver, chrome, iron, copper are often found in waste liquids. The allowed concentration of the metal is prescribed by the regulations [7]. The toxicity of a substance depends on its chemical properties, differences of individual organisms, external factors, and the synergistic action of several substances. The common effect of multiple substances is equal to the sum of their individual action, [3].

2.1. The use of ecological colors

A printing color is important for the printing process and cannot be ejected or replaced by something else. However, the color may be problematic from the point of view of the preservation of the environment. Printing colors can contain harmful substances such as heavy metals and solvents that accelerate the drying process. In the drying process, organic compounds are evaporated, and all of these vapors have an adverse effect on the environment. The color consists of: solvents, binders, additives, pigments and their carriers and solvents, [9]. Solvents make color liquid and represent one of its most important and most complex components. The solvent role is to keep the color in liquid state until applied to the substrate. The solvent must then be separated from the rest of the color to allow the color to dry and harden.

Colors used in screen printing are typically divided into the following groups:

- water soluble colors
- Colors resorb able in organic solvents
- Ultraviolet dyes

For colors which are soluble in organic solvents, various organic solvents are used depending on the pigment. These solvents are mainly based on alcohol compounds, [12]. For screen printing we use the following solvents: butyrol acetone, methoxypropanol acetate, hexane and cyclohexanone, 2-butoxy ethanol, aromatic distillates. Unfortunately, most of these solvents belong to serious environmental pollutants. Some contribute to the formation of smog, many are acutely or chronically toxic to humans, and there are few which are suspected of being carcinogenic, teratogenic and mutagenic. Lately, there have been developed solvents that represent a lower environmental risk. Also, various types of filters and purifiers are also used to prevent the flow of colors into rivers and groundwater through urban sewers.

Water-based colors use water as the main solvent. This does not mean that water is the only solvent used. It is important to understand that many waterborne colors contain ancillary solvents that can be based on petroleum and cyclic hydrocarbons. There are numerous reasons for the use of auxiliary rails, but the most important one is the shortening of the time and the lowering of the temperature necessary for drying the color, [12].

For colors soluble in organic solvents, various organic solvents are depending on the pigment used. They are mainly based on alcoholic compounds. Unfortunately, most of these solvents are considered serious contaminants of the environment.

A large number of printers are now designated for eco-management, [11]. Color manufacturers are trying to reduce the content of solvents in colors by replacing them with vegetable oils, [10]. Ecological colors are also often referred to as alternative colors, since they have a reduced content of materials that are harmful to the environment (for example: solvents, volatile organic compounds, heavy metals, etc.). In other words, ecological colors are colors in which harmful components are completely replaced by other, less harmful or harmless substances. The correct choice of alternative binders can reduce the amount of ink consumed without dropping the print quality. The choice of color types depends on the printing process, the substrate and the used products, [10].

3. THE MATHEMATICAL MODEL FOR EVALUATING THE LEVEL OF POLLUTION IN THE SCREEN PRINTING PROCESS

In order to create a suitable model for evaluating the level of pollution during the screen printing process, we use the method of Fuzzy logics. Herein, we will give only a brief description of the main concept of Fuzzy logics used for the purpose of our model. For a more detailed description, we refer to [1], [2]. According to [2], the concept of Fuzzy logic enables modeling using linguistic expressions like “low”, “medium”, “high”, etc. This theory uses sets of elements with different grades of membership - so called *Fuzzy sets*. Thereby, the grade of membership is determined by a membership function μ which takes values on the interval [0,1]. Fuzzy logics blurs the boundaries between sets: In-between grades of membership are allowed. This means that some elements can belong to two sets at the same time, [2].

We first create the Fuzzy model and then we evaluate the pollution in three cases:

Case 1: The use of two colors on Cardboard during 8 hours (manual work)

Case 2: The use of two colors on PVC during 8 hours (manual work)

Case 3: The use of four colors on PVC during 4 hours (semiautomatic machines).

The first step of a Fuzzy model is called *Fuzzification* and consists of converting numeric input data to linguistic variables based on experience, [2]. We observe to main input factors having impact on the pollution during the screen printing process: The solvent consumption per kilogram of color and the number of colors used in the printing process. Accordingly, we define two Fuzzy variables *Solvent consumption* and *Number of colors*. Figure 1 shows the membership functions for sets of the solvent consumption, whereas Figure 2 shows the membership functions of the sets for number of used colors. As we can see, we define three Fuzzy sets for Solvent consumption: *Low, Medium and High,* and three Fuzzy sets for Color usage: *Small, Medium and Large*. Then we define the Fuzzy values of the output variable Pollution, which can take values from 1-10. The Fuzzy sets in this case are called: *Low, Medium and High.* The membership functions of the variable Pollution are given on Figure 3. Figures 1-3 are created using the mathematical program *Mathematicae,* [13].

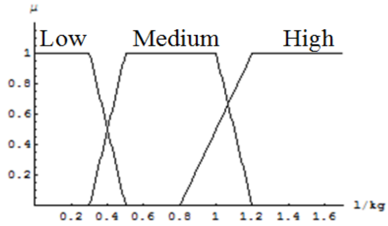

Figure 1 – Solvent consumption membership functions

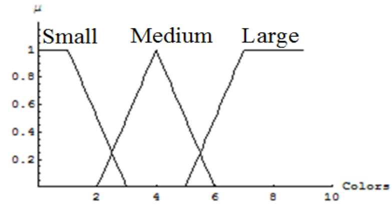

Figure 2 – Color usage membership functions

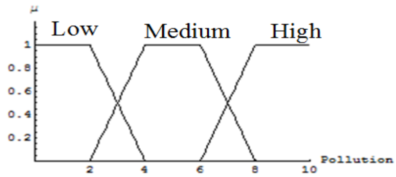

Figure 3 – Pollution membership functions

The second step of a Fuzzy model is to define Fuzzy rules according to our knowledge and to assign fuzzy output values based on this rules. According to [2], this step is called Fuzzy inference. Fuzzy rules are of the form *If-Then.* The list of Fuzzy rules for our model is given in Table 1. For example, the first rule in Table 1 reads as

If the solvent consumption per kilogram of color is low and the number of used colors is small, then the pollution is low.

On this way, we created the Fuzzy model for evaluating the Pollution caused by the Screen printing process.

Table 1- Table of fuzzy rules

Rule	Solvent consumption per kg of color	Number of colors	Pollution
1.	Low	Small	Low
2.	Low	Medium	Low
3.	Low	Large	Medium
4.	Medium	Small	Small
5.	Medium	Medium	Medium
6.	Medium	Large	Medium
7.	High	Small	Medium
8.	High	Medium	High
9.	High	Large	High

According to [2], step 3 is called the Deffuzification step, where an output numeric value denoted with *DFV* is obtained from output values using the following formulae:

$$DFV = \frac{\sum[MV_i \cdot FMV_i]}{\sum[MV_i]} \quad , \tag{1}$$

where:

MV_i- the membership coefficient of the i-th conclusion, (i=1,…,N, N is the number of conclusions)

FMV_i- the representative value of the i-th conclusion. For Z, S and TR and forms of the membership functions, the value at the boundary with the complete membership of the set is taken, while in the case of the T form of membership function, we the average value of all values with the full membership of the set.

Case 1: During 8 hours of screen printing on cardboard, according to the experience of manual workers in the printing office of The Higher Education Technical School of Professional Studies in Novi Sad, approximately 1.5 l of solvent is used (0.3 l of solvent initially, and additional 0.3 l at the beginning of every even hour of work). Using similarity of triangles at Figure 1 and 2, we obtain the values of the membership functions for both Fuzzy variables:

Solvent consumption: $Low = 0, Medium = 0,\ High = 1.$ (2)

Number of colors: $Small = \frac{3-2}{3-1} = 0.5, Medium = 0,\ Large = 0.$ (3)

From Table 1 one we can conclude that there is only one Fuzzy rule (Rule 7) that devotes to this case. Since this rule consists of a conjunction of two conditions, according to [1], we take the minimum of the values of the two membership functions of the variables, i.e. $\mu_1 \wedge \mu_2 = \min(\mu_1, \mu_2)$. So, Rule 7 gives $\mathrm{MV}_7 = \min(0.5,1) = 0.5$. On the other hand, since the membership function of the Medium pollution is of T form, we take $FMV_7 = 5$.

So, from (1) we get $DFV = \frac{0.5 \cdot 5}{0.5} = 5.$ (4).

Case 2: During 8 hours of screen printing on PVC (manual work), approximately 1 l of solvent is used (0.2 l of solvent initially, and additional 0.2 l at the beginning of every even hour of work). In this case, we have the following values of the membership functions for both Fuzzy variables:

Solvent consumption: $Low = 0, Medium = 1, High = \frac{1-0.8}{1.2-0.8} = 0.5.$ (5)

Number of colors: $Small = \frac{3-2}{3-1} = 0.5, Medium = 0,\ Large = 0.$ (6)

From Table 1 we obtain that Rule 4 and Rule 7 match this case. Accordingly we obtain $MV_4 = \min(1,0.5) = 0.5$ and $MV_7 = \min(0.5,0.5) = 0.5$. Since the membership function of the Small polution set is of the Z form, we take $FMV_4 = 2$, whereas $FMV_7 = 5$. This gives

$DFV = \frac{0.5 \cdot 2 + 0.5 \cdot 5}{0.5 + 0.5} = 3.5.$ (8)

Case 3: Roughly speaking, working on semiautomatic machines is two times faster than manual work. This is the reason for us to consider the case of a print screening job that lasts four hours. Since we consider printing on PVC, in this case 0.6 l of solvent is used. Now, we have the following values of the membership functions for both Fuzzy variables:

Solvent consumption: $Low = 0, Medium = 1, High = 0.$ (10)

Number of colors: $Small = 0, Medium = 1, Large = 0.$ (11)

As we can see from Table 1, Rule 5 matches this case. Similar as in the above cases, we obtain $DVF = \frac{1 \cdot 5}{1} = 5.$ (12)

4. CONCLUSIONS

As we can see from the previous section, the use of cardboard printing material, the number of colors and the duration of the screen printing process increase the rate of pollution. Our Fuzzy model can easy be expanded, in order to consider additional factors such as the dimensions and the fineness of the mesh, which is to be considered in our future work. In this paper we have considered the rate of pollution of a single job. Our aim is to make a more general study considering the number of working hours in the printing office per week. A last, this model can take into consideration other printing techniques, providing us with approximately information on the rate of pollution generated in a certain printing office.

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THE USE OF EVACUATION MODELS IN FIRE SAFETY ENGINEERING

Abstract: Evacuation modelling tools allow the prediction, investigation, and analysis of human behaviour during fire evacuation scenarios. Several tools are available on the market, adopting different modelling approaches and including different sub-models. Evacuation models may be designed specifically for their use in the context of fire safety engineering applications or being originally designed for pedestrian modelling application (i.e. circulation). This poses the question on whether evacuation models allow a sufficient coupling between the fire/smoke propagation and its subsequent impact on pedestrian evacuation movement. This paper discusses the methods currently adopted for the coupling of fire models and pedestrian evacuation movement models. Two examples of sub-models are discussed, namely 1) the representation of people movement in smoke and 2) the process of route/exit choice in reduced visibility conditions. The advantages and limitations of existing modelling tools are discussed as well as recommendations on future research in this area.

Keywords: Evacuation, Modelling, Simulation, Fire Safety, Pedestrian Movement, Smoke.

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1. INTRODUCTION

Pedestrian simulation models have generally two main applications in the field of fire safety engineering [1], [2]. The first use refers to the study of crowd dynamics during evacuation, aimed at identifying the occurrence of high densities and the subsequent congestion levels. This is generally investigated through the study of the Level of Service, which is a concept introduced by Fruin [3] to perform a classification of space usage. High congestion levels can lead to a reduced evacuation efficiency and even exposing the evacuating population to health risks due to possible overcrowding [4]. Pedestrian simulation models have been employed to address the study of such situations in different types of environments, such as transportation systems, complex buildings (e.g. shopping malls, arenas), etc.

The second use of pedestrian simulation models in fire safety engineering refers to performance-based design. This is generally done by using evacuation models for the study of the Required Safe Egress Time (RSET), i.e. the time needed to perform an evacuation. This time is generally compared to the Available Safe Egress Time (ASET), which represents the time in which the conditions of the environment are not tenable anymore [5]. The ASET can be estimated with different methods, such as hand calculations and fire models. Different performance indicators can be used as tenability thresholds, including smoke layer height, toxicity levels [6], temperature, etc. In order to achieve an acceptable design, the RSET should always be smaller than the ASET with an appropriate margin of safety which could be determined based on the uncertainties of the calculation and the building under consideration.

The first type of application (i.e. the study of congestion levels during evacaution) can potentially be performed with any pedestrian simulation model which is able to represent crowd dynamics with a sufficient level of resolution for the given application. In contrast, the application of pedestrian simulation models for fire evacuation (called here evacuation models) often requires the coupling between the evolution of the threat and the evacuation conditions. This is reflected for instance on the impact that the fire/smoke can have on evacuation performance. This means that the RSET calculation cannot be in many instances performed in isolation as a pedestrian simulation issue, since the fire/smoke propagation can directly affect the evacuation process.

This paper discusses two of the main issues concerning the coupling of fire and evacuation models, namely 1) The representation of the impact of smoke on walking speed [7] and 2) route/exit choice in reduced visibility conditions [8]. The need for the coupling between fire and evacuation models is discussed for the case of performance-based design applications for fire safety engineering.

2. METHOD

A review of existing methodologies and approaches used to represent the impact of smoke on walking speeds and route/exit choice has been performed. This includes the assessment of the main methodological approaches employed to simulate walking speed and route/exit choice in clear conditions (i.e. without smoke). In a later stage, the main methods employed to implement (implicitly or explicitly) the impact of smoke has been investigated. This has been done by reviewing the characteristics of a set of evacuation models available on the market [9]–[11] and categorising the approaches adopted into groups with similar modelling methods.

3. MODELLING THE MOVEMENT TOWARDS A SAFE PLACE

One important component in the calculation of evacuation time and prediction of the evacuation process is the movement phase. This refers to the movement time that it takes to evacuees to reach a safe place once they have taken a decision to leave. Different degrees of sophistication can be employed in the representation of people movement. This includes a simpler approach in which evacuees move from point A to point B (a safe place, e.g. an exit) or a more complex representation through behavioural itineraries. Figure 1 presents a simple example of the two approaches for a single room evacuation. It should be noted that more complex approaches can be used to represent movement (e.g. cognitive heuristics [12], artificial intelligence, etc.). Pedestrian movement can generally be represented at different levels [13], namely:

- Route choice, intended as the strategic level of movement, i.e. the choice of intermediate and final destinations of pedestrians;
- Local movement, intended as the local adjustment in walking speed and direction of pedestrians given the presence of obstacles and other pedestrians;
- Locomotion, intended as the physical movement of the pedestrians from the biomechanical point of view (i.e. leg movement, body sway, etc.).

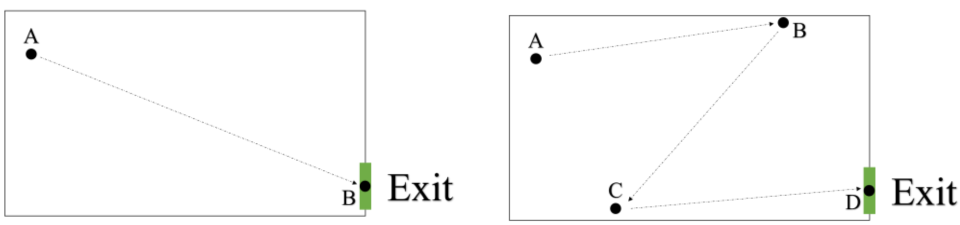

Figure 1 – Schematic representation of two main modelling approaches used to represent movement in evacuation models. 1a) movement is from point A to point B (destination), 1b) behavioural itineraries with intermediate targets are adopted.

Current evacuation models generally represent the first two elements of movement (route choice and local movement) while locomotion is generally not simulated (i.e. pedestrians are generally represented as rigid bodies moving in space and locomotion is generally only rendered visually rather than being part of the movement calculation) [1].

Once a general approach for determining the desired route is identfied (with or without behavioural itineraries), the route adopted by pedestrians can be simulated adopting different methodologies.

A set of the most common methods [1] are presented here:

- Shortest route. Pedestrians move to their target (i.e., intermediate or final destination) choosing the path with the shortest distance;
- Quickest route. Pedestrians move to their target (i.e., intermediate or final destination) choosing the path with the shortest time. This can depend on the presence of other pedestrians (i.e., avoiding congested areas) or the type of egress components (some egress components may lead to faster or slower evacuation);
- User defined. The user pre-assigns deterministically or stochastically the route adopted by the simulated evacuees;
- Conditional route. Pedestrians move to their target (i.e., intermediate or final destination) in relation to a set of conditions which are simulated within the model.

It should be noted that models can also adopt also more than one modelling approach at the same time [10].

3.1. Modelling route/exit choice in smoke-filled environments

In order to simulate route/exit choice in smoke-filled environments, the coupling between fire conditions and evacuation process may be necessary. Several evacuation models today permit this coupling (either implicitly or explictly) by allowing the representation of reduced visibility within evacuation models [14]. A sophisticated approach for route choice would consider how sensory, physical and cognitive abilities change when fire/smoke is present.

The use of a conditional route selection method is recommended since it allows considering the impact of fire/smoke on the chosen route. Other conditions may also be employed at the same time while using this method such as the impact of social interactions between evacuees on route choice [15], or the selection of familiar routes over unfamiliar routes [16].

Concerning exit choice, the recommended sub-model should allow considering (ideally explicitly) the following main questions concerning the interaction between a simulated pedestrian agent and an exit (and the associated exit signage):

- Is the exit visible to an evacuee (given line of sights and smoke)?
- Is the evacuee familiar with the exit location?
- What is the likelihood of the evacuee actually seeing the exit?
- What is the likelihood of the evacuee actually paying attention to the presence of the exit?
- Is the evacuee understanding that this is an exit (this might not be a trivial taks in smoke-filled environments [17])?
- What is the likelihood of the evacuee actually using the exit once they have understood what it is?
- Are there other visible or known evacuees going towards that exit that might influence the decision to use that exit?

The proposed set of questions should not be considered as an exhaustive list for the definition of exit choice in smoke, but it can represent a useful starting point for both model developers and model users which develop and apply evacuation models for fire safety engineering applications.

3.2. Movement speed in reduced visibility conditions

The initial speed of pedestrians is generally simulated in evacuation models by representing the so called “desired speed”, i.e. the unimpeded speed at which pedestrians would move if there would not be any factor(s) reducing their speed. In smoke-free conditions, the factors causing a reduction of speed are generally the presence of obstacles and other people (i.e., the process of collision avoidance [18]). In the context of fire safety engineering, the presence of fire and smoke can also affect walking speed. This is reflected in a reduction of speed which generally depends on the visibility conditions of the space [19].

Research studies [19], [20] have investigated experimentally the impact of smoke on walking speeds and how this should be represented. To date, the main approaches adopted include the reduction of speed in relation to the values of extinction coefficient [21] or visibility [20]. These can both be obtained by the coupled use of a fire model or hand calculations.

Two methods are currently available to apply the experimentally collected smoke/walking speed curves. The first method represent the impact of smoke as a fractional reduction of the initial speed. This means that the current speed depends on the visibility conditions (expressed as visibility or extinction coefficient) and the initial speed in clear conditions (i.e., the desired speed). The second approach relies on an absolute reduction of speed, i.e. evacuees reduce their speed in the same way regardless of their initial desired speed in clear conditions. Another variable which evacuation models also take into account is the presence or not of a minimum speed, i.e. if there is a threshold minimum speed that evacuees would adopt in complete darkness.

A further point of discussion relates to the application of a deterministic or probabilistic approach for the reduction of walking speed in smoke for fire safety engineering applications. This would highly rely on the application of the models and would possibly significantly affect the results obtained. It should be noted that the use of a probabilistic approach would require the simulation of multiple runs in order to study the impact of random sampling from distribution over results (i.e. the so called behavioural uncertainty [22]).

4. DISCUSSION AND CONCLUSION

This paper briefly reviewed the approaches currently adopted for the simulation of evacuation movement in fire safety engineering applications. In particular, the current approaches adopted for the coupling of fire/smoke models and pedestrian movement has been discussed. The application of evacuation models for performance-based design in fire safety engineering often requires the consideration of a direct coupling between the impact of fire/smoke and the evacuation process. In particular, evacuation models can make use of the simulated reduced visibility conditions in a fire model to affect the route/exit choice made by evacuees and their walking speed.

Future research should focus on further investigating how the presence of smoke can influence behavioural choices made by pedestrians in a fire evacuation scenario. For instance, a set of evacuation models have started exploring the impact that smoke may have on risk perception and subsequently evacuation decisions [23], [24]. Nevertheless, the limited availability of experimental data-sets for the validation of human behaviour in fire is a known issue in the field and several research efforts are currently ongoing in order to address it [4], [25]. Given current evacuation model capabilities – in which users' expertise play a significant role in the calibration of a fire evacuation scenario with an evacuation model - model users have the great responsibility of knowing the limitations and uncertainties of existing models and adopt appropriate measures to address them.

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PRELIMINARY FLOOD VULNERABILITY ASSESSMENT IN THE FRAMEWORK OF SPATIAL PLANNING

Abstract: Flood vulnerability assessment is one of the most important actions in the framework of the spatial planning. In this paper are shown the result of the preliminary flood assessment for the river Spreca basin. Individual parameters of vulnerability, as direct requirement of the Flood Directive are observed trough four dimensions: social, economic, physical and environmental vulnerability. Since, spatial database structure was formed on the basis of criteria for assessing vulnerability according to expressed vulnerability dimensions. Methodological approach adopted for the preliminary vulnerability assessment is based on general principles of the analytic hierarchy process. Preliminary maps of vulnerabilities represent a good initial ground and open up space for further research and risk reduction initiatives through responsible spatial planning.

Key words: vulnerability, flood, spatial plan, spatial datasets, preliminary maps

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1. INTRODUCTION

Spatial planning process and the development of planning documentation is one of the important factors of sustainable development. The basic conception of spatial organization should be based on the conception of protection and uniform use of space within the allowed amount, and which a result of conceptual conditions (analysed in the Space Vulnerability Study [01]). Space Vulnerability Study is based on determination of possible influences of particular activities or interventions and the determination of the possible scope of their influence on the quality of particular segments of living environment.

The performed analysis of the actual situation in Tuzla Canton region [1] showed the general image of living environment through the observation of particular segments, their mutual connection and determination, such as water, air, and land. However, the flood vulnerability assessment results, serving as one of the bases for the space vulnerability definition, do not reflect the level of vulnerability credibly, due to the lack of monitoring system and partly due to the methodological framework.

Flood protection problems in Bosnia and Herzegovina are specific and complex. Planning and prevention implementation in flood protection is under the competence of higher governing levels. For the areas in danger, there are measures that need to be planned and implemented according to the determined priorities. Although there is some progress in rendering strategic, legal and other methodical documents, such progress is not sufficient and in most cases it does not follow the activities of flood prevention according to priorities. Among other things, a lack of coordination contributes such situation, and an insufficient involvement of different levels in planning and implementation of measures for achieving a higher level of flood protection on the entire basin. It is important to point out that these activities are implemented in fragments and that they are not harmonized within one river basin. In the research, it was noted that there is no necessary coordination between the sectors dealing with water management, human and material resources protection and rescue, and the spatial planning and environment protection [2].

Having taken into account the need for a comprehensive flood vulnerability assessment, and the obligation of harmonizing the flood protection system, and the areas of management and environment protection with EU legislative [6] it has been started with the realization of activities having a goal to perform a preliminary vulnerability assessment and flood risk for the dominant watercourse in Tuzla Canton, the River Spreca. A part of the assessment which has produced flood vulnerability maps development as a result, according to the defined vulnerability dimensions (social, infrastructural, economic and living environment vulnerability) for the whole Spreca river Basin [2] was in the focus of this work.

2. CONCEPT AND DIMENSIONING VULNERABILITY

As a part of a modern spatial planning practice and management of space, the segment of protection of nature and the environment, extraordinary situation management, there are different concepts and definitions of vulnerability. Bradley and Smith (2004) say that vulnerability has multiple elements in its definition but that the simplest way is to present them as the possibility that future influences will cause changes in negative direction.

Nakagawa and Shaw (2004) point out that there are mutual characteristics pointing out to the fact why are some communities more and others less resistant to natural hazards. They notice that there is a very complex set of economic, social, physical and environmental factors influencing the resistance of the community to natural hazards.

Generally, it can be acted in order to reduce the vulnerability depending on the goal set and the priorities through one of the following four forms/dimensions [5]:

- environmental vulnerability,
- social vulnerability,
- physical vulnerability,
- economic vulnerability.

Extreme natural events can cause infrastructural, social, economic or ecological losses at the area of occurrence, so that these four forms of vulnerability can be considered as four most comprehensive dimensions of vulnerability.

3. RESEARCH AREA

The Spreca River is the tributary of The Bosnia river and belongs to the river Sava basin. It rises below Snagovo, the Municipality of Zvornik. It flows in the direction of north-west with the length of 127km. It discharges into the Bosnia River near Doboj. The total surface of the basin is 1947m^2 [1]. The source of the river is at the altitude of 261.32m and 137.7m at the confluence, from which it comes out that the difference is 123.64 m, and the medium elevation fall of the course is 0.00098 [1] [3]. The relief is highlands, including Spresko Polje Valley, where the larger settlements are located like Tuzla, Zivinice, Kalesija, Lukavac, Gracanica, and Doboj.

It is indicative that in the area of Tuzla Canton, as the most settled region in the Federation of Bosnia and Herzegovina, with the population of about 480,000 [2] , the industrially most developed part of Bosnia and Herzegovina, with the largest

[1] Source „JP Spreča“
[2] Agency for Statistics of Bosnia and Herzegovina, preliminary results of census in Bosnia and Herzegovina

concentration of farmland, the floods have been intensively affecting mostly the same areas in the last few years, causing the great damage in economy, agriculture and housing facilities. The flood risk in the Spreca River basin has been assessed as potentially important according to the preliminary flood risk assessment [4].

The floods that affected the region of Tuzla Canton, first in May and then in August of 2014, caused the greatest material damage and human loses that had ever been recorded. The preliminary assessment of the damage for Tuzla Canton region is presented in Table 1 [7].

Table 1- Preliminary flood assessment in Tuzla Canton in August 2014

Preliminarna procjena štete od poplava za Tuzlanski kanton				
1	Vrsta nepogode	Stanje elementarne nepogode u Tuzlanskom kantonu za period 5-9.8.2014.		
2	Područje	Pogođene općine	Banovići, Čelić, Doboj Istok, Gračanica, Gradačac, Kalesija, Kladanj, Lukavac, Sapna, Srebrenik, Teočak, Tuzla, Živinice	
3	Stanovništvo	Smrtno stradalih	0	
		Ozlijeđenih	2	
		Evakuiranih	2367	
6	Preliminarna procjena štete	Stambeni objekti	Uništeno (broj)	3
			Financijska procjena (USD)	81796,86
			Oštećeno (broj)	3319
			Financijska procjena (USD)	11,743,895.56
		Zemljište Voćnjaci	Površina (ha)	7,273.50
			Financijska procjena (USD)	16,424,183.22
		Stoka	Uginulo	1,927
			Financijska procjena (USD)	34,082.03
			Ozlijeđeno	200
			Financijska procjena (USD)	6816.41
		Ostala šteta	Financijska procjena (USD)	53,286,774.9
7	UKUPNO (USD)			81,577,548.98

4. ANALYTICAL METHODS

The main prerequisite for a quality elements management in the region where we live are the adequate data which can be obtained by continuous monitoring of spatial conditions and the development of a high quality database. The available data have been structured and situated in Oracle database, thanks to MapInfo software, with the possibility of supplementation with the missing data (the depth and speed of water in flooded areas, spatial damage distribution). The modelling of the obtained data has been developed according to the quantitative and quality demands for vulnerability demands and risk assessment, in order to repeat the analysis in a fast and efficient way as soon as possible in case of data update and supplementation. Figure 1 shows the applied model of assessed vulnerability in GIS environment by AHP multi-criteria decision model application.

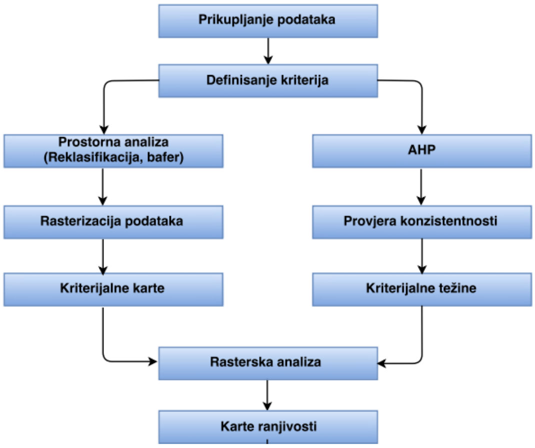


Figure 1– Applied vulnerability assessment model in GIS environment

On the basis of available data there have been eight criteria selected for the vulnerability assessment according to the defined vulnerability dimensions [2]. After the implemented structuring of the abovementioned criteria, their evaluation was performed, as shown in table 2. The evaluation of the criteria was performed in numerical values (intensity factors 1, 3 or 5), where 1 is a low level of flood exposure, 3 medium level of exposure, while 5 represents a high level of exposure. After that, generic maps for each selected criterion were generated.

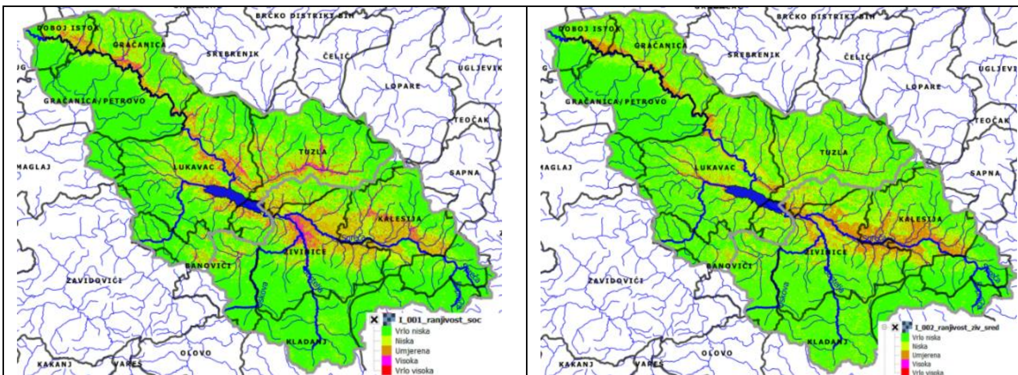
Table 2- Intesity values for some criteria

No	Criterion	Intensity factor		
		5	3	1
1	Relief and terrain inclination	0º - 5º	5º - 10º	>10º
2	Population	>250 /km^2	100- 250 /km^2	<100 /km^2
3	Agriculture- bonity	II – IVa	IVb - VI	VII - VIII
4	Particular objects and buildings	National importance	Regional importance	Local importance
5	Road infrastructure (traffic load)	Freeway	Commuter freeway	Local freeway
6	Buildable land	High share of building areas, high danger from destrutive geomorphological processes	High share of buildings, moderate danger from destrutive geomorphological processes	Small surface under buildings, destructive geomorphological processes not present.

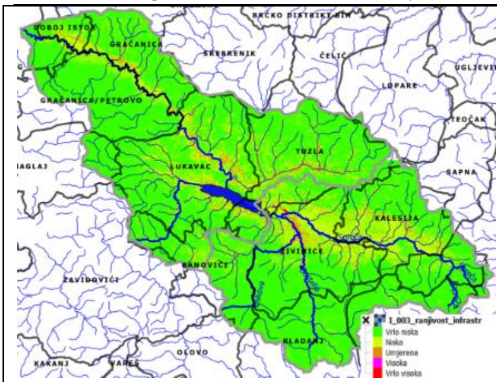
7	Industry	Relevant industrial polluters, high general environment vulnerability evaluation	Industrial polluters present, moderate general environment vulnerability evaluation	No industrial polluters, low environment vulnerability evaluation
8	Forest (Areas under forests)	<25%	25-50%	>50%

Since the vulnerability is observed through four dimensions, the ranking and assessment of all criteria was performed for each dimension of vulnerability individually, involving AHP, which allows the decision makers to set priorities an create choices on the basis of their knowledge, experience and objectivity, with the intention to render the most convenient decisions. This method enables the activation of qualitative and quantitative goals and factors with the possibility to determine the hierarchy of goals.

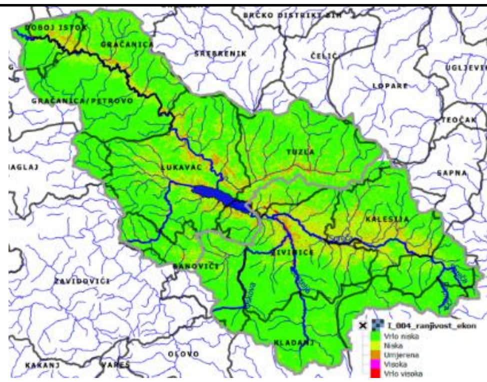
Multi-criterial analysis in GIS is realized by the application of mapmaking algebra over factor (criterial) maps, because of which the classification of space was performed, i.e. each spatial entity was given an intensity value according to the classification outlined in Table 2. After such data classification, the factor maps for all criteria are developed, and then, by AHP application, the preliminary vulnerability maps are generated according to the vulnerability dimensions (Figure 2). Preliminary vulnerability maps generating was done by summing up the multiplication products of normalized intensity factors with factor maps for each defined criterion. The generating was performed in MapInfo Pro program package by using the "Grid Calculator" tool, which comes with Raster model.



a) *Social vulnerability* b) *Environmental vulnerability*



c) *Physical vulnerability*



d) *Economic vulnerability*

Figure 2 – Preliminary vulnerability maps

Preliminary vulnerability maps contain the vulnerability marks from 1 to 5 for the whole Spreca River basin, where zones 4 and 5 are separated [3](high and very high vulnerability zones). These maps served as the basis for the development of preliminary flood risk maps and prioritizing, in the sense of recommendations for the measures that should be done to prevent, reduce and minimize the risk in the area of research.

5. CONCLUSION

The results presented within the work are a good ground for the creation of framework for an efficient continuous vulnerability assessment which will include the qualitative and quantitative data and improve the vertical communication between all participants and decision makers, and also for the visualisation of the results in order to make them closer to everyone. They can also be a good basis for the improvement of the existing Regulation on Integral Methodology for Preparation and the Development of Planning Documents.

The methodology for vulnerability assessment within the work enables the upgrade of the system in the sense of different demands; modern and actual way of spatial vulnerability condition review, rational and efficient data archiving about floods in Tuzla Canton region, information and knowledge transfer, and the development of an integral researches network, achieving positive effects in water resources management, the support of all aspects of management and sustainable water resources exploitation, the basis for taking adequate and economically justified measures for living environment, catastrophe risks reduction through a responsible spatial planning.

[3] P=15,2 km^2

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Filipe ALVES CRUSAT

EXPLORING THE POSSIBILITIES FOR UAVS IN EMERGENCY MANAGEMENT IN THE EUROPEAN UNION

Abstract: Unmanned Arial Vehicle (UAV) technology, commonly known as "drones" has developed rapidly in recent years. Many industries are seeing potential benefits from implementing this technology in various processes, and as computer, camera, and positioning technology evolves, UAVs become increasingly user-friendly and controllable by untrained pilots. The present paper examines the possibilities for use of UAVs in various areas of emergency management. In the context of firefighting operations, the paper discusses how the use of UAVs can give an increased overview of the situation, allowing for a better allocation of resources and strategy planning. Finally, present EU legislative restrictions are examined with regard to using UAVs in urban areas, which is considered one of the main implementation challenges of UAVs for firefighting purposes.

Key words: UAVs, Drones, Emergency management, European Union, Firefighting, Fire detection

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1. INTRODUCTION

Drones are often referred to as unmanned aerial vehicle (UAV), unmanned aerial system (UAS), remotely piloted aerial systems (RPAS) and remotely piloted vehicles (RPV). The terms describe remotely controlled, programmed and autonomous vehicles that can be either driving, sailing or flying. UAS is currently the internationally most commonly used term to describe a drone. The expression covers all kinds of aerial drones, and not only the vehicle, but the entire system, which also includes the control system known as the remote pilot station and the contact between these two (RPS). In recent years, there has been rapid development of drone technology. The possibilities for the use of drones in various industries are increasing exponentially, and as the market expands, emergency managers are also starting to see the benefit of using drones for increased efficiency. For search and rescue teams (SAR), a quick bird view of an area can be of immense value to provide inputs such as exact locations where people are stranded and the nature of the difficulty of reaching the locations. These benefits also apply in firefighting situations where locating people and the sources of fire can help develop a more effective emergency management strategy.

2. DRONES IN EMERGENCY MANAGEMENT

In this section, I will be reviewing some of the possible methods for drone use in emergency management (DRM) that can improve the efficiency of disaster risk management procedures.

2.1. Drones for mapping purposes

One of the challenges that firefighters and SAR teams can encounter during a mission is the lack of sufficient mapping of an area. Natural disasters and large accidents can change the environment and the surface of an area, making it difficult for emergency managers to establish a detailed plan of how to search and secure the incident zone. By using drones, this problem can be overcome. Drones equipped with affordable cameras are able to map areas as is described in a paper about “UAV-Borne Photogrammetric Survey as USAR Firefighter Teams Support” from the 2017 International Conference on Computational Science and Its Applications in Italy [3], however, it can be time consuming to only use one drone. In the said scientific article it is mentioned that it took approximately 90 minutes to map an area of 1300m2.

Researchers in Austria have found a method to reduce the temporal scale of the mapping procedure by testing a network of collaborating drones to scan an area and thereby creating detailed situation maps for emergency management purposes. The test took part in a county fire service drill in Austria where the scenario was a leaking railroad car with hazardous materials. The experiment had two objectives. The first objective was "to build an up-to-date overview image of the affected area, which allows the officers in charge to assess the situation and allocate field personnel".; the second - "to frequently update the overview image of the area during the mission to keep track of ongoing ground activities." Three precomputed drones were used to map an area of approx. 55.000m2 using a total of 187 pictures on a flight altitude of 40m. The images had a 50% overlap between neighboring images to create redundancy in case a picture quality was too low to be used. The flight procedure took approximately 15 min. but the time of flight could be reduced depending on the desired image quality.

During the flight, the drones were able to immediately transmit low resolution images during flight for instant overview of the covered area and increasing the quality over time. This allowed for instant assessment of the situation and for re-planning as the map evolved. In the precomputed route, forbidden areas were marked, so that the drones avoided overflight of these. In a real situation the forbidden areas could represent obstacles that drones need to avoid. [12]

2.2. Drones for 3D mapping

Not only is it possible to vertically map an area, it is also possible to create 3D images for better investigation. In Italy, researchers have tested a method that enables 3D modeling of damaged structures by using drones in the area of L'Aquila after the 2009 earthquake. This method can reduce the risk for investigators of structural damage as well as provide access to otherwise inaccessible areas of damaged zones, thereby improving conditions for SAR workers.[4]

2.3. Drones for fire detection

Infrared cameras are not a new technology but as this paper on "Fire Detection Using Infrared Images for UAV-based Forest Fire" shows, that the technology is not outdated and applied in new ways can prove to be very effective. This surveillance method combines drone technology with infrared camera technology to create an effective forest fire detection system. The process is as follows: the drone flies over a forest area; the infrared camera detects hot objects as fire candidate regions, then by using histogram-based segmentation method the system is able to filter out the non-fire background. In the next step, optical flow method is then applied to detect moving objects for eliminating stationary non-fire objects in the possible fire object region. The system subsequently analyses motion vectors by optical flow to reduce false fire alarm rates caused by hot moving objects. Lastly, when the fire pixels have been confirmed, the fire areas are tracked by blob counter scheme. [13] This method enables easier fire detection in large areas for a swift response to a forest fire.

2.4. Time efficiency with the internet of things

Researchers from Shih Chien University and Tamkang University in Taiwan have done an analysis comparing conventional firefighting and SAR to firefighting and SAR using the internet of things (IoT), including drones, by applying a monte carlo simulation and t tests, to find out how much time firefighting and SAR operations can be reduced by using IoT. The simulations showed that it is possible to radically reduce the time spent fighting the fire in the fireground. [10] In their statistical test cases, the technology was able to reduce the time spent in the fireground with as much as 77,76 %, and the SAR operation by as much as 68,13 %. For both operations, the IoT can cut at least half of the time that firefighters spend in the dangerous operation situation.

3. THEORETICAL EXAMPLES OF DRONES IN FIREFIGHTING OPERATIONS

Although the previous mentioned paper from Taiwan, combined several technologies to reduce the response time of a fire incident, drone technology can by itself be an instrument of time reduction as it is evident in the paper E. Yanmaz, M. Quaritsch, S. Yahyanejad, B. Rinner, H. Hellwagner, and C. Bettstetter, 2017 as well as in the paper C. Yuan, Z. Liu, and Y. Zhang, 2017. If some of these methods were combined, they could generate some effective tools for emergency management.

The following section, will present some theoretical examples of how some of these methods can aid the response phase of three different fire incidents in an urban area if exemptions to some of the regulative restrictions are given.

The three different scenarios are countered by using two separate ways of controlling a drone with mapping ability, and IR vision. This is shown through the event tree model. Two event trees (event tree A, and event tree B) represent the two separate ways of using the drone. The three scenarios are a small fire, a medium sized fire and a large fire.

- •Small fire is defined as a fire that is put out before the arrival of the firefighters, or is put out by handheld fire extinguishers.
- •Medium fire is defined as a fire that is extinguished with one to two high-pressure water jets.
- •Large fire is defined as a fire that requires at least two high-pressure water jets.

All scenarios are within urban areas. In event tree A (figure 1), it is analyzed which advantages the technology would afford if the drone was not allowed to fly beyond visual line of sight (BVLOS). This means that there must be an operator present who can see the drone at all times during its flight. Therefore, in this case the firefighters transport the drone in their vehicle, to the emergency situation. According to event tree A, in the first scenario (the small fire), the drone would not give an advantage because the emergency team would quickly be able to gain an overview of the situation without needing extra technology. In the small fire scenario, the technology would only contribute to a slower response as resources allocated to operate the drone would be wasted. In the second scenario (the medium fire), there are benefits to be gained as the overview of the situation and fire source location would be identified faster by mapping technology and IR camera. In the third scenario (the large fire), the same advantages as those in the medium fire scenario are identified.

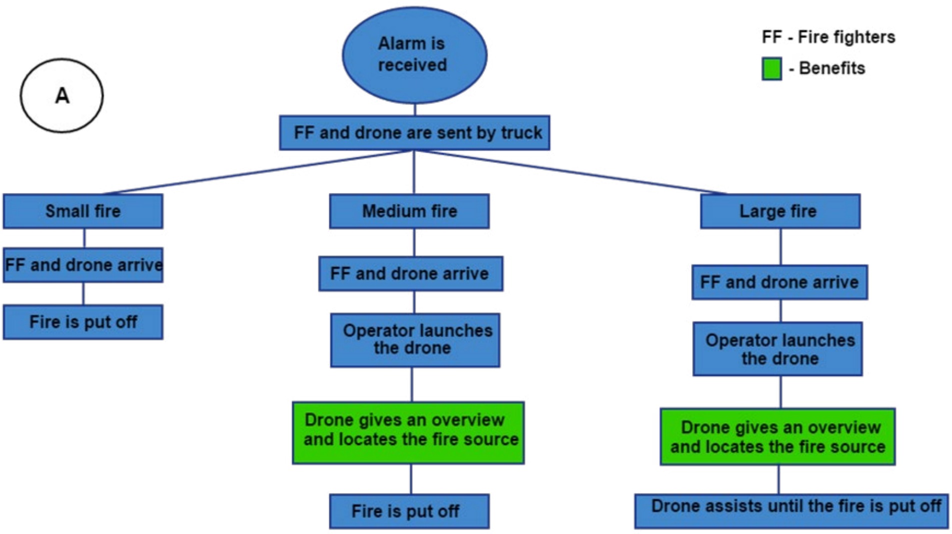

Figure 1 - Event tree A: drone operating within Visual Line Of Sight

In event tree B (figure 2), it is explored how a drone would be able to help if it was allowed to be used BVLOS. In this scenario, the drone is sent separately but simultaneously as the firefighters to the location of the alarm. Looking at data from Denmark collected by the Danish Emergency Agency (DEMA), it was we found that on average it took firefighters 2 minutes and 34 seconds in 2016 to put on their protective equipment, and leave the fire station, when the alarm is received.[2] This gives the drone a 2 minutes and 24 second head start to get to the location. When the drone reaches the location, it transmits information from the incident to the firefighters who then upon arrival have an increased knowledge of how to handle the situation. In all scenarios in event tree B, the drone was able to benefit the firefighters with a pre-obtained knowledge to strategize before arrival and a better overview of the situation.

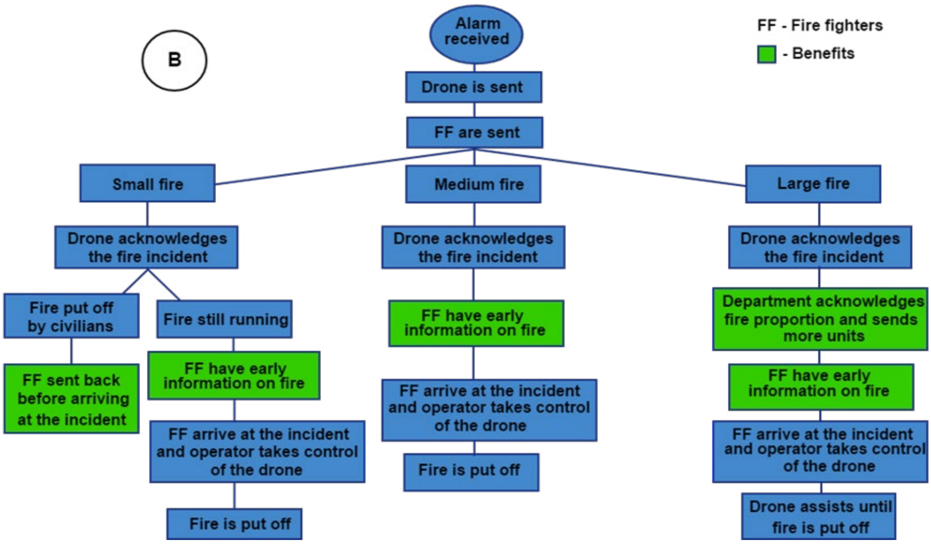

Figure 2 - Event tree B: drone operating Beyond Visual Line of Sight

4. DRONE IMPLEMENTATION CHALLENGES

While there are obvious benefits to be gained by using drones, there are also challenges to using this technology. As with most new advanced technology, advanced drones can be susceptible to various operating issues. [11] A risk of cyber-attacks to UAVs is present [7], obstacle avoidance also seems to be a problem for the current drone sensors.[1] These technological problems give rise to ethical challenges of using drones, e.g. how safe is it to use drones in densely populated areas. Instances of casualties due to drone crash have been documented[9]. Furthermore, how much should SAR teams rely on drone technology, given a risk of error during a mission is open to debate [6]. These ethical challenges can in turn lead to legal restrictions.

4.1. Drone regulations in EU

There are, as of yet, no formal legal regulations implemented by the European Union (EU) on the use of drone technology. However, since drones are defined as aircrafts they do fall under the 1944 Chicago Convention on International Civil Aviation (ICAO) article 8 [8], and therefore they are grounded unless exceptions are made in national law. Many EU member states have already developed their own regulations regarding drone flight but as of yet, there are no adopted regulations across the EU space. In 2017 the European Aviation Safety Agency (EASA) has published a draft of Commission implementing rules, the "'Notice of Proposed Amendment 2017-05 (A): Introduction of a regulatory framework for the operation of drones Unmanned aircraft system operations in the open and specific category (NPA

2017-05 (A))" [5] to provide an idea of what could be a joint set of rules for the EU member states. The proposed legislation will be based on three risk categories for drones with a Maximum Take-Off Mass (MTOM) between <250 grams and <25 kilograms and the operators divided into two groups named open and specific. The legislation is intended for commercial use of drones and does not specifically consider the use of drones for emergency management. Therefore, there are certain operational limitations that could affect an emergency response that relies on the use of drones. The issues that challenge emergency services' drone use in urban areas are the prevention of flying over large crowds of people, the prevention of sharing airspace with other aircrafts, (e.g., helicopters), the limitation of a minimum altitude of 20m above private property for privacy reasons, and privacy rights of casualties. All these points are scenarios of legal conflict that are likely to occur when using the technology for firefighting and SAR.

In the NPA 2017-05 (A), there is, however, an option that may be enough to exempt some of the limitations. According to the proposed regulation, it will be possible to apply for a Light UAS operator Certificate (LUC). This certificate enables the operator to authorize its own operation within the limits of a predefined contract, and may therefore include operations pertaining to emergency management. This proposal is expected to be adopted by the European Commission in the first quarter of 2018.

5. CONCLUSION

This paper has described some of the methods of drone use that can aid emergency management efforts. It is evident from the literature that there are many ways to combine drone technology with other technologies, creating effective tools that can facilitate a number of emergency management tasks. Yet some challenges remain that need to be solved for the technology to be accepted as a regular part of emergency management services. There are some technological issues that need to mature as well as regulative obstacles in the EU that need to be cleared for the emergency operations to become effective. As the market for this technology is expanding, these problems are rapidly being countered.

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Miriam NDINI

FLOOD RISK ASSESSMENT IN THE DRINI-BUNA CATCHMENT

Abstract: The Drini-Buna the basin, including Shkodra Lake is a complex hydraulic joint. This basin is very important for the region in terms of economy and it has many unique natural resources. Shkodra town situated in the middle of this hydraulic triangle is the biggest in northern Albania. These three water bodies represent a unique hydrographic system collecting water from a watershed with a total area of 19582 km^2. Due to the combinations of the discharges from these three water bodies, floods mechanism in this low area is complicated. The Lake Shkodra basin receives an average annual precipitation of 2060 mm with over 3000 mm in some parts of the catchment. The Drini basin has lower average rainfall but with a wider variation from upstream of the catchment to downstream. The hydrologic response of the Drini catchment is strongly influenced by the cascade of three hydropower reservoirs downstream of Kukes and it influence itself the water flow of Buna River. The annual average runoff is calculated to be 16.9 l/s/km2 (530 mm) for the upstream part of the basin to 24.7 l/s/km2 (780 mm) for the whole catchment. In this paper the hydrometric and hydrological data are analyzed and a GIS based mapping of the Study Area, mapping of flood extents and depths, and evaluation of flood damages are performed. The risk analysis has been undertaken in the study to quantify the risks within the existing system associated with flood events of a range of magnitudes.

Key words: Flood, risk, hydrology, maximum discharge.

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1. INTRODUCTION

1.1. Potential Risks

Albania is vulnerable to risks as floods, earthquakes, landslides, drought, extreme temperatures, wind storms, high snow fall including avalanches and epidemics. The country is highly vulnerable to floods, accounted as the major disaster events (32%), followed by earthquakes, (18%) and landslides. .

The data show that 62% are hydro meteorological hazards - flood and drought related events. Flood has killed more people than any other hazards.

1.2. Study Area

This study is focus on the Lower Drini–Buna River basin. The water system of Shkodra Lake-Drini and Buna River- from its hydrological and the hydraulics considerations is a complicated one.

The catchment of the Drini-Buna River is an international basin that is shared by Albania, Macedonia, Kosova and Montenegro with a catchment are of 20,000 km^2 (Figures 1).

The catchment area of Drini River is estimated to be 14,173 km^2 with a length of 285 km. The river originates from Ohrid Lake in Macedonia (Black Drini) and joining the Buna River below Vau Dejes HPP (Figure 2).

Figure 1- Location of Study Area within Albania

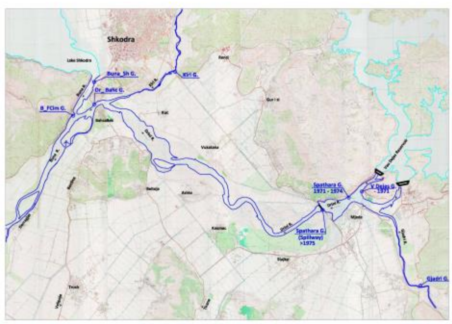

Figure 2- The Study Area

Shkodra Lake in terms of water surface area is the largest lake in the Balkan Peninsula. Its catchment area is about 5,500 km^2 (of which 80% is in Montenegro and 20% in Albania) and the water surface area varies between 353 km^2 in dry periods and 500 km^2 in wet. The only significant outflow from the lake is the River Buna which flows south-westwards to the Adriatic Sea. The right bank of the Buna from Fraskenjel downstream lies within Montenegro. The river meanders over the coastal plain through mainly agricultural areas and, during floods, provides a source for the wetland areas downstream.

There are a number of large hydropower plants (HPP) on the Drini. Two large reservoirs (Globochica and Spilje) have been constructed in Macedonia and, in Albania, dams and reservoirs at Fierze, Komani and Vau Dejes were constructed between 1967 and 1985. The lowest dam, Vau Dejes, is located in the lower part of the Drini river valley some 18 km upstream of the city of Shkodra. These reservoirs and associated dams attenuate flows leading to reduced peaks and increased low flows. There are also two recently completed run-of-river HPP between Vau Dejes and Shkodra at Ashta (Ashta 1 and Ashta 2).

2. FLOODINGS

2.1. Major Flood Events in the Drini/Buna Basin

The lower Drini-Buna River basin is at an unacceptably high risk of flooding. In recent years this area has suffered major economic, social and environmental losses due to a series of major flood events, most recently in January 2010 and again in December 2010.

Floods were common and known from historical times as described by Romans and Turks. Major floods in the Drin/Buna Basin were reported in the 1850's (11 major floods), in the 20th Century[1], in 2003-2004 and 2010. Floods also occurred after the construction of the Drin-reservoirs that begun in the 1970’s.

The flood risk within the catchment is characterised by the historical joining of the two rivers due to major floods and an associated geological event in the 1850s. The diversion of the Drini River to flow west into Shkodra Lake has resulted in a lack of capacity in the Buna River which flows out of the lake to the Adriatic Sea.

Floods have, in general, a pluvial origin, so they are observed during the period of November-March, when 80-85% of the annual runoff is generated.

Causes of Floods in the Lower Drin– Buna/Bojana, Shkoder/Skadar area:

- flow variability due to both natural and anthropogenic factors (extreme weather phenomena, water releases from the dams on Drin River);

[1] 1962-63, 1970-71, 1979 and 1992

- high sediment input through the tributaries of Drin downstream the dams due to erosion caused by gravel extraction and loss of plant coverage;
- accumulation of alluvium in the tributaries of Drin, Drin itself and Buna/Bojana. In the case of Drin this is due to the decreased sediment transport capacity as a result of the controlled outflow from the artificial lakes; in the case of Buna/Bojana the latter is combined with the low gradient of the riverbed;
- blockage of the natural secondary channels of the Buna River that existed in the past in the delta area; the pick flows exceed the capacity of the main (existing) channel;
- poor maintenance of the drainage channels and flood preventing constructions.

Most severe floods however result from the combination of heavy rainfall and snowmelt runoff in spring. During such flood incidents, water inundates the floodplain for several weeks.

2.2. Flood event in 1962-63

The maximal river stage observed in 13 January 1963 in Drini River at Vau Deje was 673 cm, which is at the same time the highest river stage ever observed in this station. Waters of Drini inundating the field downstream, joining the waters of Buna River and those of the Drini of Lezha coming from the swamps of Kakarriqi, inundating the city of Lezha and causing a lot of damages in residences and administrative buildings. The water inundated all the area in south, until they joined the waters of Mati River. The cities of Shkodra and Lezha were partially flooded. During this flood the estimated flow at the Drini/Buna confluence was 5000 m^3/sec.

2.2.1. Developments in the 1960s and 1970s

After this flood event, a system of flood protection embankments has been developed downstream the Buna River to protect against flooding over the left bank into developed residential and agricultural areas . These embankments have been partially effective in protecting land from flooding, however in the most serious events breaches have occurred in their constructions.

As a result of these constructions and two pumping stations, some 4000 ha of land could be used as productive agriculture land. The height of the embankments was designed to allow the Buna to pass a flow of 2200 m^3/s with a water level at Belaj at 5.6m asl. Once the design flow was exceeded, the remaining flood water was discharged over the weir towards the Murtemza Collector.

2.3. Flood events of 2010

In January 2010 Albania was exposed to a severe flooding event in the Shkoder region. This flood was mainly caused by snow melting in the Drin Basin, which caused very high water levels in the three Drini reservoirs. Albanian authorities were forced to release water from these reservoirs, thus increasing the flood risk in the

Shkodra and Lezhe regions. After water releases from the reservoirs, the discharge increased to 2450 m^3/s while the maximum capacity is only 800 m^3/s.

The maximum water level reached in Shkodra Lake was 9.4 m and the maximum discharges were 1300 m^3/s and 2800 m^3/s from the lake and from the Drini Cascade respectively.

The Albanian government declared the flood a "natural disaster" on January 5th 2010 when the flooding displaced thousands of people. The Shkoder District reached a critical situation as the water level on main roads reached one meter. Inside the village of Berdices the water level reached two meters. The overflow of water alienated the city from national road access and cut communication with the town (*Figure3,4)*.

In November of the same year 2010, rains were exceptionally heavy, starting in the second week of November and continuing until mid December. Over this period the total rainfall was some 900 mm, half of the annual average rainfall. As a result the level in Shkodra Lake reached the maximum ever recorded level of 10.55 m asl, and the inundation was one of the biggest remembered in terms of area extent, depth and duration. The 2010 December flood peak flow was about 3000 m^3/sec from Drini and about 1500-2000 m^3/sec on the Buna (outflow of Shkodra Lake). It is estimated that the maximum discharge at Buna River downstream of the junction was 4250 m^3/s.

Figure 3 - Dajç Village during the flood of 2010

Figure 4 - The city of Shkodra during the 2010 flood

During the year there were 18 days with flow over 1500 m^3/s (6 days in each of the January and December events, plus three periods of 2 days in February, April and November). In the previous 27 years there were only 4 days with such flows - a short, sharp flood event with 3 days over 1500 m^3/s in December 1995 (following a period of very low flows) and a single day in 2004.

The flood was one of the largest in living memory with respect to the runoff volume, river flows, duration and area inundated. On the left bank of the Buna River all the villages were inundated. During this flood, known generally as the “2010

December Flood", there were three breaches located on river embankments and in many others the water overtopped.

2.4. Damages and Costs Associated with Historical Flood Events

Information on the economic damages and costs of historical flooding is limited. The 1962-63 event caused widespread flooding, some 70,000 ha of agricultural land were flooded throughout Albania and 20,000 ha of land was inundated in the Drini/Buna Basin. The cities of Shkodra and Lezha were partially flooded, national roads were cut and the existing system of protective dikes was severely damaged, and in some cases destroyed.

The flooding of December 2009-January 2010 in the districts of Shkodra and Lezha was at the time considered the biggest ever emergency event, in terms of rainfall, flows and secondary effects. As a result of this disaster 10,400 hectares of land were flooded, about 2500 houses and 4780 people were evacuated. In December 2010 the flooded area was 14,100ha, 4600 houses inundated and 12,145 people evacuated. Preliminary losses for the December 2009–January 2010 event have been estimated by the Local and National Government to be close to EUR 18 million.

3. FLOOD RISK ASSESSMENT

The international practices suggest that flood risk management planning should be a cyclical process adapting changes conditions and priorities. The EU Floods Directive requires from Member States to adopt each six year planning cycle. This fits with the six year cycle required by the EU Water Framework Directive, and is appropriate for related plans such as strategic and local development plans. Implementation of the actions must be monitored leading to a review at the end of the planning cycle.

The planning cycle begins with a flood risk assessment to identify vulnerable areas. Potential actions and measures can then be identified and prioritized based on economic assessment, stakeholder liaison and technical viability. The actions to be adopted should be agreed with stakeholders.

3.1. Flood Frequency Analysis

In the catchment area there are in function a number of hydrological stations with the available data of the flow for a period of 40 years. The data of maximum flow are used to perform an extreme value analysis to get a relationship between flood frequency and annual maximum flow. The data shows that the annual maximum most often occurs in December-January (9 times in 29 years). The maxima are shown in Figure 5. In the overall period the largest flow was in December 2010, with the second largest in January of the same year.

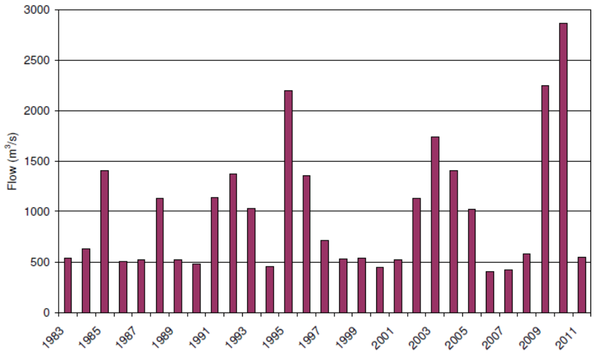

Figure 5- Annual Maximum Flows from Vau Dejes Reservoir

From the frequency analysis it is evident that the December 2010 event has a return period of just over 50 years, which is consistent with local experience and historic records (Figure 6).

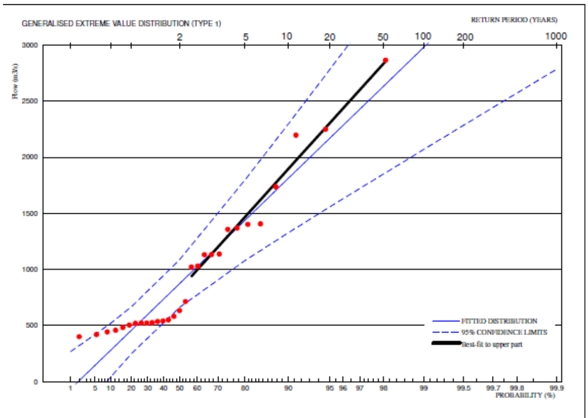

Figure 6: Frequency Analysis of Annual Maximum Flows, Drini River

The second largest event on record based on evidences is that of 1963, although the HPP cascade did not exist at that time and there is no reliable record of the peak flows. Before the flood of the 2010, the flood of 1962-63 was considered as an event with a return period of 100.

Determining Buna Shkoder flows (outflows from the lake) it is more complicated. The outflow from the lake is depending from the water level of Drini, discharging in Buna River. Sometimes the outflow from the lake in Buna is impeded due to the increase flow of the Drini River. This occurs mostly in the period from December to February, but may also occur during the other months, depending on the water released from the hydro-power dam upstream the Drini River. The influence of the water retention from the H/P dam in Drini River, is spread also in Shkodra Lake.

For the December 2010 event, the hydrograph of the outflow from the lake (Buna Shkodra) has a sharply reduced (but not negative) flow at the time of the Drini peak flow. In addition, the lower flow in the Drini at Bahcallek would lead to proportionately greater outflows from the lake. This, at a certain point confirm the assumption that an increase in Drini flows will tend to cause a reduction in flow from the lake, as high levels at the Drini-Buna confluence reduce the driving head and hence the flow that can leave the lake.

Analysis of the annual maximum series of lake levels shows that maximum levels would be well below 10 m even for very high return period events. But during the flood in December 2010 the level of the lake was reported to be 10.55 m. with the water levels of 10.28 m (or 10.32 m) for the 1962-1963 flood, it is obvious that the flooding in 2010 was the greatest ever experienced.

3.2. Design Return Period Events

For the design purposes, flows are required for the return periods of: 2, 5, 10, 20,50, 100 and 1000 years. The peak outflows for Drini/Buna River for these return periods are shown in Table 1.

Table 1 The peak flows for all design events

Return period	2	5	10	20	50	100	1000
Buna River	1888	2778	3209	3599	4084	4433	5182

However the peak of the event is important, it is obvious that the duration and volume of a flood event is important as well in determining flood extents, and consequently that a long duration event with a moderate flood peak might produce greater inundation and damage than a shorter event with a higher peak. As a result, it was decided that all design events should use the same hydrograph shape. Because of the availability of information the selected "base" event is that of December 2010.

The figure 7 shows the map of return period of 100years calculated based on the floods of 1962-63. Meanwhile the figure 8 shows the map of risk flooding calculated from 2010 flood events that represent a flood with a return period of 50 years. Comparing these values we conclude that the flood of the 1962-63 events that was consider with a return period of 100 years now with the new data from the flood events of 2010 is just an event with a return period of 50 years.

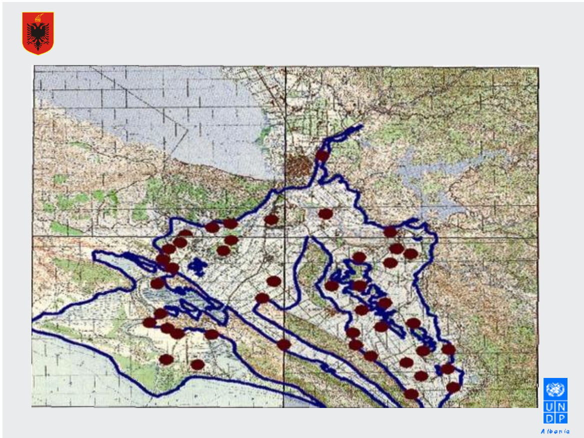

Figure 7- Flooding with e return period of 100 year BunaRiver

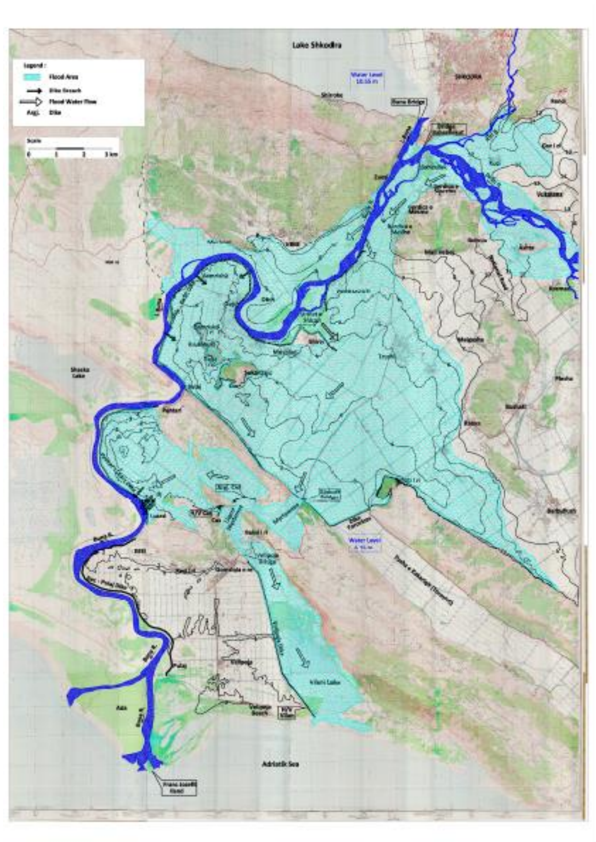

Figure 8- Flooding with e return period of 100 year BunaRiver

This map can be used for the design of the new structures or for the rehabilitation of the old ones. With a continuous monitoring system of water level and water flow, the data gathered and analyzed will serve to further update these conclusions.

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KNOWLEDGE (EDUCATION) AS AN IMPORTANT FACTOR IN DECREASING POPULATION VULNERABILITY (EXPERIENCES FROM UNS - FTN)

Abstract: Different emergencies, chronic or acute, such as climate change, as well as the increase in the frequency and intensity of extreme events caused by climate change, have led to an increase in population vulnerability. Adapting to climate change and a reduction of the influence of catastrophic events on ecosystems has become a focus of interest of various sectorial policies. Education is an important element for decreasing vulnerability to climate change, hazards, and emergencies. At the Faculty of Technical Sciences at the University of Novi Sad, at the educational program Disaster risk management and fire safety, students learn about the multidisciplinary aspects of the field of impact reduction of disastrous events. This paper focuses on the importance of integrating fundamental concepts of disaster risk management into educational systems, and also emphasizing, at the aforementioned academic program, the importance of public health as an important element of building communal resiliency.

Key words: Population vulnerability, Education, Knowledge, Public Health, Risk reduction, Vulnerable groups

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1. INTRODUCTION

As a result of man's actions on a local and regional level, changes in the environment are visible on a global level. Climate change represents the greatest threat, and the ramifications of acting on the principle of "business as usual" are frightening, especially taking into account that the increased vulnerability of certain communities towards the influence of disasters is already evident. According to CRED data [1], over 301 catastrophic events have been reported just for 2016, and over 102 countries have been influenced by them [1]. These events have affected 411 million people, while 7628 have died [1]. The total economic damage, caused by disasters, has been estimated to be at 97 billion American dollars [1]. Scientific evidence points towards the fact that catastrophic events are going to become more frequent, changes in evaporation will lead to overabundant rainfall, and that both the frequency and intensity of various severe weather conditions will increase [2]. The total challenges of urbanization under the effect of climate change is the point of interest for many experts who wish to secure a safe future for the future generations, as well as to secure the sustainability of all systems and to increase their resiliency [3]. The Paris Climate Summit in 2015 (Climate Conference - COP 21), represented a global agreement important to public health, serving as an answer to the threat of chronic catastrophes and the rising vulnerability of the human population.

By mitigation, we mean efforts to reduce or prevent greenhouse gas emissions. Adaptation means preparing for a safer and more efficient life in spite of the ramifications of climate change and includes steps such as securing cities against high winds and gales, protecting crops from high temperatures and droughts, as well as developing technology that facilitates these measures [4], but also adapting the body to the changed or new environment. In normal conditions, individuals are capable of maintaining an internal dynamic balance, or rather, a physiological optimum. Man's ability to adapt is limited [5], but there is often a tendency to overestimate the defensive abilities of humanity, which is a very dangerous notion, for it devalues the efforts that are invested into the improvement of the environment.

Taking into account that by 2050 more than two-thirds of the human population will live in urban environments, the rising risk towards both individual and collective health is evident, as is the vulnerability of cities. The goals of sustainable development emphasize the connection of urban health and the health of the population. They emphasize the importance of an inclusive, safe, adaptable and sustainable approach towards city development, by which the number of deaths and people at danger will decrease, as will the economic losses caused by disasters, all with the focus on protecting low-income households and at-risk individuals[6]. The challenges of urbanization under climate change are the focus of a great number of experts, who wish to secure a safe future for future generations, as well as to secure the sustainability of all systems and to increase their resiliency [3].

2. POPULATION VULNERABILITY

The importance of the frequency and intensity of catastrophes has led to an intensification of research whose focus is the assessment of the economic and social cost of climate change, relating to the vulnerability of populations, infrastructures and financial systems that can be affected by disasters. The attention of the international community is directed towards vulnerability, especially to the fact that adaptation to climate change and the reduction of the influence of catastrophic events on ecosystems can have an important role in decreasing population vulnerability to natural disasters. Vulnerability is ubiquitous, dynamic, and an idiosyncratic trait of every community (household, region, country, infrastructure or some other element), and can be defined, in one way, as a degree to which a certain society, structure, office or geographic region can endure a certain hazard at the expense of its nature and structure, as well as their actual proximity to areas prone to hazardous events [7]. A catastrophe occurs when a natural disaster affects a population that is not adequately prepared for, or is not capable of recovering from, the consequences of a catastrophic event without assistance. Potential dangers - hazards affect a group of individuals who are usually at varying levels of preparedness, resistance and with different capacities for recovery. Vulnerability does not only include bodily integrity, but also standards of living and other economic, social, political and ecological influences. Certain individuals, households or other groups can be more vulnerable than others (the elderly and children) to the influence of potential dangers. Variability is conditioned by changes in living standards (adequate and sustainable standards of living contribute to a decrease in vulnerability) and the increase or decrease of poverty (low-income groups are more vulnerable to, and less capable of recovering from, the consequences of catastrophic events). Hazards and extreme events can change the context of economic and social development, which as a consequence, decrease the ability of the population to adequately react to future extremes. The cumulative effects of events such as hurricanes, floods or droughts do not only destroy material property and human lives, but also can influence the ability of the individual to prosper. Losses create socioeconomic hardship and later influence mental health [8].

Frequent emotional reactions after catastrophes (fear, sadness, anger, guilt, shame, helplessness), which in combination with rational reactions such as confusion, indecision, worry, can make recovery last for days, weeks, months or years after a catastrophe, and so, in turn, represent a threat to public health. Specific risks to health caused by climate change which in the future can be expected to occur in Europe are: An increase in morbidity and mortality caused by direct exposure to high temperatures; malnutrition caused by a decrease in food production; an increase in the number of alimentary and hydric epidemics due to the rise in temperatures; an increase in the number of respiratory diseases due to the extension of pollen season; change of the geographic distribution of vector-borne diseases [9] [10]. Morbidity, as a consequence of natural catastrophes caused by climate change, includes injury, emotional stress, epidemics and an increase in endemic diseases. The relative number of injuries and deaths varies and is contingent on a multitude of factors, such as the type of catastrophe, population density and distribution, environmental conditions, preparedness levels and timely warnings. Injuries are usually more common than deaths during hurricanes and tornadoes, while deaths are more common during floods, avalanches, and landslides [5].

3. THE CONTRIBUTION OF EDUCATION IN DECREASING POPULATION VULNERABILITY

Education for the purposes of gaining knowledge in order to reduce the exposure towards hazards and vulnerability towards catastrophes, increase the level of preparedness to react and to recover, and so in turn increase community resilience towards catastrophes. This is one of the priorities of the Sendai Framework for Disaster Risk Reduction 2015-2030 [11].

With careful assessment and planning, physical protection and environmental protection, as well as with a readied action plan, we can prevent extreme events from causing catastrophic outcomes [12]. One of the ways to mitigate risk of natural catastrophes is to introduce catastrophe education at all education levels, in order to raise the consciousness of citizens on the importance of preventive measures directed towards risk reduction and to increase the readiness to respond in the case of a certain natural catastrophe [13]. Schools are universal institutions which provide knowledge and skills, and their role in catastrophe prevention (and its consequences) is vital. Successful mitigation of the consequences of catastrophes can be a valid indicator of a successful education [12]. The acquisition of knowledge on the risks of catastrophes, including their prevention, mitigation and on the preparedness, reaction, rehabilitation and recovery during catastrophes, should be included as part of both the training of experts who are to deal with these issues, and part of the education of citizens. [14].

Including the process of acquiring knowledge on risk management relating to catastrophic event into the educational programs and curricula for all levels of education is important in a number of ways: Raising public consciousness on the presence, causes and effects of catastrophes; understanding risk and its parameters; understanding the available instruments of risk transfer; building a culture of catastrophe prevention; active involvement of the population towards reducing vulnerability; efficient responses during emergencies, etc. The integration of fundamental concepts of disaster risk management into school systems provides the opportunity of educating experts who are prepared to solve complex problems relating to risk management, but especially solving problems focusing on decreasing vulnerability in industrial and economic systems, and in public institutions. The importance of creating multidisciplinary programs based on case studies that facilitate not only the creation of new knowledge but also the acquisition of new skills is emphasized. One issue is that, so far, mental health as a subject has been given very little attention in the academic programs [15].

Even though progress in developing resiliency and mitigating damages has been achived, extensive decreases in vulnerability, and also a decrease in disaster risk, necessitates persistence, with a clear focus on people and their health and the conditions for creating quality living standards, as well as regular follow-up activities [11]. It is of the utmost importance to the health of the population and the community at large that the notion of a health crisis and the concept of public health, as an important element in building a culture of resiliency of communities, be integrated into the educational system at various levels and in various areas[16].

3.1. Experiences of UNS-FTN - course “Disasters and vulnerability”

At the Faculty of Technical Sciences at the University of Novi Sad, as part of the education program Disaster risk management and fire safety, students learn about the multidisciplinary aspects of disaster risk management. During the undergraduate (8 semesters) and postgraduate/master studies (2 semesters), the students acquire knowledge and skills relating to the field of complex activities for emergency planning, reacting to emergencies, as well as activities relating to the restoration of a community after an emergency has occurred.

For the purposes of identifying possible problems and solutions which can provide the best results, content relating to emergency response is conceptualized in a way that the focus is placed on the analysis of previous experiences. In this way, critical thinking of students is encouraged and developed. In order to acquire applicable knowledge relating to disaster recovery, students conduct comprehensive analyses of communities, i.e. determine the strengths and weaknesses of the observed community, and identify the factors required for the communities’ successful recovery and the renewed facilitation of sustainable development. The ultimate goal is the mastery of the knowledge and skills needed to create and improve disaster management strategies and to create and improve plans and procedures that are a fundamental precondition for timely and adequate emergency response. Taking into account that the basis of risk management is the decrease in the number of human casualties and the preservation of the bodily integrity of the individual, the students of the Disaster risk management and fire safety program are, during their sixth semester, introduced to the concept of public health and the decrease in population vulnerability, through the academic course “*Disasters and vulnerability*“. So far, this course has been taken by 4 generations, or rather, 94 students (29 female students and 65 male students).

During the practical sections of the course, students have shown the greatest interest, and the highest performance, during assignments that essentially take the form of case studies. It is expected that students research and analyze certain current events and specific problems that are present in their environment, and on that basis provide their own suggestions on how to solve said problems and to improve the existing structures. The topics that were subject to research and analysis during the practical portion of this course, and for which the students showed the most interest during their assignments, were the following: Demographic features of a population, recognizing vulnerable groups, responding and communicating during emergencies, analyzing cause and effect chains of actual catastrophic events, health safety. Students learn the importance of planning, and learn how to facilitate and organize activities used to decrease population vulnerability. Also, they, in the interest of public health, study the types of interventions executed under catastrophic event conditions, including understanding how to organize on a local, national and international level, as well as understanding the importance of international partners. Through a range of practical assignments, the students deal with the following topics: regulations and conventions in the field of humanitarian law; strategies of prevention and rehabilitation in the domain of health safety under disaster conditions; the role of state institutions and NGOs; partnership between organizations on various levels; operational aspects of humanitarian interventions; planning and accommodation during emergencies; food and water provisions during emergencies; assessment of population needs, health aspects during a crisis, the importance of data relating to infectious and noninfectious diseases; mental health of the population during emergencies.

The ultimate outcome of this academic course is the acquisition of knowledge and skills that allow for the critical assessments of current national and international strategies, application of the appropriate analytical models that are relevant to public health, formulating proposals for the improvement of activities, and the development of appropriate management strategies during emergencies, as well as planning, coordination, monitoring and evaluating humanitarian activities and activities in the public health domain.

4. CONCLUSION

Introducing disaster risk management into school programs and curricula at all educational levels, a community will increase its own capacity for disaster risk management, and by that token, decrease its vulnerability. By educating experts we facilitate the development of qualified professionals who can contribute to the development of a resilient and sustainable society, professionals who can lead projects for disaster risk management and can help decrease population vulnerability on a local, national and intentional level, and contribute to the development of the field of disaster risk management. Finally, it is important to highlight the significance of developing the Ph.D. program which would allow to comprehensivly educate a number of experts in the region who would with their own work and knowledge contribute to risk management, and the preservation of public health, during catastrophic events.

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VALUE INFORMED CONCEPTION, DESIGN, IMPLEMENTATION AND OPERATION OF EDUCATION AND TEACHING ACTIVITIES

Abstract: In the present paper we take basis in the basic postulate that the objective of education and teaching is value creation. With this setout we take up two implications, namely: i) decision analysis is the logical choice of management framework for conceiving, designing, implementing and operating (CDIO) education and teaching activities and ii) a thorough, transparent and continuously informed discourse is necessary among all stakeholders to education on what this "value" actually is.

To illustrate and discuss these implications, a management framework for educational programs and teaching-learning processes is sketched and outlined in full analogy with decision analysis for complex interlinked systems - as commonly applied for, e.g. disaster risk management. Emphasis is given to the importance of the first task of decision analysis for systems, namely systems identification. Moreover, it is explained how the concepts of vulnerability, risk, robustness, and resilience carry over to the management of educational programs and teaching-learning processes. Finally, the concepts of value and virtue are introduced from the perspective of comprising important parts of cultural entity or assett and a discourse is provided on their characterization and potential for strategic and operational management.

Key words: Educational Programs, CDIO, Decision Analysis, Systems Modeling, Values

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1. INTRODUCTION

Principles of learning and design of education have attracted the attention and interest of scholars,educators and statesmen since Plato. In the 18th century, the British philosopher John Locke had major influence on the evolution of philosophy of education, laying the foundations for modern education theories and practice by addressing the fundamental question how “does an individual learn a new thing?”. The amount of contributions since then to the theory and practice of learning, is overwhelming and a broad and almost humbling variety of philosophies for educational designs has emerged.

Generally, and not least in the context of higher education, the general perception is that education and teaching serves to structure and provide knowledge and skills to individuals so that they may use this knowledge to the benefit of society and also to themselves. Thus here, without any further justification we postulate that education and teaching activities dedicatedly aim to provide value and that all stakeholders aim to benefit from this value. This perspective to teaching is in no manner a novel one – however some of its logical implications may not have been fully appreciated as of yet.

In the present paper we take up and discuss two such implications, namely: i) decision analysis is the logical choice of management framework for conceiving, designing, implementing and operating (CDIO) education and teaching activities and ii) since “value” is the singular reason for providing education and teaching, a thorough, transparent and continuously informed discourse is necessary in society on what this “value” actually is.

It is important to appreciate that the present paper reports on early phases of research aiming to establish a formal philosophical basis and theoretical framework for design and management of education. Our objective here is limited to introducing the general idea of addressing education from a decision analytical perspective and to draw attention to some of the potential benefits of doing so. A detailled description of all steps in such a process is beyond our present scope. The ideas and their implications are brought forward and discussed in mostly qualitative terms supported by introduction of the main corner stones of a management framework for education and teaching in analogy with decision analysis for complex interlinked systems - as commonly applied in e.g. disaster risk management. The system considered including main stakeholders, assets and instruments is illustrated in principal terms in Figure 1. Design and maintenance of educational activities might be considered to constitute a decision problem spanned by these descriptors.

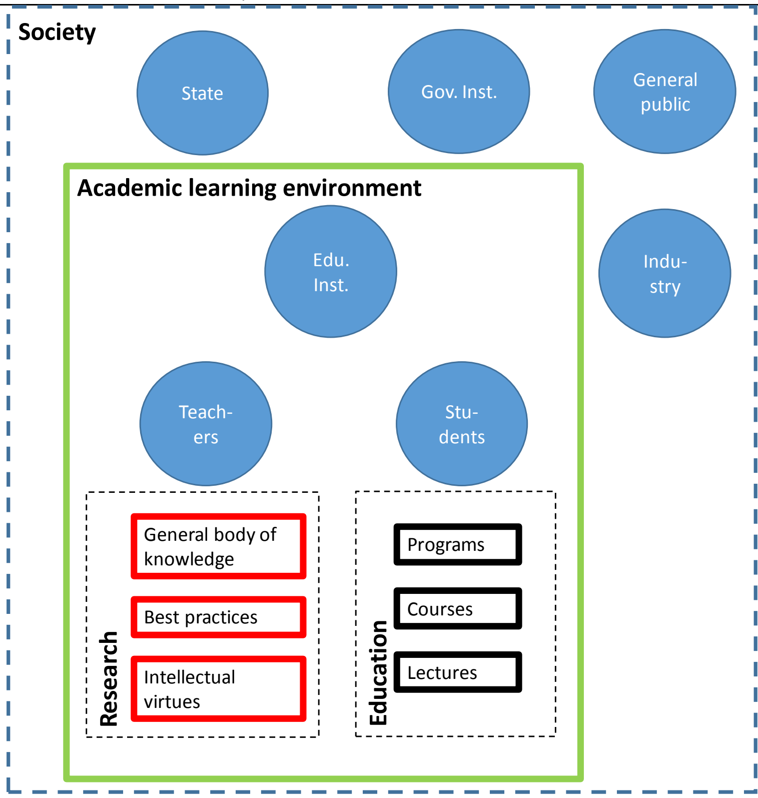

Figure 1- Illustration of main stakeholders (blue circles), assets (red frames) and instruments (black frames) in education.

In Figure 1 it is seen that education and research go together, the general body of knowledge has to be developed continuously and new finding and insights must find their way into bast practices and educational activities. However, it is also important to appreciate that even in ares of education where the research front is not moving, or moving very slowly, there is a tremendeous task for the educational institutions in preserving the already available knowledge.

In the following we will discuss how this decision problem might be synthesized and analysed. Section 2 starts out with a brief summary of the main steps in decision analysis for systems. Thereafter focus is directed on one of the most important tasks of decision analysis for systems, namely the system identification process. In Section 3 analogies are drawn between the characteristics of systems supporting education and teaching and systems in the normal context of risk informed decision support, and it is explained how the concepts of vulnerability, risk, robustness, and resilience carry over to the design and management of educations and teaching activities. In Section 4 it is discussed why the discourse with respect to “value” is central for education and has critical impoirtance for sustainable societal developments. Finally, in Section 5 preliminary conclusions and suggested further research directions are suggested.

2. DECISION ANALYSIS AND SYSTEMS REPRESENTATION

A generic guideline on risk informed decision support and systems modeling in the context of design and management of engineered systems is provided by the Joint Committee on Structural Safety in JCSS (2008). Due to space limitations we here refrain ourselves from providing details on the theoretical and methodical basis for decision anlysis and refer to Raiffa and Schlaifer (1961), Faber andStewart (2003) and Faber (2009) for details and more explanation. However, it should here be noted that the basis for ranking decision alternatives and for optimizing systems performances in accordance with von Neumann and Morgenstern (1953) is the expected value of utility. For most applications utility can simply be understood as a representation of the decision makers preferences between outcomes of decisions. Typically, functions of metrics like economy, loss of life, damages to the environment, lost time of functionality, etc. are used to represent utility.

With this basis, the following section contains a brief summary of the main steps involved in establishing adequate system representations in the context of decision analysis.

2.1. Basic constituents of system representations

In accordance with JCSS (2008), Faber et al. (2009) and Faber (2015) a sytem representation in the context of decision analysis is generally comprised by:

- Decision makers
- Preferences
- Temporal and spatial scope of decision analysis
- Stakeholders
- Commitable resources/budgets
- Boundary conditions to decision making – regulation, policies and law
- Decision processes/organisation
- System functionality representation – interactions between organisations, individuals and technology providing desired functions – provided in terms of causally interrelated system constituents
- Exposure events - potential hazards/threats to system constituents
- Direct consequences – immediate effect/damage to system constituents caused by exposure events (measured in accordance with preferences)
- Indirect consequences – loss of functionalities caused by direct consequences (measured in accordance with preferences)

- Potential event scenarios leading from hazard events over direct to indirect consequences – including possible cascading damages/failure in provision of system functionalities
- Knowledge/uncertainty – Bayesian probabilistic models ultimately providing a full probabilistic representation of probabilities of possible event scenarios and facilitating evaluation of expected value of consequences
- Possible means and strategies for managing risks – including organisational, process related and technical means but also collection of additional knowledge and not least communication

As highlighted in Faber et al. (2009) the level of detailing of the system representation should be choosen to facilitate a consistent ranking of available decision alternatives with respect to expected value of consequences – risk – and this depends on the context of decision making.

It should be highlighted that whereas different decision makers might agree on the formulation of the objectives and the utility which is subject to optimization, their selection of preferred measures and strategies to facilitate this might differ significantly. As a consequence some decision makers cannot achieve the same level of achievement of preferences – utility. This is because the measures and strategies inherently are associated with value - an important point to realize when trying to understand and inform on how culture, traditions and politics might affect achievement of preferences.

3. RISK MANAGEMENT IN EDUCATION

Following the generic approach for systems representations proposed in JCSS (2008) and following the scheme of system representation outlined in the forgoing, an educational system at national scale can be depicted as illustrated in Figure 2. At this scale decisions with regards to geographical allocation of economic resources to educational institutions depending on local demographics and needs for education by, e.g. local industry and public authorities might be assessed and ranked.

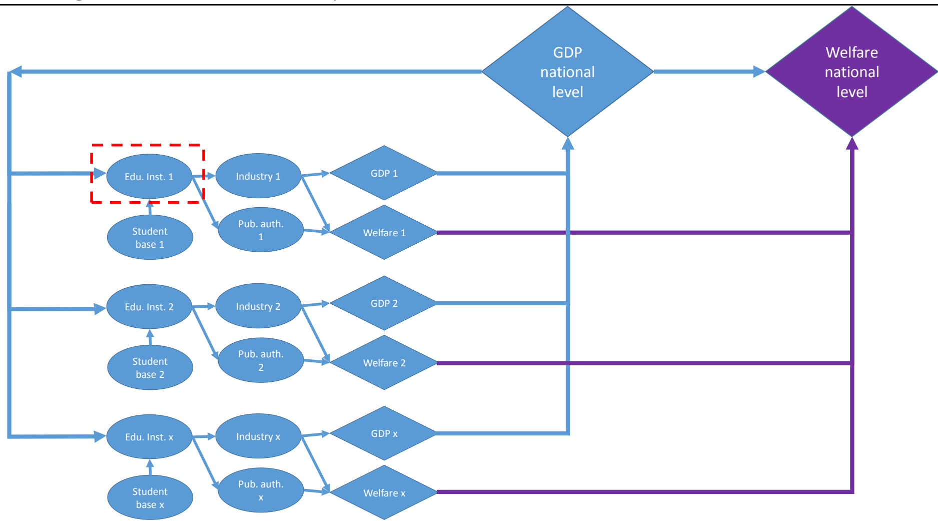

Figure 2- Illustration of educational system at national level.

In Figure 3 we expand the detailing of the part of the system from Figure 2, indicated with the red box with broken line edges (i.e. at educational institution level). At this level of decision making decisions on internal allocation of resources for purposes of research together with development, operation and quality management of educational programs, courses and lectures, administrative and infrastructure services may be assessed and optimized.

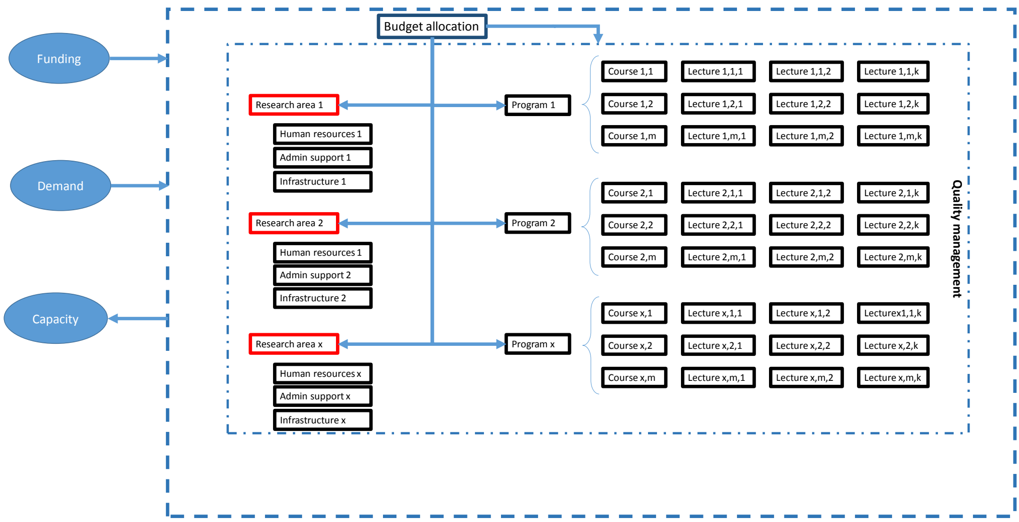

Figure 3- Illustration of educational system at institution level.

For each of the processes involved in providing educational programs indicated in Figure 3 it is possible to develop a systems representation comprised by the components listed in Section 2.1. With respect to the modeling and assessment of risks as a function of different decision alternatives, the scheme illustrated in Figure 4 may be utilized. The scenarios and their probabilities of occurences are assessed based on the best available evidence and degree of belief. Risk may be managed with different means at the different levels in the system representation. Exposure events may be mitigated (e.g. through efficient resource allocation and appropriate control of quality of new students and faculty), the vulnerability of the system may be reduced at the level of direct consequences (e.g. through adaptive and targeted teacher training, reallocation of available resources) and the robustness of the system, i.e. the degree to which consequences of exposures are limited to direct consequences may be improved at the indirect consequence level (e.g. through adaptive capacity of management, faculty and students, available economical reserves, goodwill and reputation, etc.).

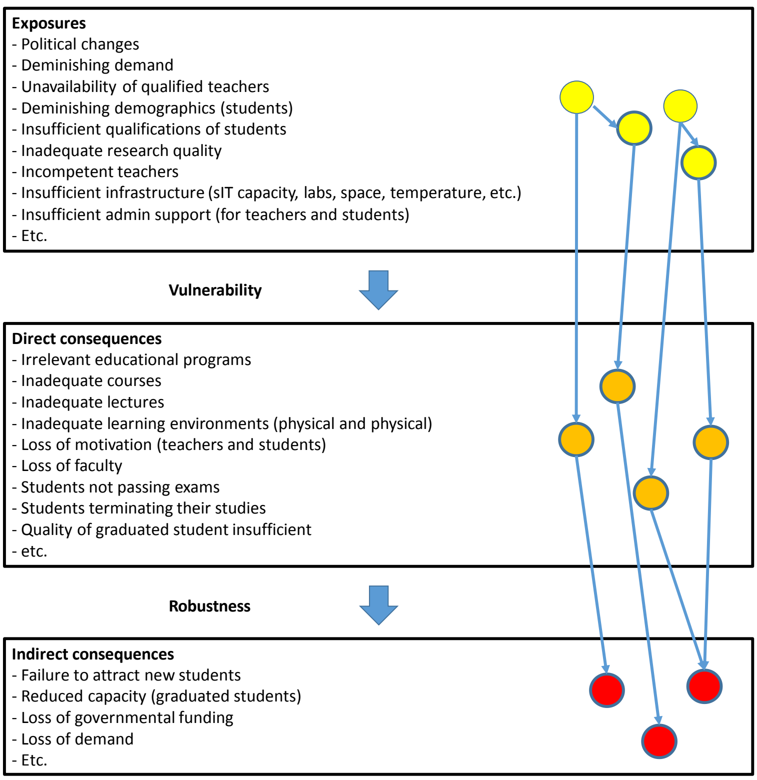

Figure 4- Illustration of systems risk model (adapted from JCSS (2008)).

Following the framework and approach described in Faber et al. (2017) the resilience of the system – at any system level – may be modelled and assessed through the ability of the system to maintain its functionalities, i.e. meeting its demands over time. The resilience for an educational system will be strongly dependent on its vulnerability and robustness but in addition to these characteristics also its social capacity and ability to recover from disturbances.

A further detailing of the system illustrated in Figure 3 would be possible for the purpose of, e.g. representing the interrelations between the performances of the individual educational programs, courses and lectures and the education capacity with respect to different types of professions and to assess how these might further be influenced by utilization of different didactic schemes, culture and basic scholary values. In the subsequent section we will discuss this in more detail.

4. ON VALUES IN EDUCATION

In the management of educational programs and teaching-learning activites it should be appreciated that the outcomes of strategies and planned actions not only depend on the strategies and actions themselves but also and often even more so on the way they are realized – encompassing all aspects of organisational and personal communication - objectively and subjectively. Through the communication, whether explicitly or implicitly, values are unavoidably assigned and virtues are ranked – the result of which can be associated with a culture; in the context of risk management methodology denoted a risk culture. This principally applies for all processes at all scales illustrated in Figure 2 and Figure 3. A full account on the characteristics of cultures in terms of values and virtues in the context of management of educational programs and teaching-learning activities is well beyond the scope of the present paper. Therefore in the following we address this problem complex only at the level of the teaching process but note that many of the considerations made also apply to other processes in the system at other scales.

On the practical level, learning designs for educational programs or individual modules of study often list intellectual capacities that they promote and that the student should acquire through the course of study. Typical candidates are: intellectual curiosity, dedication and determination, honesty, equity in scientific argumentation, search for truth, humbleness, etc. In real life, these are hardly ever more than just glossed over by both teachers and students as bureaucratic requirements of lesson plan writing.

We argue that these values are a paramount asset of educational activities that should be treated on par with assets such as the general body of knowledge and best practices (Figure 1). Intellectual virtues (Roberts and Wood (2007)) fall in the philosophy domain of virtue epistemology which can be viewed as a normative discipline in the sense that it not only outlines the rules and duties of cognitive performance but also the values we attach to knowledge, how it is acquired, and how it is used by individuals as well as by groups. The nature of intellectual virtues and the value of knowledge has been a major theme in the philosophy of Plato, Aristotle, Aquinas, Descartes, Kirkegaard, Nietzsche, Hume, Dewey, etc.

In the epistemic domain of risk, the notion of the value of knowledge, understanding, information, belief, and justification could not be more salient in that the aim of risk analysis is to provide risk-informed decision support to societal decision-makers that is based on justified true belief and evidence. Indeed, the demand for scientific knowledge based on evidence has been at the forefront of policy requirements as evidence is evoked to legitimize the decision making process. Yet scientific evidence is only one type of evidence. In the policy and executive realms, evidence can mean a number of things. Networks and partnerships bring to the negotiation table a diversity of stakeholder evidence and testimonies, which are an interpretation of the knowledge and priorities from the perspective of individual stakeholders. Thus not one evidence base but several come to the consideration during the decision-making process. Disparate bodies of knowledge become multiple sets of evidence that can only inform and influence policy but not determine it. Evidence seen from the political lens is about persuasion and support rather than objective truth. The intellectual qualities that support the acquisition and dissemination of knowledge encompass therefore much more than curiosity for learning and a quest for truth.

A tailored strategy at the level of educational design should thus account for the specific intellectual virtues to be promoted and actively pursued in the course of studies. It is not in the scope of the present paper to suggest a conceptual design for the selection criteria of intellectual virtues and their operationalization through specific didactic practices, but simply to outline some necessary considerations. A taxonomy of intellectual virtues might consider, e.g. to distinguish faculty virtues such as perception, intuition, memory and cultivated virtues such as epistemic justice, open-mindedness, determination, intellectual courage, intellectual humility, etc.

Furthermore, as intelligence qualities are now recognized to be of value not simply on account of analytical reasoning but also on account of emotional and social intelligence, a taxonomy should furthermore explicitly contain epistemic emotions, e.g. states of curiousity, fascination, trust, distrust, surprise, doubt, skepticism, boredom, confusion, fear, etc. Work in this area has been pioneered by Morton (2010), Morton (2015), Stocker (2012) and Kashdan and Silvia (2011). The traditional focus of both epistemic and moral virtues has been the individual agent and the cultivation of these virtues for personal benefit. An individual who acts for his/her benefit might want to cultivate rather different types of virtues than one who is involved in a group or a community or somehow acting on behalf of others. Thus a distinction should be made among virtues that promote individual flourishing (e.g. courage) and community flourishing (e.g. epistemic justice/injustice).

Intellectual virtues could be classified according to the type of value they provide, e.g. instrumental, constitutive or intrinsic. Such classifications would aid in the learning design concerned with identifying appropriate didactic methods and practices to cultivate the desired virtues. For instance, a problem-based learning project exercise could incorporate explicitly in its design the promotion and reward of certain types of intellectual virtues conducive to knowledge acquisition and production as a group rather than an individual. Finally, the performance evaluation process should also reflect the extent to which a student (or a group) is assessed to have demonstrated particular intellectual virtues during a specific task or a full course of study.

5. CONCLUSIONS

Based on the plausible postulate that the objective of educational programmes and teaching-learning activities is value creation we introduce decision analysis as the logical choice of management framework for conceiving, designing, implementing and operating (CDIO) education and teaching activities. Moreover, we point at the significance of a thorough, transparent and continuously informed discourse among all stakeholders to education on what this “value” actually is how it relates to virtues and how this may be managed.

To illustrate our perspective we outline a management framework for educational programs and teaching-learning processes in full analogy with decision analysis for complex interlinked systems - as commonly applied for, e.g. disaster risk management. Moreover, we explain how the concepts of vulnerability, risk, robustness, and resilience carry over to the management of educational programs and teaching-learning processes. Finally, the concepts of value and virtue are introduced from the perspective of comprising important parts of cultural entity or assett and a discourse is provided on their characterization and potentials for their strategic and operational management.

The perspectives brought forward in the present paper should be considered as early insights of recently initiated research. The detailing of the framework, underlying systems and the systematic assessment of characteristics and roles of value is yet to come. But the novel perspectives set out show significant potentials for a deeper understanding of how decision making with respect to optimal management of educational programs and teaching-learning activities might be formalized and undertaken in consistency with both preferences and values.

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NATIONAL SECURITY AND RESILIENCE

Abstract: A concept of national security focused on military threats has been transformed and expanded under the influence of the changed nature of the security challenges, risks and threats generated in the process of globalization. In the context of complexity and the "Risk Society", security is all about proactive policy-making, and designing futures in which the disruptive event, an emergency or a disaster, should not materialize. Resilience as a strategic solution for responding to unforeseen events is aimed at strengthening readiness and reducing the vulnerability of the system. The changed nature of different forms of security threats has led the creators of national security strategies to create new responses focused on strengthening capacities for responding at different levels. Authors of this paper used content analysis and expert interviews to explore and describe the impact of security risks and threats to national security system.

Key words: national security, resilience, risk, threats, system

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1. INTRODUCTION

The challenges contemporary society and nation states face are characterized by great uncertainty and complexity. The hyper-connectedness that characterizes our globalized world makes it hard, if not impossible to clearly isolate causes and effects of any given threat. [1]Therefore, in contemporary settings, national security does not refer to simply military defense, as it was its initial meaning. We should remember that the term "national security", as used in 1950 by Lasswell, once meant "freedom from foreign dictation".[2] Now national security includes other broad issues that affect the economic security and even the values of a country. [2]It includes activities pertaining to disaster and emergency management, as well as critical infrastructure protection, for instance.

Today, we understand that both natural and human-made disasters, such as wars, conflicts and technological disasters can undermine the development gains of countries. In addition, the number of people at risk is increasing significantly, with rapid urbanization inducing uncontrolled and densely populated informal settlements in hazard-prone areas. We also understand that not only state, regional and local governments, but in the first place citizens, need to increase their capacity to reduce both the damage and the recovery period from any potential disaster. [3] According to the US Academy of Sciences Committee on Increasing National Resilience to Hazards and Disasters capacity building starts with individuals taking responsibility for their actions and moves to entire communities working in conjunction with local, state, and federal officials, all of whom need to assume specific responsibilities for building the national quilt of resilience. [4]

In the continuation of our paper we will in more detail explain the concepts of resilience and national security, establish the connection between these two concepts, and give some examples of the existence of the resilience concept in the national security and defense strategies of some states.

2. RESILIENCE

The term resilience has many meanings in academic discourse. It is derived from the Latin word resilio, meaning "to jump back". The resilience concept in social sciences can be traced to the early 70s, when C.S. Holling in his seminal paper "Resilience and Stability of Ecological Systems" argued that the particular attractor around which a system is organized is only one of a multitude of possible states, which emerge and disappear over time. [5] Therefore, this approach emphasizes such concepts as complexity, self-organization, functional diversity and nonlinear ways of behaving. Resilience provides complex systems with the ability to withstand and survive shocks and disturbances. It also emphasizes the capacity for renewal.

In the context of complexity and “Risk Society”, security is all about proactive policy-making, in accordance with whom preventative and precautionary policies plan futures in which the disruptive event, an emergency or a disaster, should not materialize. However, disruption cannot always be kept outside of society as not everything will go as planned. As opposed to the preventative paradigm, resilience policies act on the assumption that a disruption will take place. [6]According to C. Fjaeder from Finnish National Emergency Supply Agency: “security is essentially preventive and proactive in nature, (…) whereas resilience, is a combination of proactive and reactive measures aiming at reducing the impact but not at preventing threats as such. On the contrary, resilience as a concept suggests that preventive measures have not had a full effect, and it consequently focuses on minimizing disruption to critical services to the society once an event has nonetheless happened.” [7]

Proactive measures can be costly with little effect and, occasionally, completely counter-productive. This particularly holds true for the highly unpredictable situations and events, which N.A. Taleb called “Black Swans”. [8] However, Taleb simply put on the agenda what had already been discussed in some academic and expert circles. According to Aaron Wildawsky, Resilience and Anticipation are two strategies that when used in a balanced manner can result with the optimal level of security. “Either strategy has its uses; the central problem in trying to determine which is wisest for human societies is to examine the likeliest risk conditions we face. If our most serious risks come from unpredictable or low-probability sources, then resilience (by conserving generalized resources that may be shifted around and applied where and when they are needed) is best. If danger will come from reliably foreseeable sources, then anticipation makes sense. Real human situations usually involve a mixture of the known and unknown; hence, there is a tradeoff – the most likely large dangers, if they are known and can be countered without making things worse, can, and should be prevented. […] To show that anticipation is the best strategy in a particular situation, therefore, one would first have to demonstrate that the worst risks we face are in fact the ones we already can predict with high probability”. [9]

Resilience has been defined as the ‘capacity of a system to absorb disturbance, undergo change, and retain the same essential functions, structure, identity, and feedbacks’, whereas the systems in question ‘reorganize in the absence of direction’. [10]The World Resources Institute defines resilience as ‘the capacity of a system to tolerate shocks or disturbances and recover’ and argues that this depends on the ability of people to ‘adapt to changing conditions through learning, planning, or reorganization’. [11] Resilience, therefore, can be related to the way that societies adapt to externally imposed change. Taking that into account, presenting resilience as simply something that is reciprocal to vulnerability would impoverish the meaning of this complex concept. [12]

There have been many attempts to discern dimensions and capacities pertaining to those systems deemed resilient. The dimensions, i.e. the constitutive elements of the system, will differ in accordance whether we observe an organization, a nation, a community or any other system, whereas resilience capacities are equal for any type of a system. Generally, three capacities are mentioned – absorptive, adaptive and restorative, whilst some also add the predictive capacity.

Absorptive capacity is the degree to which a system can automatically absorb the impact of system perturbations and minimize consequences with little effort. Adaptive capacity is the degree to which the system is capable of self-organization for recovery of system performance levels. Finally, the restorative capacity is the ability of a system to be repaired easily – either to its original, pre-event state, or to a completely new state that anticipates future system requirements. [13]

The capacities relate to various phases in the crisis/emergency response can be graphically represented (Figure 1).

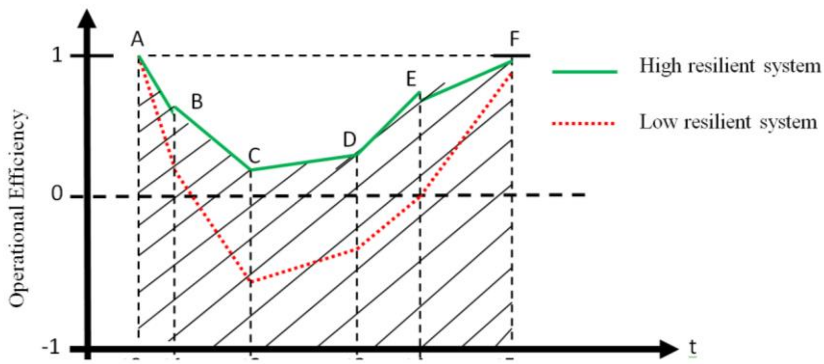

Figure1. Resilience Evaluation Curve [12]

Resilience aspect of the system's response to accident:

t0 – accident start, t5 - end of the system's response to accident

A-B Predictive resilience phase

B-C Absorptive resilience phase

C-D Adaptive resilience phase

D-E-F Restorative resilience phase

Polygon P0 (t0-A-F-t5-t0) – ideal resilient system

Polygon P1 (t0-A-B-C-D-E-F-t5-t0) – real resilient system

Resilience measure (ratio of the polygons surface area) R = P1/P0

Despite (or, perhaps, because of?) its rootedness in neoliberalism, due to its foundations being based on skepticism about the capacities of government to always "do something" and insistence that the resilient systems should be built "bottom-up", implying the reduced interference of state, resilience paradigm has become increasingly popular among the decision makers in creating strategies and other national legislation in the field of national security. A particular aspect of the national security is a disaster resilience of communities and larger regions. According to the Australian National Strategy for Disaster Resilience a disaster resilient community is one that works together to understand and manage the risks that it confronts. Disaster resilience is the collective responsibility of all sectors of society, including all levels of government, business, the non-government sector and individuals. [14] British Department for International Development (DFID) defines disaster resilience as the ability of countries, communities and households to manage change, by maintaining or transforming living standards in the face of shocks or stresses - such as earthquakes, drought or violent conflict - without compromising their long-term prospects. [15]

3. NATIONAL SECURITY AND RESILIENCE

The end of the Cold War and the disappearance of the bipolar power structure changed the security structure of the New World Order. The traditionally understood role of sovereign states as primary security providers has been transformed under the influence of the transnational nature of security challenges, risks and threats.[16]

Transformation of global structure under the influence of "fragmegration" (simultaneous integration and fragmentation processes) has created a complex security environment in which countries are losing monopoly over the use of force, and other entities also got the same opportunity. [17]Narrowly understood concept of national security focused on military threats has been transformed and expanded under the influence of the changed nature of the security challenges, risks and threats generated in the process of globalization. Redefined concepts have changed the meaning of national security borders, the relationship between principles and power, the structure of international security, multilateralism and threats to national security in certain time dimensions. [18]The proliferation of new security threats created an atmosphere of insecurity on a global scale by forcing creators of national security strategies to anticipate the responses of various segments of the system to external or internal factors that threaten to disrupt the functioning of the system.[7] As Fjäder points out, the readiness of the national security system to respond to various forms of security threats and recovering for a short period of time without jeopardizing vital functions and system identity can be quantified through the preventive, adaptive, absorption and restorative capacities that the system possesses.[7] Furthermore, he argues that the resilient nation "has the ability to resist unwanted influences and maintain stability in given conditions, and recover in the short term with minimal unintended consequences for the safety of citizens and their property."[7]

Uncertainty as a key characteristic of the authoritarian character of globalization has led to the design of adequate strategies for the preservation of the vital values of the society and the state. A complex security environment requires the establishment of balance between the reactive and proactive activities of the state and other relevant actors involved in the decision-making process. When it comes to national security, the resilience is implemented in the security strategies of economically stable countries and as such is focused on the adaptive capacity of an individual, community or system with the aim of maintaining an acceptable level of functioning, structure and identity.[19] In 2013, the World Economic Forum presented the definition of government resilience as an ability to adapt to change, to resist destructive influences and recover to the desired equilibrium, established before an unwanted event occurred, while preserving the continuity of vital functions.[20]

The progressive growth and unpredictable nature of various forms of threats to security that come from a turbulent geopolitical environment and internal structures lead to numerous changes in the structure of the national security system of modern states. The concept of resilience basically has an implicit assumption that the world that surrounds us has systemic features and characteristics of dynamic change and interdependence.[21]

The US Security Strategy is the only valid strategy that explicitly cites the concept of resilience as "the vision of national security that arises as a process of adaptation based on complex interactions and experiences of individuals, communities and nations."[22] The Presidential Directive (PPD-21) defines the resilience in the context of national security as an ability System to prepare and adapt to changing conditions, resist negative effects and quickly recover from them.[23] Unlike the US, the security strategies of the People's Republic of China and the Russian Federation implicitly point out the resilience through the need to empower preventive, absorption, adaptive and restorative capacities in order to respond to the unpredictable nature of security challenges, risks and threats. The current Defense Strategy of the People's Republic of China cites the need to strengthen defense capacities, while within the framework of other normative acts, such as laws and five-year plans, the necessity of empowering the early warning system and detecting hidden risks is emphasized. [24]The creators of the Security Strategy of the Russian Federation have pointed to the increased need to strengthen economic stability as the basis of the national security system for preparing and responding to threats, as well as adaptation to changes and return to normal functioning after adverse effects on national security.[25] The need to strengthening defense capacities is particularly highlighted in the Defense Strategy within the chapter related with national interests and strategic national priorities. The planned fifteen-year Development Strategy of the Russian Ministry of Emergency

Situations presented to the public in July 2015 contained elements of resilience (prevention, readiness, response and recovery). [19]

The changed nature of different forms of security threats has led the creators of national security strategies to create new responses focused on strengthening capacities for responding at different levels. Resilience as a strategic solution for responding to unforeseen events is aimed at strengthening readiness and reducing the vulnerability of the system. [19]

Risk reduction increases the degree of resilience of the reference object. The readiness of the national security system for an adequate and timely response in the event of some form of security threat, as well as the ability to adapt to changed circumstances through the continuous functioning of the system and the rapid recovery, indicates the degree of (non) resilience and the need to strengthen the defense capacities of a given reference object. [19]

4. CONCLUSION

The results of research showed that resilience studies have developed rapidly in the past few years, and are of considerable interest to governments, communities and private organizations linked to national infrastructure. When applied to national security, as elsewhere, resilience requires ongoing adaptation and innovation to respond to system uncertainty. A focus on resilience in national security has replaced the former "promise of security", previously offered by various levels of governance, i.e. the belief that national institutions can anticipate and prevent every adverse event. This change to the discourse of national security mitigates citizens' dependency and anxiety, as well as consequences arising from government's inappropriate or untimely responses to disruptive events. We have shown that various governments have incorporated the notion of resilience, either explicitly, as is the case with the USA, or implicitly (Russian Federation, China) in their national security and/or defense strategies. As the world is becoming more complex, interconnected and burdened with uncertainties we believe that resilience strategies will be ever more prominent in securing the national well-being, infrastructure and interest.

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EARTHQUAKE HAZARDS IN BOSNIA AND HERZEGOVINA

Abstract: Due to increased urban development the social costs of natural hazards steadily increasing. The society has become more vulnerable. Natural disasters reveal the fact that our economic development has impact on the resilience of society. Risk assessment has become necessary procedure for the development of sustainable communities. Risk analysis implies the proper hazard, vulnerability and exposure evaluation. This paper is dedicated to overview of earthquake hazards in Bosnia and Herzegovina, as input data for the assessment of vulnerability and sustainability of communities and the development of risk management strategy.

Key words: Hazards, Risk Analysis, Earthquake, Risk Management

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1. INTRODUCTION

Natural and man-made disasters are on the rise in recent years, with negative impact on the environment and extensive damages to the urban areas. The society has become more vulnerable and disaster managment is increasingly important. On the other hand, preliminary surveys in Western Balkan countries have shown shortage of skills and insufficient knowledge to solve the growing problems. Because of that, the K-FORCE project is ongoing with the aim to improve resilience to hazards and capability for regional cooperation in risk prevention and response in Western Balkan countries.

Disaster risk managment can be defined as the decision-making phase based on risk assessment, which can be divided in two phases: risk identification and risk analysis. Risk identification means hazard identification or hazard assessment. Hazard identification includes collecting information about harmful situation, which will be data base for risk assessment. In the paper, some data about earthquake hazards in Bosnia and Herzegovina were presented, which will be used in future for research and improvement of knowledge in the field of Disaster Risk Management.

2. EARTHQUAKE HAZARDS

Seismic risk analysis includes assessment and mapping of seismic risk. Some examples were presented in the papers [2], [3] Chapter 5, [4], [5], [9] and [10]. The principal elements of seismic risk assessment were outlined in the papers [1] and [7]. The territory of Bosnia and Herzegovina is located northeast of active tectonic collision between Adriatic mass, as a part of African plate and Dinaric Alps as a part of Eurasian plate. Bosnia and Herzegovina is located on the Dinarides plateau, with some paleogeographic and structural units, which lie one over the other, with the outer parts of Dinaric Alps at the bottom and the Sava-Vardar thrust at the top. As you can see on figure 1 southern part of Bosnia and Herzegovina has intensive tectonic activities. Earthquakes, which occures on Dinaric plateau, were caused by the release of energy induced by sliding the African plate beneath the European continent. The earthquake measuring magnitude of 5 to 6.5 M indicates the indigenous earthquakes as well as the existence of seismic zones and tectonic structures in the territory of Bosnia and Herzegovina. In the paper [8], overview of seismotectonics of Bosnia region was presented.

On figure 2 you can see disposition of thrust and faults. The main deep faults were presented. The main direction of faults is northwest-southeast, with some faults with direction northeast-southwest. Surface geology and recent seismic activity point to their pronounced neotectonic activity.

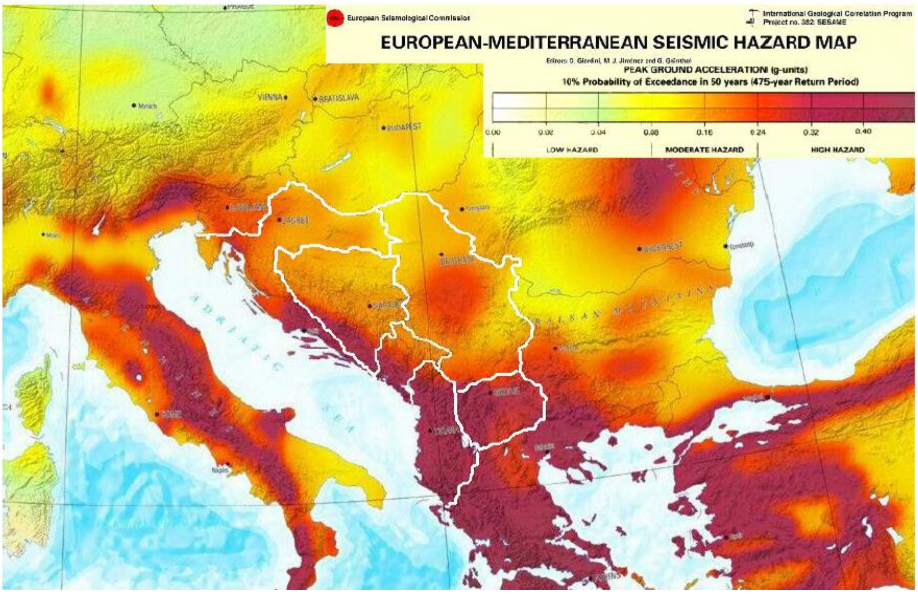

Figure 1 – Southeastern Europe's Hazard Map

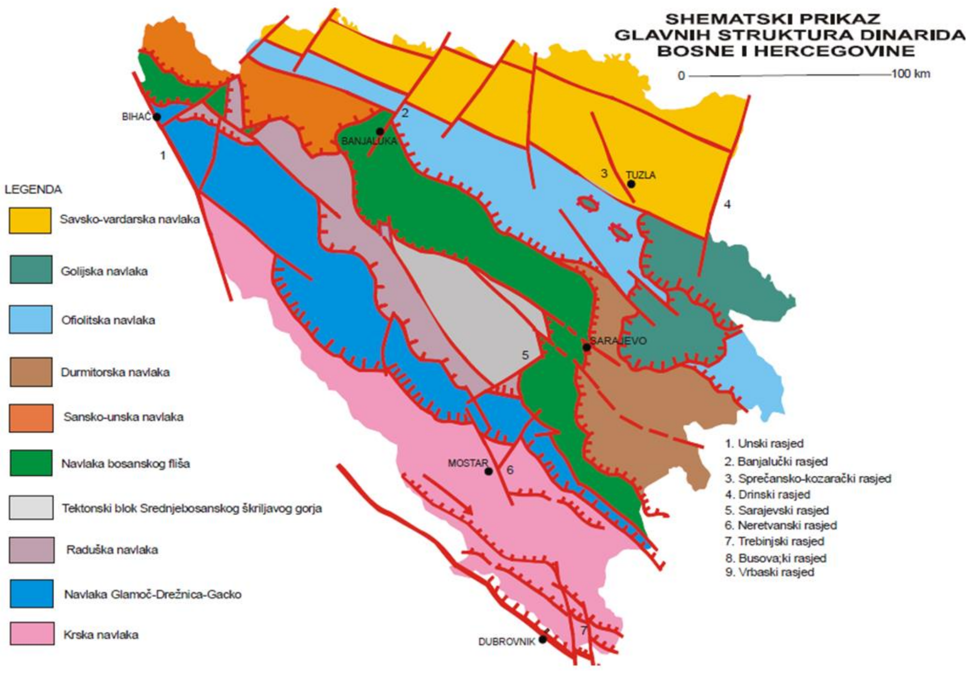

Figure 2 –Map of fault systems in Bosnia and Herzegovina

Of all the deep faults in Bosnia, the Banja Luka-Tuzla-Zvornik fault (fig.2, no.2 and 3), which is part of the large regional tectonics fault of Zagreb-Skopje, the Vrbas fault (fig.2, no.9) and the Banja Luka-Zenica fault, coupled with the Busovaca deep fault (fig.2, no.8), are particularly interesting for research. The Una fault (fig.2, no.1) is significant, in geological terms, because it is relatively deep and generaly reflects on the geological-tectonic material of this area. The fault has horizontal movement of regional character, starting from Zagreb, via Karlovac, to Split. Also,one of the most important fault is the Vrbas fault (fig.2, no.9), stretched from the Jajce through Vrbas valley to Gornji Vakuf, then extends across the Jablanica lake, Neretva valley, Gatac field to Montenegro. The Busovaca fault (fig.2, no.8) is geomorphologically very pronounced and can be clearly observed on satellite and airplanes. Start from Jajce, where it reaches Vrbas fault, via Travnik, Vitez, Busovaca, Kiseljak, Ilidza, along the slopes of Jahorina and close to Foca crosses into Montenegro. The Busovaca fault has vertical and horizontal movements. The amount of vertical movements at the perimeter of the Sarajevo-Zenica basin is 1500 to 2000 m. These vertical movements were periodically followed by significant right horizontal displacements in the pliocene. The zone of the fault is characterized by the appearance of thermomineral and mineral waters, and the neotectonic rise of Vlasic and Igman. The Spreca-Kozara fault can be distinguished, which passes directly to Tuzla city. The fault is a part of the northeastern border of the Ofiolit zone, or the southern edge of the Pannonian basin. It start from Bosanska Dubica, on the southern slopes of Prosara and goes to the southeast, via Prnjavor and Doboj, to Ozren, than continue via Zivinice to Zvornik. In the part of the fault, between Doboj and Zivinice, is a system of parallel faults, which form together with the main fault regional fault zone. In the zone vertical movements are over 2000 m. The position of the other faults is shown on figure 2.

The territory of Bosnia and Herzegovina is one of the most seismically active parts of the Balkan Peninsula. According to available data, on the territory of Bosnia and Herzegovina several devastating earthquakes have occurred with magnitude $M \geq 5.0$ and intensity in the epicenter $Io \geq 7°$ MCS scale. In the last hundred years, over thousands earthquakes were occurred in Bosnia, out of which thirty earthquakes had a magnitude $M > 5.0$. The last 35 years of the 20th century was characterized by increased seismic activity at the area of Banja Luka, Tuzla, Zenica and Herzegovina. Complete Adriatic Zone can be distinguished as a seismically highly active area, with many epicenter of earthquakes. The location of this zone coincides with the most important faults on the surface of the terrain, stretching along the Adriatic Sea. This is the area of the coastal part of Croatia and Montenegro, where occurred very strong earthquakes ranging from M 5.5 to M 7.2 (Dubrovnik, Kotor, Split). Strong seismic activity is along the fault Ploce-Dubrovnik-Bar.

In the report [6] harmonized seismic hazard maps for the Western Balkan Countries were presented. On figure 3 seismic zones in Bosnia and Herzegovina is presented. From the enclosed drawing it is evident that most of the territory is in zones 7, 8 and 9^0 MCS. The description of seismic zones is given in Table 3.

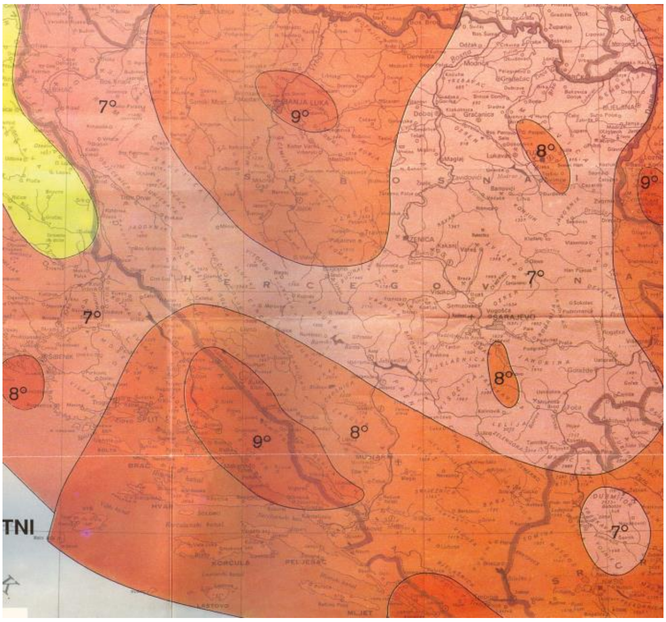

Figure 3 – Seismic zones in Bosnia and Herzegovina

Table 3 – Seismic zone classification

Degree (MCS)	Description of oscillation effect and damages caused by earthquake	Acceleration (m/s^2)
1	Oscillations register only by equipment	< 0.0025
2	Oscillations are felt only in quiet environment	0.0025-0.005
3	Some people feel oscillation	0.005-0.010
4	Oscillation are felt by many people, glasses shouting	0.010-0.025
5	Cracks appear in the mortar	0.025-0.050
6	Cracks in the mortar and damages of weaker buildings	0.050-0.10
7	Damages of the buildings in normal condition, cracks in the mortar, dissipation of the mortar, cracks in wall joints (connections)	0.10-0.25
8	Significant damages of the buildings, cracks in structural walls, wide cracks in non-structural walls	0.25-0.50
9	Wide cracks in structural walls, demolition	0.50-1.00

3. CONCLUSIONS

As can be seen from the previously presented overview, the territory of Bosnia and Herzegovina has a complex geological structure. Because of that a system approach and the development of a strategy for achieving adequate community resistance to earthquakes are essential. The first step towards raising the community resistance is the development of an adequate education system that will raise the level of knowledge needed to adequately manage natural disasters.

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Bjarne HUSTED

TURBULENT MIXING IN THE LOWER PART OF THE SMOKE LAYER USING THE FIRE DYNAMIC SIMULATOR

Abstract: Turbulent mixing plays an important part in fire safety engineering. The turbulent mixing in the plume determines the amount of hot gases in the smoke layer. The flow of hot gases past obstacles determines if the smoke will come down or stay at the ceiling. The experimental scenario chosen was a retail store in the model size 1:2 with limited ventilation. A sensitivity analysis study was conducted and it showed that grid independency could be achieved for D*/dx between 8 and 16. An overestimation of temperatures for the lower gas layer was found. This could be the result of a too large turbulence mixing in the lower area. Further simulations were carried out using all the different sub-grid turbulence models in the Fire Dynamics Simulator (FDS). There was no clear indication that different sub-grid turbulence models would significantly affect the results. Therefore, the choice of sub-grid model seems to have limited effect on the mixing in the lower zone.

Key words: cfd, fds, validation, turbulence, experiments

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1. INTRODUCTION

Validation of models for Computational Fluid Dynamics (CFD) is important to ensure that the results of the calculation can be trusted. One of the most used tools in the area of fire simulation is the Fire Dynamics Simulator (FDS), which is an Open Source code developed by the National Institute of Standards and Technology (NIST) in USA and a number of contributors from around the world [1]. Another important aspect concerning the reliability of modelling results is verification. Verification is the process of determining that the software solves the equations correctly while validation is the process of determining that the right equations are solved. FDS has been verified and validated and this is documented in the FDS Verification Guide and the FDS Validation Guide [2].

The precise definition used for these two terms in the FDS verification guide is, "Verification is a process to check the correctness of the solution of the governing equations. Verification does not imply that the governing equations are appropriate; only that the equations are being solved correctly. Validation is a process to determine the appropriateness of the governing equations as a mathematical model of the physical phenomena of interest" [2, 3].

Although the FDS has been validated in a number of cases, - not all relevant fire cases have been validated. A large validation research using a number of different scenarios is provided by a study done in Sweden in 2012 [4]. The scenarios consisted of a fire in a large room, a corridor, a tunnel, retail premises (shop) and a room-corridor-room setup. Four different CFD programs were used, CFX, FDS, SMAFS and SOFIE [4]. CFX is a general-purpose program and the later three are specialized codes for fire simulation. The study showed some difference between the results, which both could be due to the different methodology, but also how the operator set up the input parameters [4].

The aforementioned study [4] is from 2008, therefore new versions of most of the codes have come out since. Focusing on the Fire Dynamic Simulator, Shamim Ahmed in a recent B.Sc.-thesis re-validated FDS on the SP Retail Store (the retail premises case) [5]. He found that the temperatures in the smoke layer correlated well with the experimental results. In contrast, far away from the fire and in the lower part of the room, some discrepancies were found.

This result seems closely linked to the mixing of the gases in the lower part of the room, so this papers further investigates how the turbulence models used in FDS influence this mixing process.

2. CASE DESCRIPTION OF THE SP RETAIL STORE AND SETUP IN FDS

The SP Retail Store experiments are briefly described here. More detailed information are available in a Swedish report associated with this work [4]. The building consisted of a 1:2 model of a small shop, which was build inside the lab hall at SP (now RISE) in Borås in Sweden. The building is 18 m long, 7.5 m wide and has a height of 2.4 m. Three different positions of the fire were tested in the experiments, but in this paper only fire position 1 was used, marked as "Fire 1" in Figure 1. The compartment contains 6 shelves and for the present case the first shelve was removed and a fire was placed at that position as shown in the lower part of Figure 1. The enclosure had 2 small openings at each end, close to the floor. A 0.5m x 0.5m x 0.15 m pool filled with 15 liter of heptane was used as the fire source. The temperatures were measured with thermocouples in several thermocouples trees as shown in Figure 1. In addition, optical density was measured at three different heights in the middle of the room and the velocities at the small openings were measured with bi-directional probe using the method described by McCaffrey and Heskestad [6, 7]. More details about the experiment can be found in Appendix 1 of the validation report from 2008 [4].

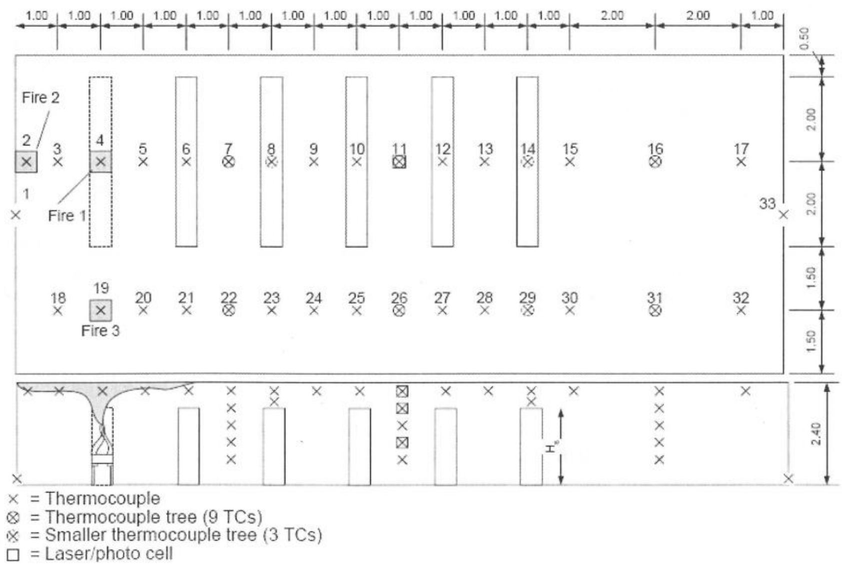

Figure 1 Experiment setup of the SP retail store

The case was setup within a thesis [5] at Lund University in FDS using four different grid sizes based on the ratio between the characteristic diameter of the fire, D* and the grid sixe dx. A high ratio means that the fire is well resolved, typical more than 10 cells across the characteristic diameter of the fire, as described by a number of authors [8, 9]. The FDS user guide used to have a recommended value of this ratio to be between 4 and 16, - where a high value is better, but this recommendation have been removed in recent versions of the user guide. The difference can be seen by comparing the FDS User Guide from April 2015 [10] and the FDS User Guide from January 2017 [1].

Table 1 Grid size, ratio of characteristic fire diameter to grid size and number of cells (from [5])

dx [cm]	D*/dx [-]	Number of cells
20	4	54000
10	8	43200
5	16	3456000
2.5	32	27648000

A grid spacing of 5 cm gave a grid independent solution [5]. A grid independent solution means that that the results did not change, even when refining the grid below 5 cm. A 5 cm grid gives approximately 3.5 million grid cells. When using the Aurora cluster at the Lund University computing centre it takes about 5 days on a single node, using 20 cores, to calculate the scenario until 3 minutes after the start of the fire. Sensitivity analyses covering different variables were conducted to study the influence of the combustion efficiency of heptane and the modelling of the openings to the surroundings.

The current development version of FDS, FDS6.5.3-2254-gd7efb27 (Rev. date: Thu Aug 10 2017) was used for the new simulations. The final setup [5] as illustrated in Figure 2 has been used. This configuration encompasses an extended domain outside of each of the openings (not shown here) and the use of a combustion efficiency of 0.7. This factor gave the best results compared the to the experiments, but also seems reasonable for a heptane fire, when compared to the figures given by Drysdale [11]. The simulations were carried out with a fixed time step of 1ms and the data were saved for every time step for later analysis of the frequency spectrum of the fluctuating eddies.

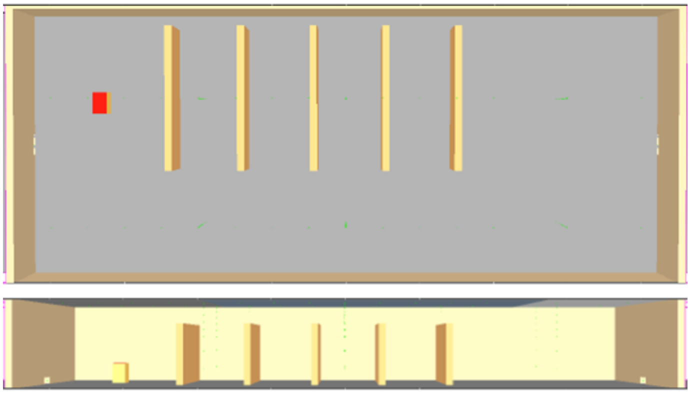

Figure 2 Setup of retail store in FDS (from [5])

3. TURBULENCE MODELLING IN THE FIRE DYNAMIC SIMULATOR

The Fire Dynamic Simulator include two ways of modelling the flow, - either Large Eddy Simulation (LES) or Direct Numerical Simulation (DNS). For all practical applications involving large enclosure like the current setup, DNS is prohibitive both in terms of time and memory requirements. Therefore, the LES model is used, where the idea is to resolve large eddies in time and space, and to model the faster and smaller eddies. This is described in the FDS Reference Guide [12], but also described in an interesting article by Pope, who discuss the concept in ten easy to read questions [13].

The smaller eddies below the filtering size, which is typical equal to the grid size is modelled with sub-grid models. Assuming that the smaller eddies are isotropic, relative simple sub-grid models are used. This is illustrated in Figure 3. The large eddies in the integral scale length and initial subrange are resolved in LES and the smaller scales in the viscous subrange are modelled in FDS. Eddies at the smallest scale (Kolmogorov scale) are dissipated into energy.

The sub-grid models included in FDS which permits the handling of the ”small” eddies is the Constant Smagorinsky, Dynamic Smagorinsky, Deardorff , Vreman and RNG (Renormalization group eddy viscosity model). The reader is referred the FDS technical reference guide for the mathematical details of these 5 models [12]. But in short the Dynamics Smagorinsky model is the most expensive in terms of computational cost while the Deardorff model works well on both coarse and fine grid. Deardorff is the default sub-grid turbulent model in all recent editions of FDS 6, including FDS 6.5.3.

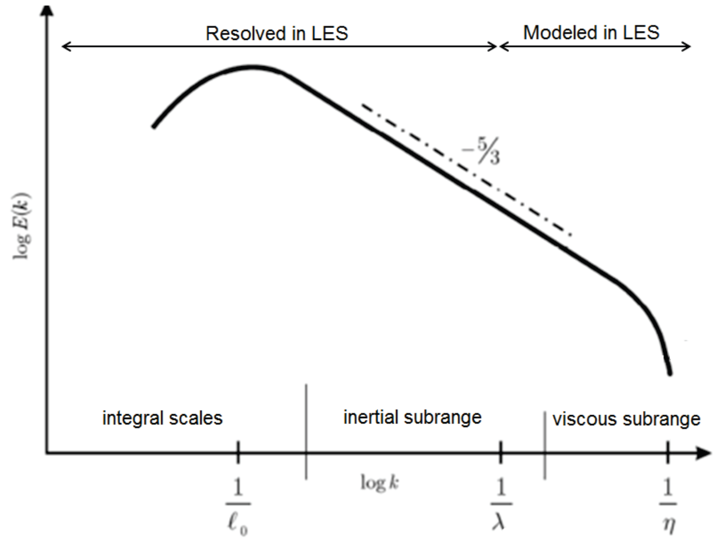

Figure 3 Energy cascade of turbulent kinetic energy (Source [14])

4. RESULTS AND DISCUSION

Temperatures in position 16-9 far from the fire and 50 cm above the floor are shown in Figure 4 (see Figure 1 for the location). After 180 seconds, the temperature is about 50°C. The experiments did not show any rise in temperature at that position until after 200 seconds. The temperatures in the simulation are very similar, regardless of the turbulence sub-grid model used.

Furthermore, a Fast Fourier Transform (FTT) of the fluctuations of the velocity in position 16-9 was carried out focusing on the period from 160 s to 180 s (Figure 5). The FFT results shows that the turbulent kinetic energy decay linearly in the log-log plot and is following the expected decay at the power of (-5/3). The decay is similar for the 5 different sub-grid models.

Therefore, based on both the temperature graphs and the FFT analysis of the velocity fluctuations, it is concluded that the choice of sub-grid turbulence model cannot explain the increased mixing in lower zone far from the fire. This mixing could perhaps be due to the hot smoke layer impinging on the far wall and recirculation downwards into the lower part of the room. But also due to mismatch between the experimental setup and the simulation setup.

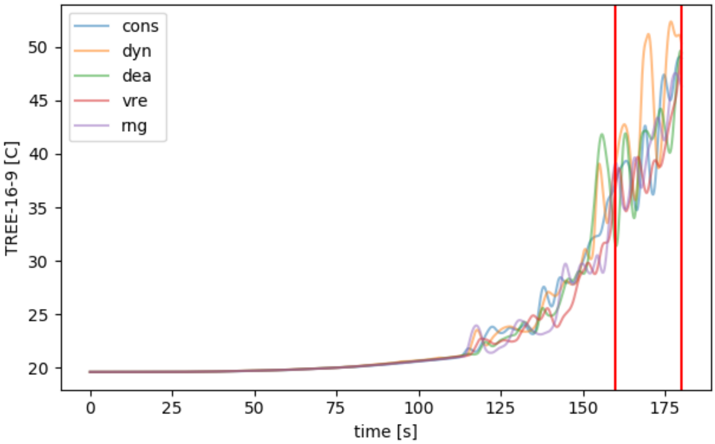

Figure 4 Temperature at point 16-9 using 5 different sub-grid turbulence models

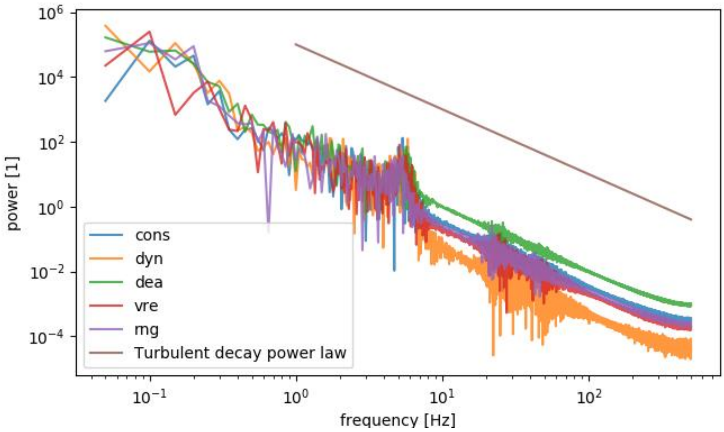

Figure 5 FFT analysis of velocity fluctuations at point 16-9 between 160s and 180s

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LIMITATIONS AND CHALLENGES FOR RISK-BASED LAND-USE PLANNING – THE CASE OF SWEDISH COMPREHENSIVE AND DETAILED PLANNING

Abstract: Risk-based land-use planning (LUP) concerns ensuring that populated areas are being planned and built so that risks are kept at acceptably low levels. In Sweden, LUP is mainly carried out at the local level ranging from comprehensive (city) to detailed (neighborhood) planning. This paper identifies limitations and challenges in Sweden when it comes to successfully carrying out risk-based LUP. Results from several studies that have been performed in an array of contexts are compiled. Although there has been progress over the past decades, several limitations and challenges remain. These may both lead to inconsistent, arbitrary and ineffective risk management as well as that the work processes become inefficient. It is argued that there is a need for clearer guidance and legislation from the authorities, as well as neutral arenas for discussing and developing good practices.

Key words: Risk management, Challenges, Land-use planning, Sweden

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1. INTRODUCTION

Land-Use Planning (LUP) concerns making sure that land and water are being used in an efficient, ethically justified way that satisfies the needs and goals of the stakeholders in a community or a nation. It is carried out at many different scales and in Sweden, for example, LUP is mainly carried out at the local level by municipalities. There, the planning processes are carried out at different level of detail ranging from the municipality as whole (comprehensive planning) to neighborhood level (detailed planning).

A large number of needs, goals and interests from an array of stakeholders must be balanced in the land-use planning process. One of these objectives concerns ensuring that the risk to people's life and health are kept at levels that can be accepted by society. These risks can arise from the localization of population in the vicinity of natural hazard zones, hazardous facilities, transportation routes, and so on. Due to urbanization, land zones in many cities are becoming more and more valuable and there is often a political and public pressure to exploit or densify many areas of cities – including those areas that are exposed to hazards of various types.

Land-use planning processes can either concern licensing processes for hazardous facilities, which for example is covered by the Seveso-legislation, or processes where land zones close to existing facilities and risk sources are being use in new ways, e.g. by building new housing. The great majority of previous research has been focused on the former situation [4].

The process of taking risk into account in LUP can be carried out in several ways. [5] describes four main approaches when it comes to supporting decisions that concerns risk in land-use planning: 1) using fixed separation distances, 2) using consequence assessments for worst credible (or conceivable) scenarios, 3) using semi-quantitative risk assessments, or 4) using probabilistic risk assessments where individual and societal risks are calculated. The latter, most sophisticated, approach is often coupled to pre-defined risk acceptance criteria, where the UK and the Netherlands are the two countries that have pioneered this approach [7] and implemented it in their regulations. Furthermore, in Sweden, which constitutes the focus of the present paper, the probabilistic approach has also been used widely although there is no legislation that require such assessments to be performed, nor are there any legislated risk acceptance criteria in Sweden.

Over the years, considerable progress has been gained in the area of land-use planning [5-6], [9]. This includes multi-plant applications, multi-risk applications [16], taking domino effects into account [13-14], [17], development of multi-national risk criteria [3] and taking risk exposure to critical infrastructures into account [8].

However, there are still many challenges for risk-based LUP for example related to the fact that the uncertainty and variability in the output from risk assessments that are carried out are great [10], [19-20]. This has prompted discussions concerning whether risk assessments should be standardized including standardizing what models to use, what scenarios to model and what values of various input parameters to use. On this topic [20] argues that "[t]he user influence on the results is in this way minimized, but the reality content remains questionable." Hence, there are some benefits, such as greater comparability and fairness, but also some negative sides, such as reduced efforts to improve upon the risk models and tools used.

The purpose of the present paper is to investigate the state of risk-based LUP carried out in practice in Sweden. A number of limitations and challenges that relate to the risk assessment and management processes are identified and described. In addition, some ideas about how these challenges and limitations can be overcome are pointed out.

2. METHOD

This paper is based on a number of different studies that have focused on various aspects related to the risk-based land-use planning in Sweden. These studies have been performed during the last five years predominantly by Master students at Lund University, Sweden, with supervision from staff at the Division of risk management and societal safety. More specifically, this paper compiles insights from the following studies: [1-2], [15], [18], [21-23].

These studies have varied from in-depth studies of specific land-use planning cases, e.g. the planning of a new emergency coordination center in Stockolm [23] or evaluations of specific risk models, e.g. a model to estimate frequency of accidents with hazardous goods [2], to broader studies that have compared the practices of various municipalities, consultancy firms [1]. In addition, the paper draws on the authors' personal experiences from collaboration and interactions with various practitioners in the area of land-use planning.

Three main data collection methods have been employed in these studies. First, interviews have been carried out with urban planners, officers from the fire and rescue services, engineers from various consultancy firms that are informed in risk assessments etc. Secondly, workshops where questions concerning risk-based LUP have been arranged. Finally, risk assessment documentation and documentation of land-use plans have been studied.

3. RESULTS: LIMITATIONS AND CHALLENGES FOR RISK-BASED LAND-USE PLANNING IN SWEDEN

3.1. Unclear roles and responsibilities

The responsibility regarding which actor should be the main driver for risk management in the Land-use planning process seems in many cases to be unclear.

This is especially imminent for the comprehensive planning process. The municipal planning office expects other actors to bring such aspects to the planning process but there is no systematic process of ensuring that this actually is the case. There are expectations from the municipal planning office that the fire and rescue services in the municipality should take this responsibility but they don't necessarily take a broad perspective on risk. Instead, they may focus on technical risks, e.g. related to the Seveso legislation, and accessibility for fire response, which of course are critical questions but do not always encompass all relevant risks.

There are also expectations that the county administration board should highlight risk issues, especially in the detailed planning process; however, several respondents express frustration that this is often done very late in the planning process. The arguments from the county administration boards is that it is not until a late stage that the plans are concrete enough to be possible to comment on. At the same time, the longer the planning processes have been ongoing, the less the possibilities there are to considerably reduce risk and the more inefficient the process becomes.

3.2. Risk management receives limited attention

The studies indicate that risk management is in many cases receiving limited attention – again this is most clearly visible in the comprehensive planning. An indication of this is the opinion, expressed by some municipal planers in the context of comprehensive planning, that the municipality first plans what they want in an area of concern and then try to make sure that these ideas are realized. Some respondents have even said they hope that no one brings up any risk-related questions since this may hinder their ambitions concerning land exploitation. This is in contrast to an approach where a comprehensive risk assessment of the area is conducted at an early stage and then used to plan the area considering the risks within this area. Another indication of risk not receiving significant attention is the fact the few comprehensive plans include any substantial information about risks - at least not from a holistic perspective.

3.3. Lack of joint understanding of the purpose of risk management in LUP

In the conducted studies the lack of common view of the purpose of risk management, as well as how the risk management should be structured have also become apparent. This has been the case even though several meetings have sometimes been arranged throughout the planning process to overcome such obstacles. This may be a crucial challenge since other studies has also pointed out that different views on what to account for, how to frame risk, may significantly contribute to controversies and inferior outcomes of risk management (see e.g. [11]).

3.4. Limitations of considering some risks in the detailed planning stage

An issue that has been identified is that questions concerning risk are many times consciously or sub-consciously, pushed from the comprehensive plan to the detailed plan. I.e. rather than proposing an overall solution in the comprehensive plan, the hope is that the risk questions will be solved at a later stage in the detailed plan. However, in the detailed plan, carried out on a considerably smaller area than for the comprehensive plan, some risks are simply not possible to manage adequately, or only managed in a sub-optimal way, since they may require the much broader perspective that only is possible in the comprehensive plan.

In some cases this issue had more to do with lack of connection between risk assessment and management at the comprehensive planning level and at detailed planning level. More specifically, risk assessments were sometimes carried out at the comprehensive plan level but they were not considered in the subsequent detailed planning process – at least not until very late in the process which meant that the planning process had to be interrupted. If, on the other hand, the starting point for the detailed planning was the risk assessments carried out at the comprehensive plan level it would probably have been a quicker process to come to conclusions about suitable land-use.

3.5. Lack of participation and transparency in risk assessment process

A key to success that is often pointed out in the research literature is transparency of risk assessments and participation of various stakeholders in the whole risk management process (e.g. [24]). However, in many of the studied cases it seems that risk assessments in the Swedish planning process are conducted by private consultancy firms with limited participation or insights from other actors. Stakeholders have expressed concerns about not being able to understand the results from the assessments or the assumptions made in the assessments. This does clearly not contribute to building confidence and trust in the results from the assessments. It may also lead to the risk assessments not being used or misinterpreted.

3.6. Large variation in assumptions and results

In the case of densification of cities, transportation of hazardous goods often becomes a key hazard that must be analysed and managed. Typically this is done in the detailed planning process. A study that focused on road transportation of hazardous goods showed that there are large variations in terms assumptions made in the risk analyses – when it comes to factors that logically should not vary from case to case. This could concern what representative substances that were suitable to use, what incident outcomes that were seen as possible (and their respective probability), what damage criteria that were used, and what consequence models that were used. Although this study could not quantify the degree of variation in the end results, it is clear that the variation is substantial. Furthermore, this observation is also in line with the conclusions from e.g. [15], [19-20].

In addition, in many of the risk assessments that are conducted in Sweden, a frequency modelling approach are used which was developed more than 30 years ago. This model is in some aspects based on very limited data and in some cases the basis is even unclear. In addition the data that is used as input is in some cases obsolete given the changes in the transportation system today. Finally, some factors that have been shown to significantly affect the frequency of transportation of hazardous goods are not taken into account.

3.7. Use of a risk acceptance criteria not adapted to the area of application

In most of the studied cases, risk evaluation is conducted by comparing the resulting risk levels with predefined risk acceptance criteria (such as individual and societal risk) – see [4] for an overview. The criteria commonly used in Sweden (although they are not legislated) were developed with reference to evaluation of the risk exposure from a single industry to surrounding areas. However, often these criteria are applied to a geographical area of arbitrary size where several hazards may be relevant (roads, industries, etc.). Especially societal risk criteria are very sensitive to the scale of the application [4] which means it is not obvious how a criteria developed for a single industry case can be applied in the context of a geographic area. UK guidelines argue that “where several sites contribute to the local societal risk, the intolerable risk region may be set an order of magnitude above that for a single major industrial activity” [4].

3.8. Inconsistent application of the ALARP-principle

Typically the ALARP-principle is used in the risk evaluation process in Swedish risk-based LUP. However, how the ALARP-principle should be interpreted and applied seems to vary across the different studied cases. In many cases risk are only reduced so that risk levels are within the ALARP-area. However, the ALARP-principle essentially says that additional measures should be taken unless the costs are grossly disproportional to the benefits [12].

3.9. Challenges of taking societal benefits into account

The risk acceptance criteria are often applied without taking the benefits of a particular land exploitation to a community into account. I.e. the required risk levels are no adjusted depending on whether there are large or small societal benefits of the planned area. However, it seemed reasonable to many respondents that higher risk levels should be accepted if the benefits are high. The respondents, furthermore, point out that they lacked practical tools to take societal benefits into account when deciding on acceptable risk levels.

3.10. Difficulties to modify existing areas

In some cases existing areas have risk levels that are unacceptable when compared to the commonly used risk acceptance criteria. This means that exploiting this area, even in a very minor way, becomes problematic without implementing significant risk reduction measures also for the existing settlement even though no physical changes that affect these settlements are proposed.

3.11. Unverified and uncertain effects of risk reduction measures

The risk assessments conducted in the detailed planning stage typically end up with propositions of measures that should be implemented when building the area. However, it is very rare that verifications of the effectiveness of the measures are carried out – i.e. how much the risk level is actually reduced. Instead, evaluation of risk measures is often carried out roughly and qualitatively which means their effectiveness, and hence the residual risk levels, are very uncertain. A reason for this is that the authorities are typically not demanding it. Another reason is simply that it is a rather complex process that requires a lot of efforts and includes large uncertainties.

4. DISCUSSION & CONCLUSIONS

This paper has summarized insights from a number of studies that have been performed in relation to risk-based land-use planning processes in Sweden. A number of limitations and challenges have been identified and described, including 1) Unclear roles and responsibilities, 2) Risk management receives limited attention, 3) Lack of joint understanding of the purpose of risk management in LUP, 4) Limitations of considering some risks in the detailed planning stage, 5) Lack of participation and transparency in risk assessment process, 6) Large variation in assumptions and results, 7) Use of a risk acceptance criteria not adapted to the area of application, 8) Inconsistent application of the ALARP-principle, 9) Challenges of taking societal benefits into account, 10) Difficulties to modify existing areas, and 11) Unverified and uncertain effects of risk reduction measures.

It should be noted that these are limitations and challenges that has been imminent in the studies that form the basis for this paper. However, this doesn't mean all these limitations and challenges are present in all Swedish risk-based LUP processes. But in the cases they are present, they give rise to land-use planning processes which are less effective and efficient than they could have been. Even though there has been significant process in the Swedish risk-based LUP during the last decades, there are clear needs to further develop on how risk assessment and risk management are carried out. To come to terms with these challenges there are several possible ways forward. First, given the large variation in the results of the risk assessment, there is a need for increased standardization and harmonization of parameter values, assumptions and models. This is preferably accomplished through developed national guidelines. Secondly, there is a need to add structure to the risk management at the comprehensive planning level in order to ensure holistic and comprehensive treatment of risks. Thirdly, there is a need for establishing neutral arenas to exchange experience and knowledge between actors involved in risk-based land-use planning. Today, there is very little active, critical discussion and reflection concerning the status of the risk-based land-use planning processes. And in those cases where discussions are ongoing this is often done in the context of a particular case which might give rise to polarization rather than more generic discussions about principles, approaches and structure of risk management.

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SURVEY AND DESIGN OF MASTER LEVEL PROGRAMS IN DISASTER RISK MANAGEMENT

Abstract: This paper summarizes the results obtained from performing a semi-structured search to identify the number of Disaster Risk Management (DRM) master level programs (MPs) offered in the western European and Scandinavian countries. The purpose of this activity is to map the external environment in which the EU Erasmus project Knowledge for Resilient Society (K-FORCE) future MP in DRM will be operating as well as to evaluate what program organization and curriculum content the new program preferrably should incorporate.

Key words: Disaster Risk Management, Risk, Resilience, Education, Curriculum Design

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1. INTRODUCTION

This paper is part of an on-going effort to identify the knowledge, skills and competancies that are needed to prepare scientific experts for a future professional life as effective advisers to public and private decision-makers on how to build and maintain a safe, resilient and sustainable society. Basis is taken in a larger study (Nielsen, 2018) that identifies major trends driving the field of risk and an in-depth stakeholder analysis of the public authorities and industrial sectors most actively engaged in commissioning risk assessment and management expertise, who are furthermore the chief recruiters of scientific experts in the various domains of risk (e.g. disaster and emergency management agencies, environmental agencies, construction and infrastructure, transport, energy, food and health sectors).

The present paper is limited to the disaster risk management domain. Section 1 briefly deals with the data sources and data types chosen for investigation. Section 2 summarizes the results of a survey whose purpose was to identify the number of master level programs offered in this knowledge domain in western European and Scandinavian countries and salient characteristics of such programs, including organization and curriculum, breadth and depth of content with regard to the level of specialization or multidisciplinarity and teaching-learning strategies. Section 3 includes a summary of observations from the survey. Based on the survey results, coupled with experiences of the authors from past research and teaching activities spanned by JCSS (2008), Faber and Stewart (2003), Faber (2011), Faber et al. (2014), Faber et al. (2017), Nielsen et al. (2015), Faber (2009) and MAS NATHAZ (2009), Section 4 makes a recommendation for a blueprint curriculum of core courses that should comprise the essential knowledge base of a master level program in Disaster Risk Management. Finally a short conclusion of the paper is provied in Section 5.

1.1. Data Sources

The sources used to identify the existing MPs were (i) www.masterportal.eu ; (ii) www.masterstudies.com ; (iii) search through individual university websites for Denmark, Sweden and Norway as these countries were almost entirely absent from the searches performed through the first two websites.

1.2. Data Types

The statistics and observations in the present paper follow the organization used collecting the data and include the following categories:

- **Country** offering the program
- **Academic Title** of program
- **Host Department/Faculty**, offering the program
- **Risk Area** and **Risk Type**

- Number of years **Since** the program has been operational
- **Number of students** enrolled
- **Duration** of program in months/years as well as study options such as full and part time, distance learning, etc.
- Tuition **Fee**
- **Admission** requirements
- Program **Description**, including objectives and target audience
- **Content**, including organization and curriculum
- **Teaching/Learning** describing teaching methodology and assessment

2. SUMMARY OF THE RESULTS BY DATA CATEGORY

In what follows, a summary of the results and conclusions is presented according to the data categories.

2.1. Country Example

In total 59 MPs in Western European and Scandinavian countries were identified. The majority of MPs are offered in English, with the exception of 6 MPs offered in the language of the host country. Those are Sweden – 1, Norway – 4 and France – 1, respectively (Fig. 1 MPs by host country).

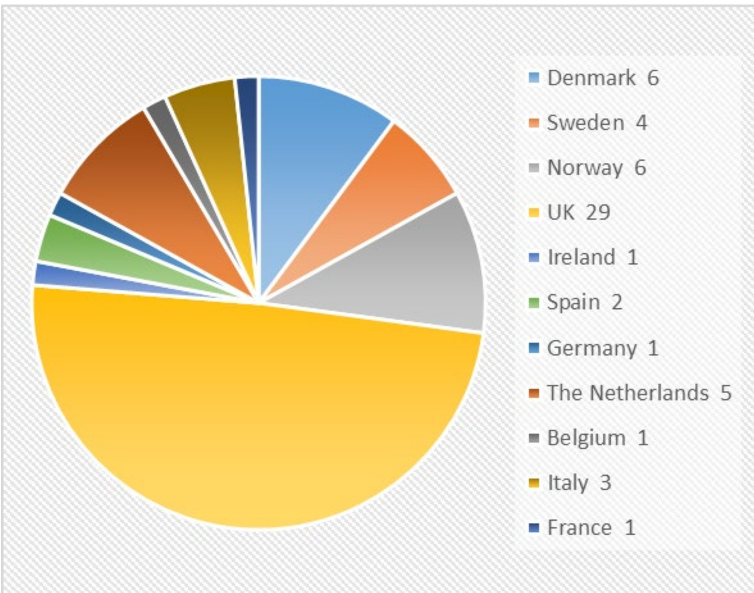

Figure 1 - MPs by host country

2.2. Qualifying Degree

By far the largest number of MPs are offered as Master of Science (MSc) programs. Several are offered as Master of Technology (MTec) and unspecified Master. A small number is offered as Master of Arts (MA). The category 'Other' refers to programs, where the student has an option to exit the program after a certain number of credits with a Post Graduate Certificate (PGCert) or Post Graduate Diploma (PGDip). In those latter cases, the programs seem intentionally geared toward working professionals and/or mature students, and are often delivered through distance learning. The PGCert and PGDip options are only offered in the UK (Fig. 2 MPs by academic title).

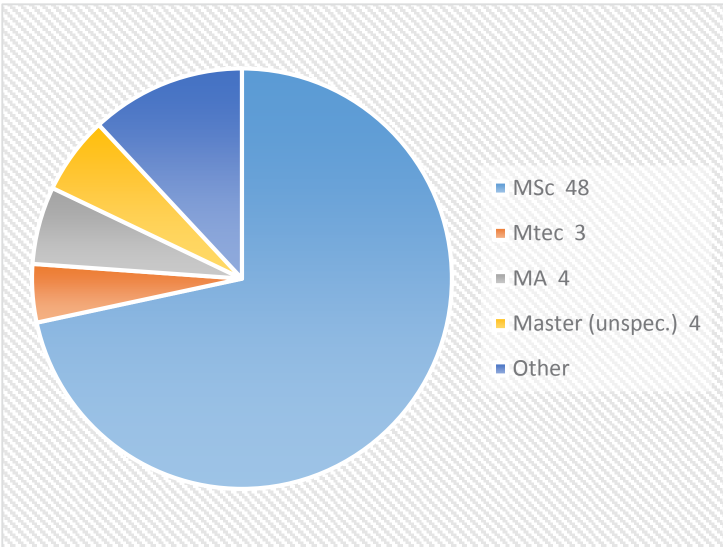

Figure 2 - MPs by qualifying degree

2.3. Hosting Departments/Faculties

The majority of MPs are quite evenly distributed among three main faculties: Civil Engineering, Earth/Geosciences and Social Sciences. Other relevant faculties include Business & Economics and Health Sciences (Fig. 3 Distribution of MPs by host department/faculty).

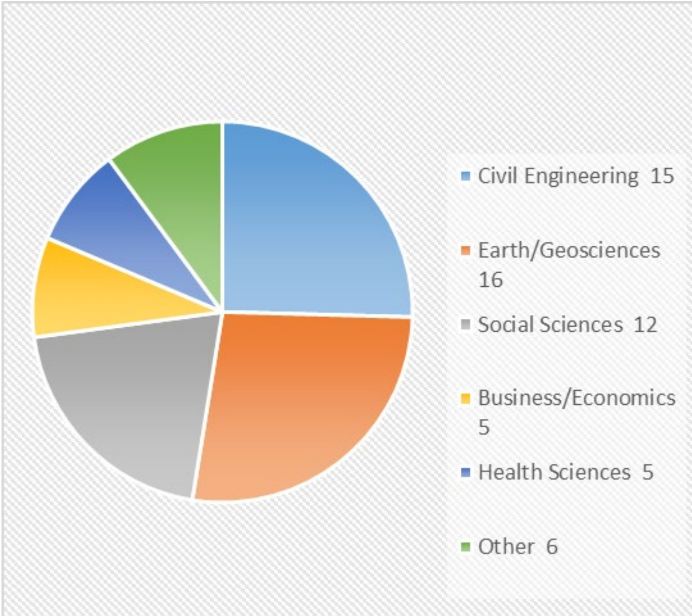

Figure 3 - MPs by host department/faculty

2.4. Risk Areas/Risk Types

In the context of Disaster Risk Management and Fire Safety, the following risk areas/types were identified as relevant: natural hazards, reliability and safety engineering, disaster and emergency management, and fire risk. It must be noted that no program was identified which combined disaster risk management and fire risk. The few programs dedicated explicitly to fire risk are offered through civil engineering departments.

A significant number of programs falling under the category 'Disaster and Emergency Management' include programs exclusively dedicated to health issues (physical and psychological) in the aftermath of disasters.

Fig. 4 illustrates the different risk areas/risk types that are considered relevant in the context of disaster risk management and fire safety.

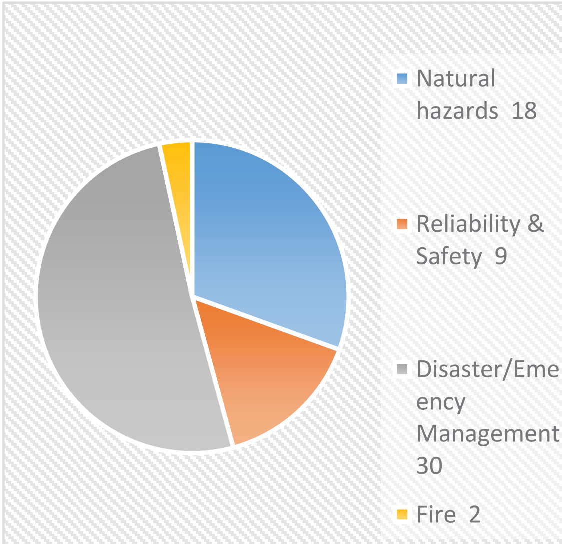

Figure 4 - MPs by risk areas/types

2.5. Program Initiation

Very few websites have information on when a program was established. However, many state that this is a "new" program. It appears that the majority of programs have been running for less than 5 years. An exception to this are traditional MSc programs rooted in civil/geotechnical/environmental engineering, which clearly have a long history of operation.

2.6. Number of Students

Very few websites mention the number of students. Of those that do, the typical number is 12-15. Several programs mention a limit to 25-30 students.

2.7. Duration

Programs duration is between 1-2 years full time, 2-4 years part time, and in the case of e-learning or individual modules open to professionals, the time can vary from individual semester modules to multiple semesters.

The majority of programs on disaster/emergency risk management are 1 year full time. Many of them include a field trip (typically 1-2 weeks in between semesters) or a promise of some NGO or international organization internship. Almost all the e-learning programs are programs in the area of disaster/emergency management.

The majority of programs offered in the context of reliability engineering and physical hazard modeling are 2 years full time and are typically offered as traditional classroom-based programs.

2.8. Tuition Fees

Home students and EU students usually pay no tuition fee in EU countries and Norway. The Master of Disaster Management at Copenhagen University is an exception. It charges the same tuition for Danish/EU students and overseas students. In general, for non-EU overseas students the cost varies between EUR 10,000 – 20,000 per year.

In the UK, the average yearly tuition for UK/EU students is +/- £ 10,000; for overseas students - £ 20,000.

In many cases, non-EU students are only allowed to pursue full time studies. In Norway, while tuition is free for all students regardless of origin, non-EU students must provide legal proof of being able to support themselves in Norway, amounting to a minimum annual income/support around NKK 100,000.

Distance/e-learning programs tend to be the same price for all students (with a few exceptions) and the tuition fees are much lower.

In the case where professionals are allowed to take individual modules, there are individual prices per module. The price goes up depending on the number of credits the student gets for the course.

2.9. Admission Requirements

It is difficult to estimate how competitive the admission to a program is since most institutions describe themselves as competitive and follow a more or less standard admission’s criteria of an above average Grade Point Average (GPA) from a bachelor degree and a completely standard English test requirement. Almost all institutions state that they will consider candidates with other qualifications or experience on an individual basis.

Those programs embedded in more traditional engineering departments, require an engineering degree.

Programs, which focus on disaster risk or where risk management instead of risk assessment is typically taught, admit just about everyone: Natural Sciences, Social Sciences, Health and Life sciences, and Business and Economics. No one explicitly mentions students with a Humanities qualification, however, it is uncertain to what extent a distinction is being made between Social Sciences and Humanities.

A handful of programs require university level calculus or advanced calculus with above average GPA as a prerequisite. None of the programs have a prerequisite for non social science students, i.e. for engineers, in basic theory or methodology in social science.

The standard English requirements are: IELTS 6.5; TOEFL (paper) 560, (digital) 88; Cambridge CAE, CPE (passing grades).

2.10. Description/Objectives

The description of the programs typically identify the program's aims, target group, specific risk specialization (or emphasis on multidisciplinary, all inclusive approach) and typical skills the student will possess at the end of program.

2.11. Content/Organization

The typical organization of a full time 2 year program is as follows:

- Semester 1 – Introductory and theoretical basis courses obligatory for all students (typically 4 modules per semester)
- Semester 2 – Methodological courses and some electives
- Semester 3 – Advanced methodological courses and some electives. In many cases, also a group project.
- Semester 4 – Master thesis

There is a clear distinction between programs that focus on the modeling of natural hazards and reliability in the context of Civil Engineering on one hand, and between programs focusing on disaster and emergency management on the other hand. The main distinction is that while the former primarily utilize quantitative methodologies and stem from the traditional disciplines of natural sciences (e.g. physical geography) and applied engineering sciences, the latter are typically qualitative or semi-quantitative and stem from the social sciences (e.g. sociology, public governance, international relations, development studies, health, etc.). A large number of the programs specializing in disaster/emergency management appear less academic, but rather more oriented towards training professionals for field work. Such programs are typically tied to national civil protection departments or international organizations and NGOs.

The Natural Hazards specialization largely concerns geotechnical and hydrological hazards. The main focus of such programs is on the physical processes and the physical exposure modelling of the hazards and much less, if at all, on risk assessment. Most programs include a crash GIS course. Consequence modelling, including any economic models for optimization and decision support are almost entirely absent in the curricula. Occasionally, a few courses are offered in the form of electives related to risk management or risk/science communication, or governance.

The Reliability Engineering specialization focuses on risks in the extraction (energy, raw material, etc.), process and transport industries. As such, it is not always fully relevant for the context of disaster risk management. Most of these programs have a strong emphasis on quantitative risk assessment based on applied statistics and probability. Surprisingly, almost none of the programs in the Reliability Engineering category have a module on Consequence Modelling. Similarly, principles of decision theory and optimization are almost entirely lacking.

No programs in either the natural hazards or the reliability specializations even remotely approach the topic of sustainability in the context of quantitative sustainability assessment. Only NTNU in Norway offers an elective module on Life Cycle Assessment.

Programs focusing on fire risk are offered through civil engineering departments in the context of reliability and safety engineering.

Table 1 outlines typical curricula for the specializations natural hazards and reliability engineering.

Table 1 – Typical curricula in specializations on natural hazards and reliability engineering.

Specialization Natural Hazards	Specialization Reliability Engineering
Physical Hazards Processes	Introduction to Risk (theory, processes, analysis)
Physical Hazards Modelling (heavy emphasis)	Risk Assessment (processes and methodologies)
Risk Assessment/Risk Analysis (less emphasis)	Risk Management (mostly maintenance, project management)
Usually an introductory GIS/Remote sensing course	Applied Statistics/Probability Theory
Very rarely anything related to Risk Management, Impacts or Consequences (in the form of an elective)	2-3 modules related to specialization (e.g. off-shore structures, subsea production systems, transport systems, etc.) – typically offered as electives
Very rarely anything related to Communication/Governance (in the form of an elective)	Risk Communication/Governance – typically offered as electives
	Safety courses typically offered as electives, e.g. Human Error/Behavior, HAZOP, Safety in Nuclear Operations, Process Safety in Oil and Gas, Process Safety in Pharmaceutical, Food and Consumer Products

A triad of related specializations in the context of disaster risk management include Disaster/Crisis Management, Health in the context of disasters and Security risk. These programs apply largely qualitative methods and typically focus on processes and procedures in the domain of risk management rather than risk assessment. Qualitative descriptive methods and descriptive statistics are used to refer to risk assessment conclusions. Table 2 outlines typical curricula for this triad.

Table 2 – Typical curricula for the triad disaster/crisis manageemnt, disaster health and security risk.

Disaster/Crisis Management	Security Risk	Health (in disasters)
Disaster Risk – Theory to Practice	Security Studies & Strategy	Risk, Vulnerability & Resilience
Preparedness and Response	Political Risk Analysis	Health Systems & Markets
Disaster Recovery, Planning & Development	Security Risk Management	Community Approaches to Health
Vulnerability & Risk Management Methods	Intelligence	Ethics, Human Rights & Health
Health in Emergencies	Knowledge Production & Evaluation	Disaster and Crisis Management
Water Supply and Sanitation in Emergencies	Organizational Management & Leadership	Management & Leadership in Health
Shelter & Settlements in Emergencies		Disease and Trauma in Developing Countries
Ethics & Religion in Disasters		Global Burden of Disease
GIS for Disaster Management		Research Methods in Global Health

2.12. Teaching/Learning

The information in this category refers to any particular teaching, learning and assessment methods applied in the program. While few programs mention explicitly the Problem Based Learning (PBL) method, many in fact seem to practice it to smaller or bigger extent. In almost all programs some combination of traditional lectures, individual research and project group work is described. Many programs promise the students direct access to industry or government/international organizations in the form of internships, or project/thesis work supported by partner institutions or companies. Most programs in the natural hazards domain (both quantitative and qualitative) offer field trips to hazard areas or areas struck by disasters as a complementary practical experience (cost for such trips is additional to the tuition).

Assessment is typically in the form of written assignments, oral presentations of individual and project work, and a final master thesis. Formal examinations seem rare. In a small number of programs, assessment for individual modules is carried out by academic staff external to the program.

3. SUMMARY OF OBSERVATIONS

Table 3 summarizes the observations and conclusions drawn as a result of the scanning of the operational education environment for MPs in disaster risk management and fire safety at the level of western European and Scandinavian countries.

Table 3 – Summary of observations and conclusions from a scanning of operational educational environments in DRM and FS for European and Scandinavian countries.

There has been a boom in educational programs on risk over the past 5 years – not many of them academically strong.
Many programs are offered at newer and/or less established universities (in the case of the UK – former polytechnics) or professional colleges, with the exception of programs rooted in older civil engineering departments.
Programs where risk is explicit in the title are typically in English and have a strong international student component; traditional disciplines where risk is implicit in the title or course of study tend to be geared toward domestic students and are taught in the country's mother tongue.
Notions such as 'risk', 'disaster', 'resilience' are highly fashionable and attract a wide range of students. There appear to be many universities taking advantage of this fashion and offering a range of questionable quality programs at exorbitant fees for international, but in some cases, also local students.
Reputation of academic institution does not equate with quality of program (e.g. UCL in the UK).
Many of the programs with specialization in disaster/emergency management are geared toward working professionals and/or mature students.

Many of the programs with specialization in disaster/emergency management are offered through distance learning or a combination of classroom and distance learning.
Many of the programs, and especially those offered in the UK, appear expensive.
In the case of programs specializing in disaster/emergency management, the orientation and focus are almost never on the country hosting the program but on developing countries in an international context.
Division between qualitative and quantitative programs is clear between programs offered through the natural sciences and engineering departments and those offered through social science departments. There seems to be no attempt made in any of the programs to harmonize these differences through a better balanced curriculum.
Division between risk assessment and risk management remains strong in perception, in practice and in education. It is the same division as that between the utilized quantitative vs. qualitative methodologies.
The humanities are entirely absent from the risk research and education domain.
Many programs lack a "red thread" or cohesion in their purpose and delivery.
The majority of programs lack a decision support component – critical for programs offered in the applied sciences.
Risk perception courses are almost never offered.
Socio-economic methods for risk acceptance criteria are almost never part of curriculum.
No program links risk assessment with quantitative sustainability assessment.
Consequence modelling is almost entirely absent from the curricula.

4. RECOMMENDATIONS FOR K-FORCE CURRICULUM DESIGN FOR A MASTER LEVEL PROGRAM IN DISASTER RISK MANAGEMENT

The traditional division of higher level educational programs in disaster risk management into programs offered by either applied Engineering departments and Social Science departments is inadequate to address the effective management of risks in an increasingly inter-connected and complex society not only because of the constantly evolving nature of the risks themselves but also in view of how even simple threats can cascade across social-ecological systems with deletarious effects as well as the need to accommodate for the varying perspectives of the cost and benefits of risks of multiple stakeholders and at various societal scales. While most international and national risk management frameworks advocate an integrated risk management approach, the reality at the level of educating risk managers is far from achieving such desired integration as the results in our survey show.

A detailed learning design is out of the scope of the present paper, however, some basic foundational requirements are listed, together with a curriculum outline of core subjects, which could then be expanded according to specifications from individual institutions. We advocate a holistic, multi-disciplinary design for educational activities in the area of disaster risk management. We emphasize that risk management before, during and after an adverse event should be regarded as a discipline in its own right rather than a sub-specialization in Engineering or Social Science. We see a need to educate and develop a cadre of professionals equipped to manage risk at all three stages. Professionalization would entail the identification of a body of knowledge relevant to the field of risk (e.g. decision theory, (Bayesian) statistics and probability theory, systems theory, ecological economics, sustainability and resilience science, together with relevant methodologies from the natural, engineering and social sciences. Furthermore, the learning design must include core skills, competancies and standards for teaching, learning and assessment processes alike that are formed of a sythesis of theory and praxis. We see in this context the Problem Based Learning methodology as particularly viable for the discipline of risk. Finally, a professionalization of the field must also address the issue of regulative epistemology through developing a code of ethics and an educational strategy for incorporating the intellectual virtues that society might expect from a scientific expert in the field of risk management.

We propose that a two-year master level program in disaster risk management, comprising 120 ECTS should consist of three semesters of theoretical and practical courses and one semester dedicated to a master thesis project. Following the PBL method, we suggest that each of the first three semesters is composed of three theoretical courses and a project course . The theoretical courses should provide the theories and methods necessary to carry out the activity in the project course. The proposed courses should be understood as the essential knowledge that should be incorporated in a curriculum for Disaster Risk Management. Elective courses could be introduced as a means of offering the students the possibility of further specialization, e.g. elective courses on particular hazards (flood, fire, etc.), more in-depth courses on either strategic (e.g. risk governance, sustainability and resilience), operational (e.g. protection and prevention measures, decision analysis) or tactical (emergency response and recovery) aspects of risk management. The last semester master thesis project further enables such specialization.

	Semester 1	
Course Title	**Thematic Content**	**Course Type**
Risk Governance	• Introduction to the Western understanding of nature and the environment and man's role in them • Ethics, Normative Imperatives, Utility and Distributive Justice issues in risk management • Risk Management codes, guidelines, best practices • National and international policies and frameworks for disaster risk management • Risk insurance	Theories & methods
Statistics & Probability Theory	• Mathematical building stones for understanding, analyzing and modeling temporally and spatiall varying uncertain (natural) phenomena • Frequentistic, classical, Bayesian interpreations of probability • Descriptive statistics & use of statistics in the social sciences	Theories & methods
Hazard Processes	• Qualitative introduction to natural hazards processes (incl. basic cause-effect, measurements, monitoring and prediction models) and inter-dependencies among them for the following types of hazards: • Meteorological hazards (rain, snow/avalanche, hail, extreme wind) • Hydrological hazards (erosion & runoff, river floods, storm syrges) • Geotechnical/geological hazards (landslides, rockfall, debris flows, rock avalanches) • Seismological/tectonic hazards (earthquakes, tsunamis, volcanic eruptions) • Effect of climate change on hazards (cryosphere hazards: glaciers, permafrost; sea level rise; draughts; salinification)	Theories & methods
Systems Modeling	• Practical application of theory and methods to identify relevant decision problems and contexts, develop a system representation and risk screening for specific context • Collection and treatment of statistical data and spatial information for different types of events	Theories and methods together with project work
	Semester 2	
Risk Assessment	• Probabilistic modeling	Theories

	• Portfolio risk assessment • Bayesian probabilistic nets • Large scale risk assessment based on indicators • Differentiation and modeling of direct and indirect consequences	and methods
Decision Theory	• Prior, posterior and Pre-posterior Bayesian Decision Analysis • Introduction to prospect theory and modeling of preferences • Life safety acceptance criteria and prioritization of options for life safety reduction	Theories and methods
Risk, Resilience and Sustainability	• Complimentarity and tradeoffs between risk, resilience and sustainability goals, theories and methodologies. • Introduction to life cycle assessment (LCA) methods • Introduction to planetary boundaries (PB) and ecological economics	Theories and methods
Consequence Modeling	• Practical application of how to develop probabilistic models for natural hazards as well as models for the quantification of loss of lives, economical losses and damages to the environment • Assessment of direct and indirect consequences as well system changes resulting from perception of consequences	Project work
	Semester 3	
GIS, Data Aquisition, Mapping, Digital Technology, Drones	• Types of sensors suitable for natural hazard monitoring • Geodetic data acquisition (terrestrial and air-borne methods) • Introduction to photogrammetry and optical remote sensings • Introduction to microwave remote sensing and airborne laser scanning • Natural hazards mapping • Database and GIS modeling • Digital monitoring technology • Introduction to the use of drones for DRM	Theories & methods
Risk Perception and Communication	• Cognitive, economic and cultural theories of risk perception • Mathematical information and communication theories in the context of Bayesian Probability Theory • Communication considerations for Type I and Type II	Theories & methods

	Error in warning communication • Operational principles of risk communication before, during and after a disaster event • Stakeholder identification and analysis • Communication between risk analyst and decision-maker (customer) • Communication among experts (peers) • Communication to the general public • Practical guidance on style and different communication media (written textx, presentations, video, etc.)	
Protection and Prevention Measures	• Understand actions (loads, hazards, environmental conditions) and materials (concrete, steel, timber, soil) • Introduction to damages to structures from natural hazards) • Understand interactions between the hazards and the measures • How to select among protection measures, including requirements for spatial, temporal, dimensional information • Engineered levees (stability: seepage, failure, sliding, hydraulic fracture, unsaturated response to cyclic perturbations) • Vegetation barriers (snow, debris, tsunamis) • Net systems and dams (avalanches, debris flows, rock flows, dynamic impact) • Structural systems (galleries, walls, damping methods) • Non-structural protection measures (organizational, land-use, etc.)	Theories & methods
Planning, Preparedness and Early Warning	• Concepts and strategies for risk reduction, emergency planning, response and information managementLand use planning and management as a tool for risk reduction • Planning of measures within an integrative risk management framework • Technical aspects of early warning systems • Principles of people-centred early warning systems • Warning Communication • Case study planning, preparedness & EW for specific hazard and location chosen by student group.	Theories and methods together with project work
	Semester 4	
	Master thesis	

5. CONCLUSIONS

The present paper reports on a survey of existing Master Programmes (MPs) in disatsrer risk management.. A total of 11countries from Europe and Scandinavia were included in the survey. It is found that 59 MPs are presently being offered of which more than 50% in the UK. The vast majority of the MPs qualify for the degree Master of Sciences (MSc) with only a few exceptions including Master of Technology (MTec), an unspecified Master and Master of Arts (MA). Equally around 75% of the programs are offered by earth- and geosciences, civil engineering and social sciences departments. It is a common characteristic that most programs focus on natural hazards and related disaster risk management, emergency interventions and relief,

Among the observations from the survey it appears that there is a general lack of a clear methodical „red thread“ in the offered programs. This points to an unfortunate but common tendency that designs of educational program only too often are shaped by the available teachers, their academic background and their individual teaching experiences and interests rather than a consistently thought through scientific and didactic idea. The lack of apparent rigor in the program designs together with the considerable number of offered programs further points to a tendency that educational programs in disaster risk management have become a trendy business case for higher educational institutions. In light of the possibilities associated with ICT in education and learning as well as the globalization and networking capacities of the professionals and academics in higher education it would appear that these unfortunate tendencies are not necessary. Joint international projects such as the present K-FORCE Erasmus+ project provide excellent platforms to show the way in this regard for future collaborative educational programs in disaster risk management. To this end, without considering the limitations of a-priori available resources and inclinations between project partners in the end of the present paper we have sketched a blue print of a program, which from a scientific and didactical perspective, bears great potential for adaptation in the K-FORCE project.

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DISASTER RISK ASSESSMENT IN SERBIA – METHODOLOGY DEVELOPMENT

Abstract: Serbia is exposed to multiple types of natural hazards, including floods, droughts, earthquakes, and landslides. The disaster losses have high immediate and long-lasting impacts on people, livelihoods, local and national economies, as well as the government's budget. Establishment of methodology is crucial for building the resilience of the country and minimizing the negative impact of natural disasters on Serbia's economic growth. In 2017, the natural and other disaster risk assessment methodology has been adopted in Serbia, with the aim to improve country preparedness to the possible natural and man-made hazards. Paper provides the short description of the methodology and brief comparative analysis of improved and previous risk assessment methodology.

Key words: methodology, hazard, risk, assessment

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1. INTRODUCTION

In the last decades, methods of risk assessment have been developed and tested within the framework of risk analysis. Risk varies for different types of hazards (floods, landslides, earthquakes, tsunamis, etc.), due to process characteristics (generation mode, intensity, area affected, population). An additional factor that must be considered in risk assessment is the target of analysis such as: buildings with vulnerable groups of people, population, activities and processes that may be differently affected by hazardous phenomena [1]. In addition, risk assessment requires accurate recording of previous disasters and in particular the associated losses.

Serbia is exposed to multiple types of natural hazards, including floods, droughts, earthquakes, and landslides. The losses from these disasters have high immediate and long-lasting impacts on people, livelihoods, local and national economies, as well as the government’s budget [2]. In recent years, the country has been severely affected by disasters and has suffered widespread damage from earthquakes, in particular in 1999 and 2010. An estimated 30 percent of the country area is at risk of landslides. The total damage caused by drought is estimated at $500 million per year (1.4 percent of current GDP), and flooding is a recurring event across the country.

Preparation of certain strategy or methodology in order to respond to disasters is crucial for building the resilience of the country and minimizing the negative impact of hazards on Serbia’s economic growth.

First version of hazard risk assessment methodology was adopted in Serbia in 2012 [3] with the basic idea for the implementation of a more proactive disaster management plan. Large number of risk assessments has not been performed, including risk assessments of the Republic of Serbia and the Autonomous Province of Vojvodina, as the country lacked sources and experts in the field of hazard risk assessments [4]. Methodology was improved in 2017, in order to overcome the prior problems and obstacles in the risk assessment process. Advantages of the improved hazard risk assessment methodology are briefly described in the following.

2. HAZARD RISK ASSESSMENT IN SERBIA

The Law on Emergency Situations [5] requires that local authorities, through their bodies, prepare and adopt risk assessment for their territory. Ministries, administrative bodies within ministries, the Republic Hydro meteorological Institute and other organizations develop risk assessment of the Republic of Serbia in the field of expertise. These institutes also make their own assessments and plans for protection and rescue.

According to the Law, following organizations are obliged to conduct risk assessment:

- companies, other legal entities, entrepreneurs and other organizations,
- local self-government bodies,
- autonomous province,
- state administrative bodies [6].

Based on the risk assessment methodology, following should be performed:

- register all potential hazards on the territory,
- perform risk analysis,
- calculate the level of risk and propose risk treatment and improvement and implementation of protection measures [7].

2.1. Protected values

The assessment defines the all hazard types effects on the following protected values (Table 1):

- Life and health of people;
- Economics/ecology;
- Social stability.

Table 1- Protected values

Protected values	Criteria
Life and health of people	The total number of people affected by some process (dead, injured, sick, evacuated, displaced-others without an apartment/house, sheltered)
Economics/ecology	Total material damage
Social stability	Total material damage on facilities and critical infrastructure

2.2. Hazard types

When assessing risk on the territory, it is necessary to identify and analyse following hazard types:

Natural hazards (NH):

- NH-1 Earthquakes;
- NH-2 Landslides and erosion;
- NH-3 Floods;
- NH-4 Extreme weather events (high precipitation, storm wind, snow, warm waves, cold waves, drought);
- NH-5 Water shortage;
- NH-6 Epidemics and pandemics;
- NH-7 Plant diseases;
- NH-8 Animal diseases.

Technical and technological hazards (TTH):

- TTH-1 Fire and explosion, wild fires;
- TTH-2 Technical and technological accidents;
- TTH-3 Nuclear or radiological accidents;
- TTH-4 Terrorist attack.

2.3. Risk analysis: Comparative analysis of previous and new methodology

Risk analysis should be performed for each hazard type, consequences level and probability level are to be determined, and the risk level calculated.

National risk assessment requires data from many different sources, which is the challenge in terms of data traceability, reliability and proper documentation. It is therefore important that data sources are available and reliable. Previous version of risk assessment methodology relied on the historical data and information about previous hazards. These databases are still in the process of preparation in Republic of Serbia. Consequently, a number of assumptions and estimations are used in risk assessment process. Based on the new Law draft [8], risk register will be created as IT-based, geographic information database for the entire Serbian territory.

The improved methodology envisage three different approaches in assessing the probability of events: a) expert assessment (Qualitative), b) probability prediction (relates to the events with harmful consequences), c) previous events (Frequency). The choice depends on the availability of previous records, data, resources and expert's judgment. This approach makes available the probability level determination even if historical data are missing. Experts' opinions considerably influence the risk assessment process. They identify new risks, develop scenarios, analyse and rank impacts and likelihoods, and assess the effects of prevention and mitigation measures. The selection of experts and their roles should therefore be carefully considered.

The risk categories are described in Table 2.

Table 2- Risk levels

(red)	Very high	Unacceptable	A very high and high risk level requires risk treatment to reduce the level to acceptible level. A moderate risk may demand taking some actions. Low risk demands no action.
(orange)	High	Unacceptable	
(yellow)	Moderate	Acceptable	
(green)	Low	Acceptable	

2.4. Risk matrix

Once risks are analysed and risk levels determined, it becomes possible to create risk matrix as the risk assessment output. A risk matrix, relating the two dimension probability and consequences, is a graphical representation of different risks in a comparative way. Risk matrix is used for risks' identification, prioritization and quantification (at a macro level).

Improved methodology proposes comparison of risk analysis results of each hazard type and their presentation in a risk matrix (Figure 1). In this example, four hazard types were identified and risk analysis were performed. Risk level for fire and explosion hazard was determined as very high, landslide - high, technical and technological accident - moderate and flood - low level.

This means that fire and explosion risk levels, as well as landslide risk level, are unacceptable and preventive / protection measures for the risk treatment are necessary to be implemented. Technical and technological accidents' and flood risks are in the group of acceptable risks and no additional actions are required.

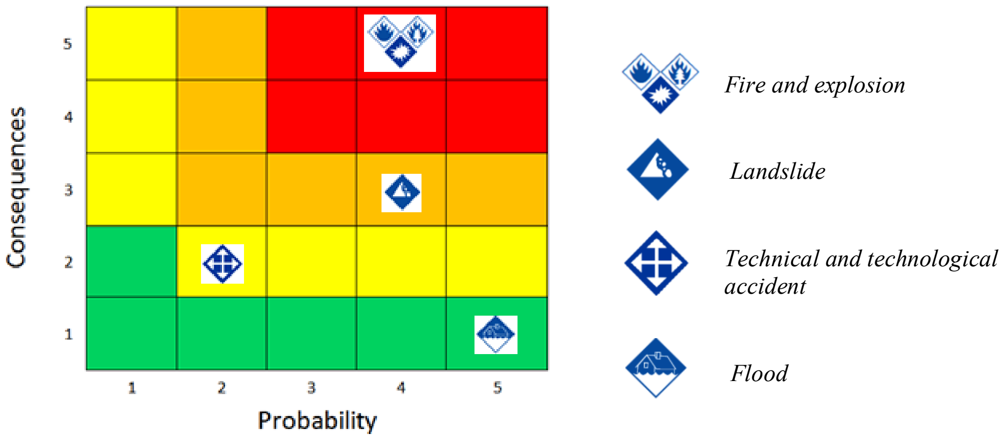

Figure 1 – Integrated risk assessment

3. PROTECTION AND RESCUE PLANS

Companies and other legal entities in the field of health, field of education, and other entities, local governments, the province and the republic are obliged to design protection and rescue plan according to the risk assessment methodology.

The goals of the Protection and Rescue Plans is to precise the tasks for protection and rescue teams, plan and organize resources / capacities engagement and harmonize foreseen activities in implementation process. Protection and Rescue Plans are to be created according to the Law on Emergency Situations and the Methodology. Plans are based on risk assessments and on available capacity and protection and rescue capabilities at all levels. The national Protection and Rescue Plan, Protection and Rescue Plan of autonomous provinces, administrative districts, city of Belgrade and municipalities contain following plans:

1) Monitoring, early warning, informing and alerting plan;

2) Emergency preparedness plan for emergency situations;

3) Mobilization plan - activation of protection and rescue units;

4) Protection and rescue plan for each hazard type;

5) Civil protection – preventive measures and tasks plan;

6) Protection and rescue units activation plan;

7) Public information plan;

8) Risk mitigation plan.

An integral part of the improved methodology is complete manual (guidelines and forms) for the protection and rescue plans design, which was not provided in the previous version of the methodology. The risk assessment results and protection and rescue plans are to be presented in provided guidelines and forms, so the results would be comparable. The main purpose of these guidelines is to improve coherence and consistency of the data in prevention, preparedness and planning stages in each municipality. It will facilitate and accelerate the risk assessment and mitigation plans development at all the state administration levels.

4. CONCLUSIONS

In recent years, Serbia has taken important steps, moving from an reactive response to proactively managing and reducing the risk from disasters. The most important one is the establishment of the hazard risk assessment methodology in 2017. The purpose of the methodology is to improve the country preparedness to the possible hazards by identifying risks, calculating risk levels and creation / implementation the necessary measures for risk reduction.

The new version of methodology is improved, compared with the previous version, regarding more practical approach in risk analysis. Risk level calculation is based on available data on previous hazards, as well as on expertizes assessment. Expert teams play the crucial role to identify new risks, develop scenarios, analyse probabilities and possible impacts.

Methodology provides complete guidelines and forms for the Protection and Rescue Plans development. These guidelines improve coherence and consistency among the protection and rescue plans of companies and municipalities in the prevention, preparedness and planning stages. The improved risk assessment methodology increases the efficiency of natural and man-made risk management in Serbia. The precondition for development the society resilient to hazard is to provide the competent, skilled experts and knowledge based strategy applicable for companies and local communities exposed to risks.

5. ACKNOWLEDGEMENTS

The paper presents the part of research realized within the project “Improvement of educational process and theoretical and applied research in civil engineering” conducted by the Department of Civil Engineering and Geodesy, Faculty of Technical Sciences, University of Novi Sad.

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PRELIMINARY SEISMIC RISK ASSESSMENT FOR THE CITY OF SKOPJE, R.M.

Abstract: A rapid seismic risk assessment method is proposed for the City of Skopje consisting of three input components: seismic hazard, inventory of building stock and vulnerability model based on fragility curves, which correlate damage directly to the input spectral acceleration. The building stock was simulated with 120,000 reinforced concrete and masonry buildings with a total replacement cost of \$47.45 billion. Hypothetical earthquake scenarios with M6.1 (downtown) and M7.2 (30 km from downtown) generated economic losses of \$3.54B and \$0.86B, respectively. The expected losses from probabilistic seismic scenarios ranged from \$0.34 billion (1/100yrs) to \$11.5 billion (1/10,000yrs). The maximum annual economic loss was \$4.51M/yr for a return period of 1/250yrs.

Key words: seismic hazard, risk assessment, fragility curve, building inventory, economic

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1. INTRODUCTION

The metropolitan region of Skopje is located in a vast NW-SE trending depression bounded by the Vodno Mountain to the south and the Crna Gora Mountain range to the north (Fig. 1). The densely urbanized core is approximately 15 km long with a width varying between 5 and 10 km. According to the last 2002 census, there were about 507,000 inhabitants, but it is believed that nowadays the population approaches 600,000 inhabitants.

The study area belongs to the Vardar seizmic zone, which is most active in its northern part toward borders with Kosovo and Serbia. In the region, seismically most active are the Peshkopi-Debar-Ohrid-Korcë seismic zone along the Albanian border and Berovo-Pehcevo-Valandovo seismic zone along the borders with Bulgaria and Greece (Daskalov 2011). Both zones, distanced approximately 100 km from downtown Skopje, were the sources of large earthquakes in the last century with maximum estimated magnitudes of M7.0-7.5. The Skopje region itself represents a local seismic zone with known capacity to generate relatively shallow M6.0-6.5 earthquakes. One of the strongest historic earthquakes to hit the region occurred in 518 AD and destroyed the Roman city of Scupi located in today's neighborhood of Zlokukani, near the confluence of the Lepenec and Vardar rivers (Fig. 1). Ottoman records from 1555 incorporate mention of a strong earthquake east of Skopje with estimated MMI shaking intensity of XII and devastating impacts to city's structures (WDC-SEG 1992). More recently, the 1963 M6.1 earthquake caused enormous damage to Skopje and the surrounding area. The fault zone was approximately 5 to 7 km deep extending from the Zlokukani neighborhood toward downtown Skopje. The observed losses include about 15,800 extensively damaged and collapsed dwellings and 28,000 slightly to moderately damaged dwellings. Human losses were also high with over 4,000 injured people and 1070 fatalities. The economic losses were estimated to 15% of the 1963 Yugoslav GDP, or $3-5 billion in today's US dollar value (www.igeografija.mk/Portal/?p=4239).

The regional seismic hazard was the subject of a number of studies (Arsovski and Petkovski 1975, Jancevski 1997, Daskalov 2011, Salic 2015). The conducted literature survey indicates that there is a considerably knowledge on the earthquake hazard, however, information about the potential physical impacts to the population and built environment is practically inexistent. Skopje has been affected by strong earthquake events in the past and, if not adequately addressed, the loss of life and property during future disastrous events can be enormous. The conventional scientific knowledge of the seismic hazard alone, such as type, intensity and frequency, is not sufficient for informed decision-making. Mitigation, preparedness and emergency response measures need to be tailored with respect to the expected hazard, people and infrastructure at risk and respective vulnerabilities (Nastev et al 2017).

The primary motivation of this paper is to fill the current knowledge gap by analysing potential seismic losses at urban scale for the City of Skopje. To attain the objective and to meet the pressing need of municipal emergency managers to perform multi-hazard risk assessment, a relatively simple method for evaluation of seismic losses is proposed and validated. The presented analyses involve the following basic steps: (i) estimation of site specific earthquake motion parameters combining the current seismic hazard, ground motion prediction equation (GMPE) and local site effects, (ii) model of the existing building stock, and (iii) vulnerability analysis based on fragility functions which correlate directly the intensity of the seismic shaking to the probability of exceedance of a specified damage state. The respective economic losses were computed applying mean damage factors.

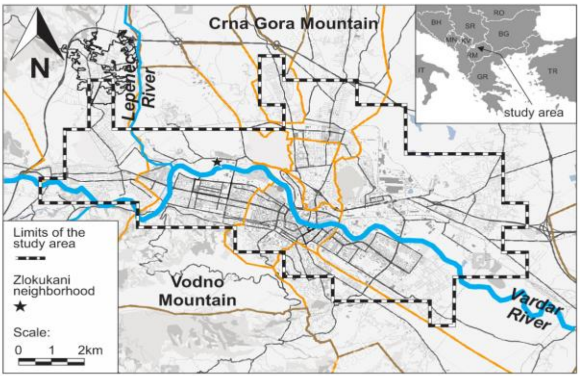

Figure 1 – Study Area

2. SEISMIC HAZARD

Local geological conditions can significantly affect the amplitude and frequency content of incoming seismic waves. This may result in considerable short-distance spatial variations of the intensity of ground shaking and associated damage. The U.S. National Earthquake Hazard Reduction Program guidelines and the Eurocode EN-1998 suggest local site amplification as function of the travel-time weighted shear wave velocity of the top 30 m, VS30 (NEHRP 1994, CEN 2004). Shear wave velocity dependent amplification is also commonly employed in modern ground motion prediction equations GMPE (Akkar and Boomer 2010). The ongoing geophysical and geotechnical measurements in the Skopje plain indicate VS30 values mainly in the range of 360<VS30<800 m/s, deposits of very dense sand, gravel, or very stiff clay (CEN 2004, Gjeorgjievska 2017). In the absence of extensive field measurements and appropriate geotechnical models, the VS30 mapping method proposed by Allen and Wald (2007) was combined with field measurements. Fig. 2 shows the proposed site class map. It can be observed that dense stiff soils cover the relatively flat plane, where rock site conditions are exclusive to the steep foothills, areas where Neogene units crop out.

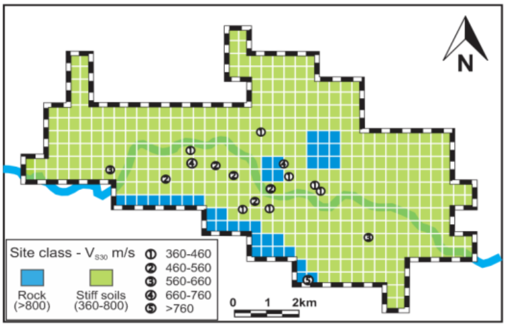

Figure 2. Site class map with V_{S30} field data. Soil type definitons are from Eurocode EN-1998.

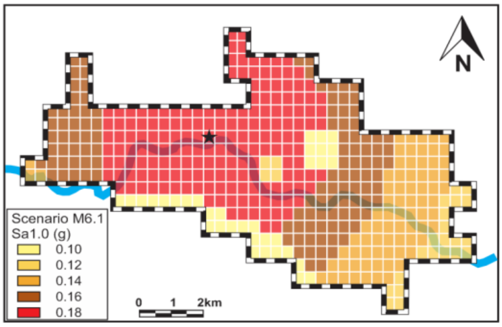

Figure 3. Sa1.0 distribution, for scenario M6.1 (epicenter indicated with star symbol).

For this preliminary study, it was decided to simulate two hypothetical what-if scenarios: a close moderate earthquake and a distant large earthquake, both capable to generate considerable damage to man-made structures in Skopje. The first considered scenario represents a replica of the occurred 1963 M6.1 earthquake with a local epicenter within the Skopje city limits. For the second scenario, M7.2 was selected with an epicenter located just outside of Kumanovo, approximately 30 km northeast from downtown Skopje. Ground motion parameters were generated applying the empirical AB10 GMPE (Akkar and Boomer 2010). This attenuation equation was developed based on a database of strong-motion records from Europe, the Mediterranean region, and the Middle East. It considers simple fault geometry (point source) combined with strike-slip mechanisms. The obtained spatial distribution of the expected Sa1.0 across the study area for M6.1 is given in Fig. 3.

Next, a series of scenarios was generated based on the recent new generation probabilistic seismic hazard analysis PSHA (Salic 2015). Four GMPEs compatible with active tectonic regions were applied in the PSHA analyses (gridded seismicity model M1), among which AB10 fits well with the median estimates. Spectral accelerations were computed for return periods of 95, 475, 2475 and 10,000 years (Salic 2015). Herein, other return periods were also considered with spectral values inferred with the best fit curve method: 100, 250, 750, 1500, 2000 and 5000 years.

3. BUILDING TYPES

The second input component in the risk assessment process are the assets at risk, buildings in this case. In general, the minimum information a building inventory for seismic risk analyses should include is the building location, number of storeys, structural material and type, occupancy, content and economic value of structural and non-structural components. As there are no actual building inventories for the study area, the USGS PAGER (Prompt Assessment of Global Earthquakes for Response) models for Eastern European urban and rural municipalities was used (Jaiswal and Wald 2008). In discussion with local engineers and architects, the retained urban model was further upgraded to reflect better the urban environment in Skopje. The final model applied in the analyses consisted of 6 basic generic structural types based on the Hazus classification system (FEMA 2012b): low- and mid-rise ductile reinforced concrete moment frame structure (C1), mid-rise reinforced concrete shear wall structure (C2), low- and mid-rise non-ductile reinforced concrete frame with masonry infill walls (C3) and unreinforced stone or brick masonry buildings (URML). These generic types are each representative of a group of buildings with similar structural properties rather than those of an individual building. The number of buildings was generated by arbitrarily assuming 1 building for each 5 residents, which for approximately 600,000 inhabitants gives 120,000 buildings. Out of this number, 95% of the buildings were assigned with residential occupation (114,000 bldgs.) and 5% with non-residential occupancy (6,000 bldgs). In Fig. 5 is given the retained distribution of the generic building types for residential and non-residential occupancies, together with their heights and design codes. The final assumed building types, occupancy class and replacement costs are given in Table 1(not presented in the paper). The total modelled replacement cost for the 120,000 buildings is approximately $47.45 billion.

4. VULNERABILITY MODELS

Central to the vulnerability analyses at urban scale is the concept of fragility curves, which combine the expected damage of a given building type to a measure of the intensity of the seismic shaking, usually drift response. The seismic vulnerability modelling presented herein was inspired by the standard framework for performance-based engineering (Kircher et al. 1997). Porter (2009) proposed a method for generating fragility curves which correlate damage directly to input spectral accelerations Sa0.3 and Sa1.0 instead of to the maximum displacement response. To further accelerate the damage assessment and decrease the computational effort, the discrete values are fitted with continuous lognormal cumulative probability functions (Abo-El-Ezz et al. 2013). A database was built with pre-developed fragility curves defined in terms of Sa0.3 and Sa1.0, which are considered as structure-independent IM of the seismic shaking. For example, the sets of fragility curves shown in Fig. 4a provides a closed form solution for continuous prediction of probability of damage for C1L-L buildings for Sa1.0 compatible with a given earthquake scenario (magnitude, distance, site class), respectively. In Fig. 6b are given as an example the damage state probabilities for Sa1.0=0.4g.

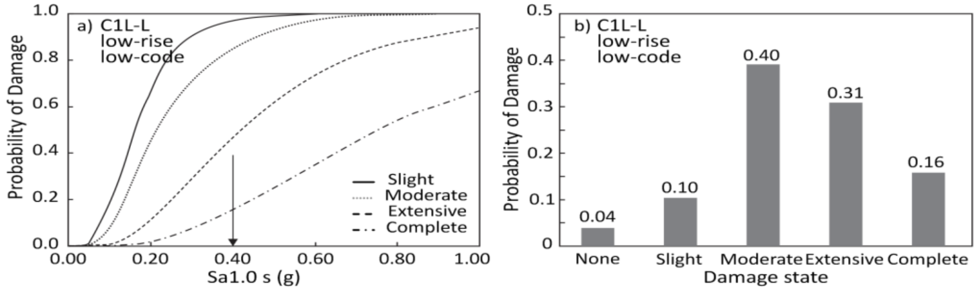

Fig. 4. Examples of closed form fragility curves conditioned to spectral acceleration at a) 0.3 seconds (Sa0.3) for unreinforced masonry buildings URML-P and b) 1 second (Sa1.0) for ductile reinforced concrete moment frame C1L-L. Probability of respective damage states for c) Sa0.3=0.4g for URML-P and d) Sa1.0=0.4g for C1L-L.

The objective of the loss analysis is to correlate the expected structural damage to economic losses due to repair or replacement costs for damaged buildings. This is achieved by applying the so-called damage factors (DF) which correlate the cost of repair for each damage state (i.e. slight, moderate, extensive, and complete) to the replacement cost of the building. Different DFs are proposed for different countries. Herein are applied DFs proposed by Yucemen (2005) for Turkey: 5% for slight damage, 30% for moderate damage, 70% for extensive damage and 100% for complete damage. The loss results for the damage states of the example given in Fig. 4b (C1L-L building) are shown in Fig. 5a. The full MDF function, often referred to as vulnerability function, can then be computed by repeating the same procedure for different Sa1.0 intensities (Fig. 5b).

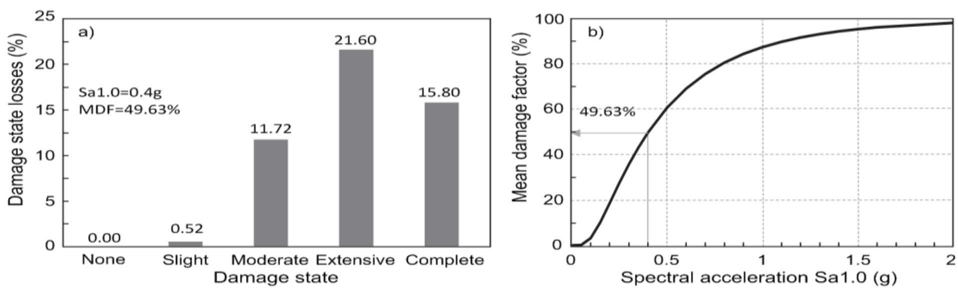

Fig. 5. Example of computation of economic losses as % of the replacement cost for C1L-L building type: a) economic losses for the considered seismic scenario with respect to the damage states, and b) mean damage (vulnerability) function for a full spectrum of Sa1.0 values from M7 scenarios.

5. LOSS ASSESMENT

The vulnerability assessment procedure described in the previous chapter was tested for the retained what-if seismic hazard scenarios M6.1 and M7.2 and the probabilistic scenarios with return periods from 100 through 10,000 years. Sa0.3 and

Sa1.0 for 5% damping were considered as structure independent IMs to represent the seismic demand in the analyses. The assumed building type model for Skopje consisting of 114,000 residential and 6,000 non-residential buildings (Table 2,not presented in the paper) was considered to be uniformly distributed across the study area, i.e., in each of the 434 grid elements there are 258 residential and 14 non-residential buildings. The resulting economic losses to buildings are given in Table 2. It can be observed that the M6.1 earthquake scenario close to downtown Skopje generates considerably higher damage ($3.54B) when compared to the M7.2 scenario distanced about 30 km ($0.86B). In the case of probabilistic scenarios, as expected, gradual increase of the economic loss is observed with the increase of the return period. The probabilistic seismic scenario with probability of exceedance of 1/10,000 years generates economic losses about one quarter of the total replacement cost of the considered buildings

It is now of interest to characterize the earthquake risk through the annualized earthquake loss AEL, which serves as a link between the probability of ground motion and the consequences in terms of economic losses. Fig. 6 depicts the AELs for the 10 probabilistic scenarios. It indicates that frequent smaller earthquakes which result mainly in slight damage have the potential to generate higher yearly losses than infrequent but larger magnitude earthquakes. For example, the ground motion with probability of exceedance of 1/2475 year (2% in 50 years), which is generally considered to provide adequate level of safety in building design, the analysis yields an AEL of about $2.1M per year, considerably less than the maximum AEL computed for the return period of 250 years, $4.5M.

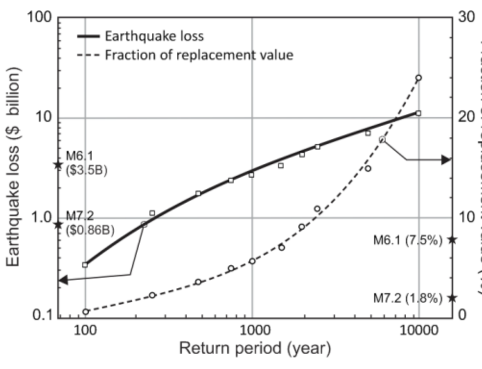

Fig. 6. Expected earthquakes losses

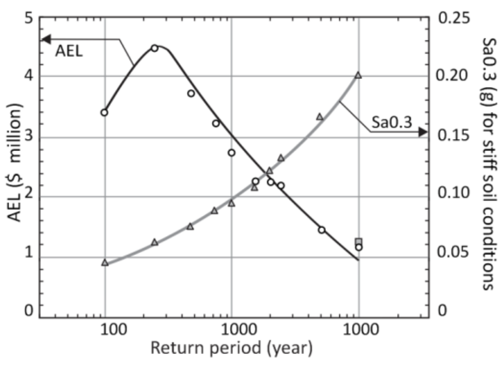

Fig. 7. Annualized earthquake loss

6. CONCLUSIONS

Preliminary seismic risk assessment for the building stock in Skopje was discussed in terms of economic losses. The applied methodology involved generation of the spatial distribution of the spectral accelerations Sa0.3s and Sa1.0s as intensity measures of the seismic hazard. The set of scenarios was selected so that the ensemble reproduces the potential earthquake intensities and frequency for the region. Two deterministic what-if scenarios with M6.1 in downtown Skopje and M7.2 with epicentral distance of about 30 km were considered. The impacts of probabilistic seismic scenarios with return periods of 100 through 10,000 years were also studied. The local site effects were addressed with respect to the shear wave velocity of the top 30 meters within the applied ground motion prediction equation and according to the standard NEHRP provisions. The building stock was simulated with 6 generic structural types: low- and mid-rise ductile reinforced concrete moment frame (C1), mid-rise reinforced concrete shear wall structure (C2), low- and mid-rise non-ductile reinforced concrete frame with masonry infill walls (C3) and unreinforced stone or brick masonry buildings (URML). A set of pre-developed fragility curves which directly relate the probability of exceedance of a specified damage state to the intensity of Sa0.3s and Sa1.0s was associated to each of the considered building types. In this way, the computational time for conducting damage and loss assessments was significantly reduced.

The generated loss results can be summarized as follows:

- What-if scenarios: The average economic losses for the what-if scenarios were estimated at $3.54 billion and $0.86 billion for the M6.1 and M7.2, respectively.
- Probabilistic scenarios: A gradual increase of the expected economic loss was observed with the increase of the return period from $0.34 billion (1/100 years) to $11.5 billion (1/10,000). These correspond to a fraction of the total replacement cost in the range of about 1% to 24%. The annualized earthquake loss averages the expected losses on a yearly basis. The maximum economic loss on annual basis was measured for the return period of 1/250 years or $4.51M/year.

The presented hypothetical results are not predictions for a catastrophic earthquake impacting the urban area of Skopje; they are first of all planning scenarios useful in determining the needed response and recovery capacities. In the case of the probabilistic scenarios, it is obvious that it is impossible that all of the potential seismic sources affecting Skopje trigger earthquakes at the same time and that the high-intensity shaking covers approximately uniformly the urbanized area. Due to the uncertainty in the number, location and magnitude of future earthquakes, probabilistic hazard scenarios are rather suggested in building codes for design of structures to withstand seismic loads with a given return period. Government and emergency managers use probabilistic scenarios for comparative purposes against seismic losses in other geographic areas and for prioritization of resources considering other natural hazards (e.g., earthquakes and floods). The insurance industry also needs an estimate of the probabilistic losses in seismic prone areas to assess the insurance premiums, types of earthquake coverage and deductible rates.

The authors acknowledge that the simplifications and substitutes for the actual conditions have to be considered when interpreting the reported results as they have substantial impacts on the reliability of the reported results and could contribute to significant spread and uncertainty. In spite of the important assumptions upon which the analyses were based, the above results fall well within the order of magnitude of the losses during the 1963 M6.1 earthquake estimated between $3 billion and $5 billion. It is, however, acknowledged that the losses cannot be directly compared for several reasons: at the time the population was about 200,000 inhabitants and the design practices have been drastically changed since 1963. As well, while damage to the building stock and related economic losses can be considered as a reasonable indicator of earthquake impacts, other parameters not included herein, such as damages to essential and transportation facilities, lifelines and other critical facilities combined with the indirect economic losses (business, increased transportation costs, debris removal, etc.), have also to be accounted for.

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GEOPHYSICAL INVESTIGATIONS AT CHARACTERISTIC LOCATION IN MOSTAR URBAN AREA: MASW METHOD FOR NEAR-SURFACE CHARACTERIZATION

Abstract: Geophysical investigations for definition of the surficial soil deposits characteristics were performed as a part of the project: "Support for Construction of Integra Cultural and Sport Facility" Mostar, BiH. The location of the fieldwork was in the urban area of Mostar. The surveys were performed using Multichannel Analysis of Surface Waves - MASW method, based on the analysis of dispersive characteristics of the Rayleigh waves. The seismic measurements were performed under specific conditions, at the basement of a partly built facility, 11 m below ground level. The results are represented with 2D cross-sections of the shear wave velocity (Vs) variation with depth of up to 30 m. According to the variations of the Vs values, the final seismic models indicate complex heterogeneous stratigraphy

Key words: geophysical investigations, MASW, shear wave velocity, stratigraphy, 2D Vs cross-section

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1. INTRODUCTION

Geophysical investigations were performed in the urban area of Mostar, Bosnia and Hercegovina using the method of Multichannel Analysis of Surface Waves – MASW. The seismic investigations were performed as a part of the ongoing project entitled: "Support for Construction of Integra Cultural and Sport Facility". The main objective of the survey was to determine the local stratigraphy of the terrain and its seismic properties which could contribute to modification of the amplitude-frequency content of the seismic shaking during strong earthquake motion. The second objective was to detect possible subsurface anomalies and local discountinuities in the terrain structure. This type of surveys is important for geohazard assessement of the investigated site.

The surveys were performed under specific field conditions, at the basement of an exsisting partly built facility at elevation of 11 m below ground level. First, preliminary measurements were conducted using three different seismic methods in order to design the seismic array and acquisition parameters: MASW, conventional seismic refraction and seismic reflection. The analysis of the MASW seismic data showed best results and helped the optimization of the design parameters. Seismic measurements were then performed along 6 transects using the MASW method [1,2].

The result of the surveys are represented with 2D Vs models which map the subsurface variation of the Vs shear wave velocity with high resolution [3].

1.1. Local geology

The lithological structure mainly consists of quarternary deposits of gravel with different granulation, sands, clay lenses and layers of well-cemented conglomerates. All these unconsolidated materials were deposed by the Neretva River.

The deposits of gravels represent high hydrogeological potential for recharge and groundwater flow due to the developed intergranular porosity determined by the coarse grain size, degree of compaction, the presence of the fine grain particles and conglomerates and the degree of the conglomerate cementation. According to the physico-mechanical features, these deposits range between loose gravels and solid conglomerates characterized by high compactness with behavior close to rock units. These deposits are also referred to as river terraces, or locally as "caves". Due to intensive groundwater flow directed to the contact zones of river terraces, the finer sediments were washed away and what remained in place are high porosity gravel and sand which sometimes contain specific empty spaces with patterns similar to speleological caves.

The highest thickness of surficial deposits is generally found in the central part, where the gravel and conglomerate deposits are about 20-30 m thick. The basement of the deposits consists of low porosity marls [4].

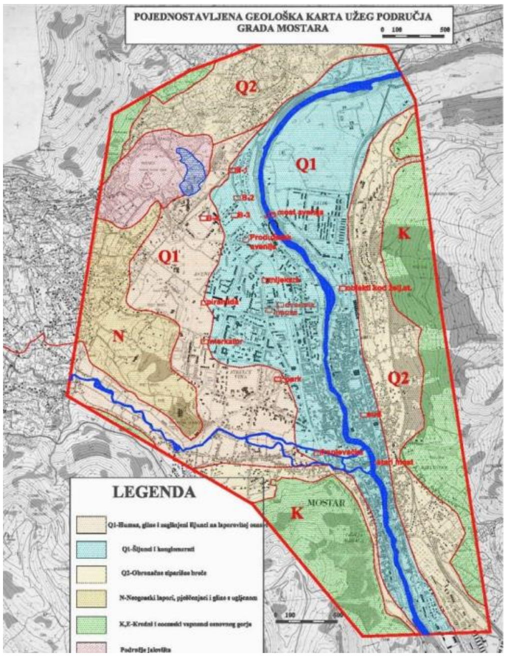

Figure 1 – Simplified geological map of Mostar

2. INVESTIGATION METHOD

The MASW method was applied for subsurface imaging of the terrain of investigated location. The standard MASW procedure consists of three steps: (i) array design and field acquisition of Rayleigh waves, (ii) processing of raw data and determination of dispersion curves, and (iii) inversion of the dispersion curves and estimation of the modal parameters, Vs in this case. The first step is particularly important for improving the dispersion curve resolution. Surveys were performed using roll-along technique, i.e. the source-receiver configuration was moved for pre-determined distance increment.

A 16 channel SoilSpy Rosina seismograph, produced by MoHo - Science & Technology, Italy was used for the field measurements. The geophones were with a natural frequency of 4.5 Hz. The distance between the geophones of the seismic array was 2 m and 3 m, the excitation step and source-receiver configuration displacement increment was 2 m and 3 m adequately, the minimum off-set (minimal source to receiver distance) was 5-6 m. The seismic energy was generated manually with a sledgehammer. The recording length was with 0.5 s duration with a sampling frequency of 2048 Hz [5]. The data processing was conducted using the SoilSpy

Rosina software provided with the equipment. The analysis was carried out applying the SurfSeis software of Kansas Geological Survey (KGS)

The result of the raw data processing is a dispersive image, i.e., a function of the phase velocity vs. frequency. It maps the fundamental mode together with the higher dispersion modes of the Rayleigh waves. For each source-receiver displacement, dispersion image using "wavefield transformation" was generated [6]. Dispersion curves were extracted from the dispersion images and the estimation of the 1D Vs model was performed with application of the iterative method [7]. For each displacement of the seismic array, 1D Vs model representative of the middle of the array was estimated. 2D Vs models were generated next with the Kriger interpolation of 1D Vs models. The final model provides the variation of the velocities of the seismic shear waves for the vertical cross-section along the surveying transect.

3. RESULTS

The results of the preliminary seismic refraction surveys conducted on top of the location were combined with the geological knowledge for the location. It was concluded that the vertical stratigraphy consists of the following major units (from top):

1. Unit1: A surface layer consisting of: gravel with clay, with seismic wave velocities in the interval of: Vp= 440 - 1060 m/s; Vs=190-400 m/s;
2. Unit2: gravel, and sub-layers of conglomerates with seismic velocities: Vp=1120 -1500 m/s; Vs=450 - 600 m/s;
3. Unit3: gravel, and sub-layers of conglomerates with seismic velocities in the interval of: Vp=1510 -2500 m/s; Vs=610 – 900 m/s;
4. Unit4: Marl, with seismic velocities in the interval of: Vp=2800 -4200 m/s; Vs=1000 - 1500 m/s;

The seismic refraction method, however, cannot detect velocity inversion and cannot resolve thin beds (hidden layer) problems. The result is a layering structure of the terrain defined on the base of the approximated average values of the seismic velocities. The final 2D Vs models resulting from MASW surveys, on the other hand, map the Vs variations with high resolution and accuracy in depth and laterally and are successful in detection of any subsurface anomalies.

The MASW results are shown at Fig.3 -Fig.9. MASW transects 5 and 6 were performed on top of the investigated location, whereas the rest of the models are the result from the surveys performed in the basement of the facility, at a depth of approximately 11m.

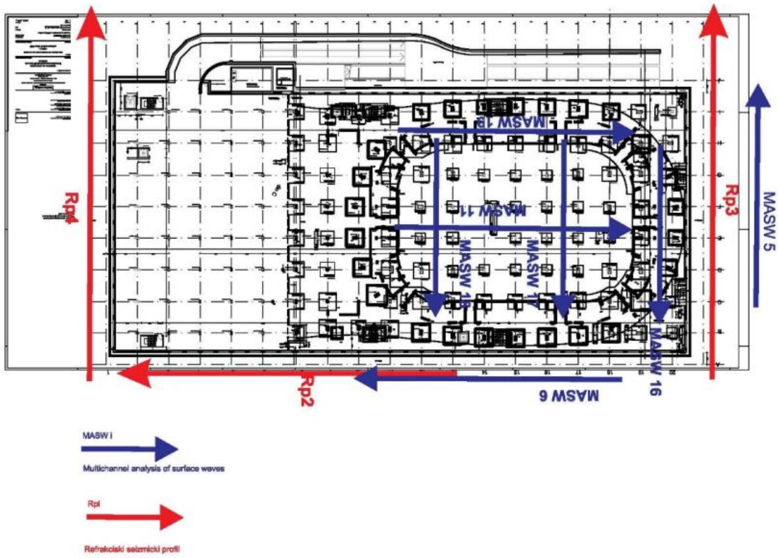

Figure 2 – Location of the seismic profiles within the study area.

MASW5 2D-Vs model (Fig.3) points out to variation of the seismic velocities of surface layers from Vs=200-400 m/s at the beginning of the profile to Vs=600-800 m/s at the distance of 13-17 meters and 21-24 meters along the profile. At depth of 5-10 m , this Vs model indicates the presence of a weak zone or sublayers of relatively loose soil material with Vs=200-400m/s.

MASW6 2D-Vs model (Fig.4) shows high variations of the seismic velocities as well. In this case, at a depth of 11-18m are registered weak zones with velocity decrease from Vs=1000 m/s to Vs=500 m/s, which is significant difference and indicates to significant heterogeneity that characterizes the terrain of the investigated location.

MASW11 2D-Vs model (Fig.5) indicates a few weak zones with Vs =200-400 m/s at a depth of 2-3m (i.e. 13-14 m), and, increasing the depth, up to 9 m (20 m from ground surface) there is continuous increasing of the velocity.

MASW16 2D-Vs (Fig.6) is similar to the previous MASW11. In this case the zones with shear wave velocities of approximately Vs=500 m/s are estimated at the depth of 9.5m (20.5 m from ground surface).

MASW17 (Fig.7) and MASW18 (Fig.8) 2D-Vs models the weak zones are observed at a depth of 1-3 m(12-14m from ground surface) with the values of shear wave velocities at the interval of Vs=200-400 m/s. With increasing of the depth, the velocities also increase, but there are some isolated zones where velocities drops again to approximately Vs=500 m/s.

MASW19 2D-Vs model (Fig.4g) indicates shear wave velocities Vs=200-400 m/s observed at depths from 1-4 meters (i.e., 12-15 m from ground surface) at the distance of 0-10 m along the profile. An increase in the velocity values to Vs=800m/s is observed at a distance of 17-25m along the profile, accompanied with a drop of the seismic velocity down to 3 meters depth (14 m from ground surface). With depth, another drop in velocities is observed at 10-15 m along the profile at a depth of 7-8 meters (18-19 m from ground surface). In fact, variations in seismic velocities are observed throughout the whole cross section of the model.

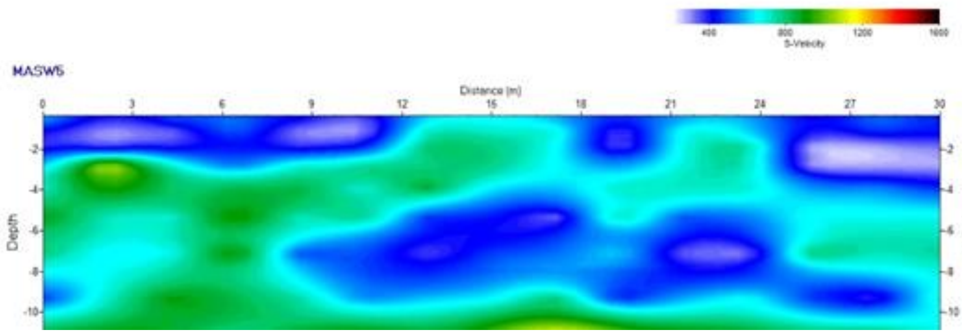

Figure 3-MASW5 2DVs model (16 source-receiver displacements, 2 meters interstation distance);

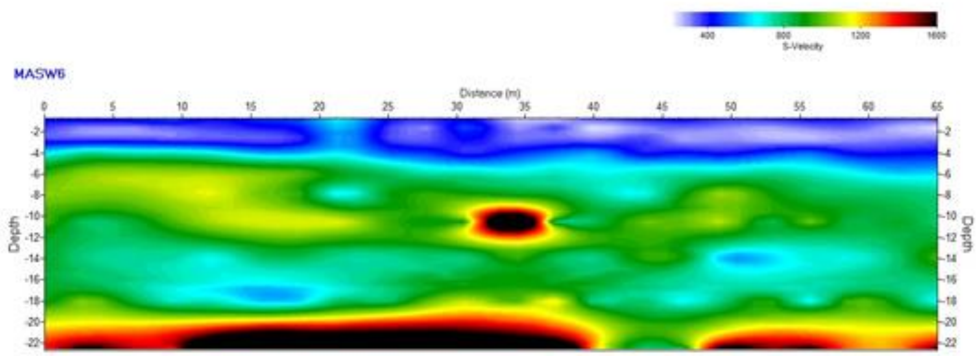

Figure 4- MASW6 2DVs model (22 source-receiver displacements, 3m interstation distance)

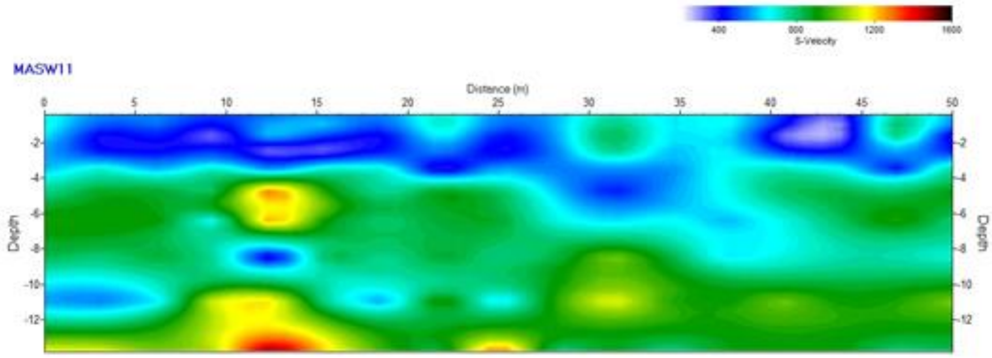

Figure 5-MASW11 2DVs model (17 source-receiver displacements, 3 meters interstation distance);

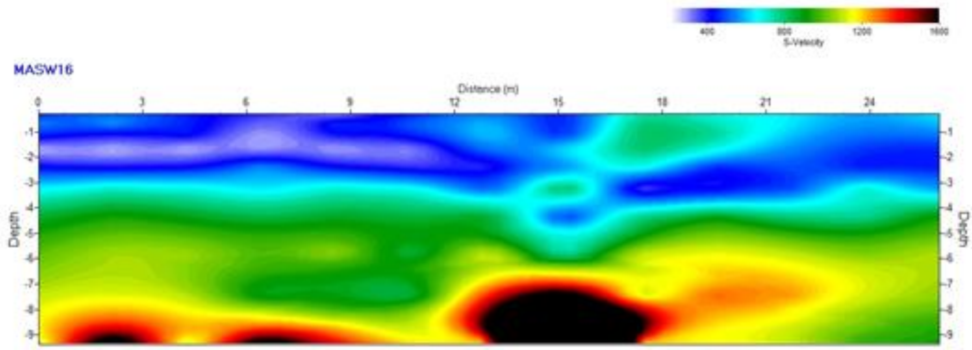

Figure 6-MASW16 2DVs model (13 source-receiver displacements, 2 meters interstation distance);

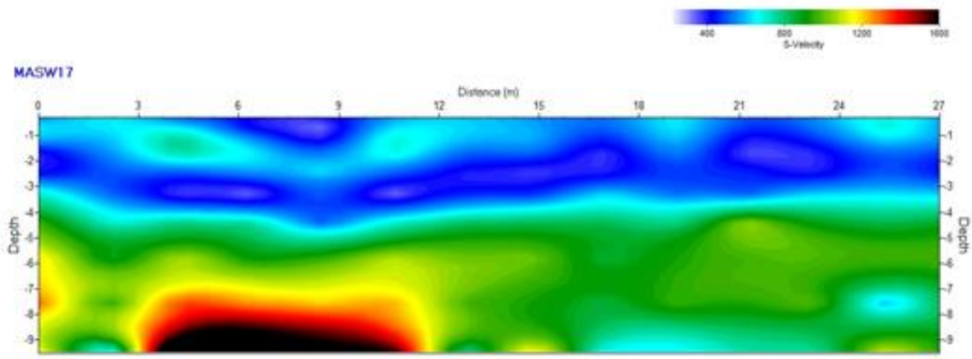

Figure 7-MASW17 2DVs model ((14 source-receiver displacements, 2 m interstation distance);

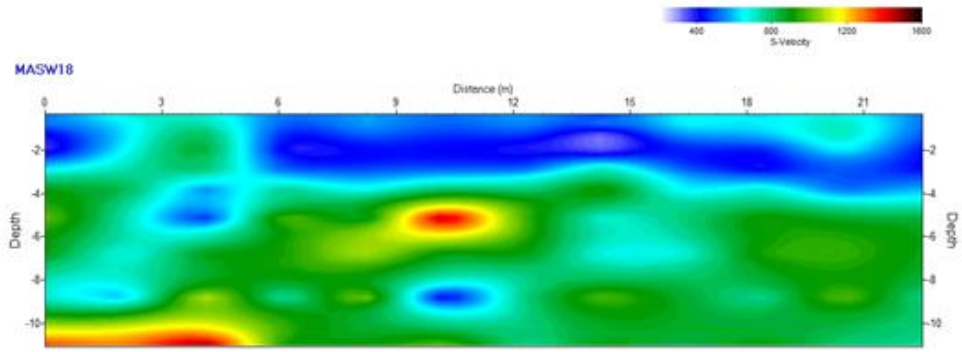

Figure 8-MASW18 2DVs model ((12 source-receiver displacements, 2 m interstation distance);

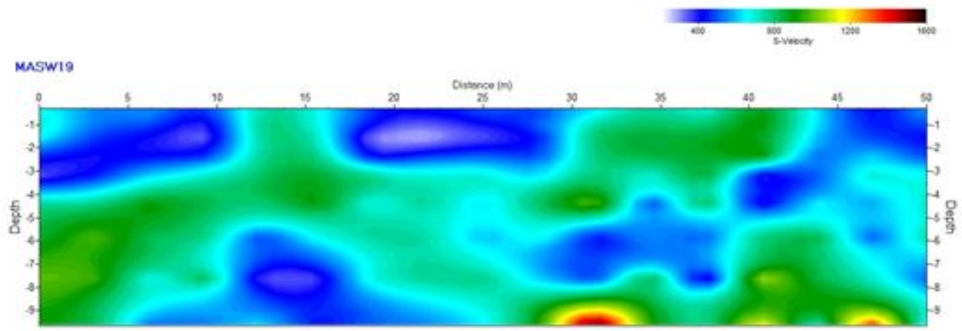

Figure 9-MASW19 2DVs model (17 source-receiver displacements, 3 m interstation distance);

4. CONCLUSIONS

The terrain of the investigated location could be characterized as a heterogeneous media because of the physical-mechanical properties variations of the quaternary deposits. The quarternary deposits vary from loose gravels to compact conglomerates. Between these two extremes is the series of transient variations according to the degree of the conglomerates cementation.

According to the existing geological data of the investigated area the subsurface of the terrain is composed of gravel and conglomerates to the depth of 20-30 meters and mainly marls at their basement. The observed weak zones at different depths throughout the volume of the subsurface soil can be result of several factors: variation in the grain composition of the gravels and sands, stiffness of the conglomerates, presence of lenses/strips of sands or other soil materials with variable geomechanical properties, variations in the underground water table, etc

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FIRE SCENARIO INFLUENCE ON THE FIRE RESISTANCE AND THE BEHAVIOUR OF RC FRAME STRUCTURE

Abstract: Understanding the performance and the response of the frame structures in fire is of a particular importance for structural fire design. The specialized computer program SAFIR enables analysis of different types of structures, constructed with different structural materials. The options of program SAFIR are presented on eight different fire scenarios of standard fire exposure of a three bay two story RC frame. The results for the: temperature distribution within the structural elements, fire resistance of the whole structure, bending moments and deformations of elements are presented and discussed. The worst fire scenario of the frame is defined.

Key words: reinforced concrete frame, fire resistance, fire scenario, internal forces, deformation

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1. INTRODUCTION

Fires are rare but possible catastrophic events in building`s lifetime with serious consequences on building`s operation, stability, bearing capacity, etc. Different fire scenarios mean different locations of the fire in the building. In general, fire location is hard to be predicted and therefore defining the worst fire scenario that has to be considered in the structural fire design is very challenging. In order to create the worst but still realistic fire scenario, several variations of the fire position are done in this research.

The aim of this research is to determine the behaviour of a 2D reinforced concrete frame in case of fire, with accent on the different fire scenarios influence on the frame`s fire resistance. For this purpose, eight different fire scenarios are considered and the heating regime is defined with the standard temperature-time curve ISO-834 ($T=20+345\cdot log_{10}(8\cdot t+1)$) [1].

The nonlinear numerical analyses presented in this paper are conducted with the computer program specialized for structural fire analysis – SAFIR [2]. The nonlinearity of the problem comes from the changes in material properties by high temperatures (mechanical and thermal), the nonlinear temperature distribution in the element cross-sections (no heath transfer is considered along the axis of the beams and columns) and the continuous change of the internal forces [3].

Using the SAFIR program, the numerical analysis of the structure exposed to fire consists of two steps. The first step involves determining the temperature distribution inside the structural members, referred to as 'thermal analysis'. The second step of the analysis, termed as 'structural analysis', is carried out for the main purpose of determining the response of the structure due to static and thermal loading [2]. For modeling the structure BEEM elements are used.

2. NUMERICAL ANALYSIS

2.1. Description of the structure

The three-bay two-storey RC frame analyzed in this paper is shown in Fig. 1. The structure is made of concrete with siliceous aggregate, with a compressive strength f_c=30 MPa and reinforcing bars with a yield strength f_y=400 MPa. The RC structure was designed for load combinations that include seismic action, according to the national standards. The cross-sections of all beams are 0.35x0.45 m^2 and the column sections are 0.40x0.40 m^2. The concrete cover of all cross-sections is a=2 cm. Uniformly distributed load of 50 kN/m including self weight, was applied on the beams and forces of 12 kN were applied in the beam to column joints of the first floor. Geometry, support conditions, reinforcement details and numeration of: bays, beams, columns and joints are shown in Fig. 1. Top compartment beams are assumed to be fire exposed on three sides (bottom, left and right side) and bottom compartment beams are assumed to be fire exposed only on the top side. Outer compartment columns are heated only on one side and middle compartment columns are heated on two sides.

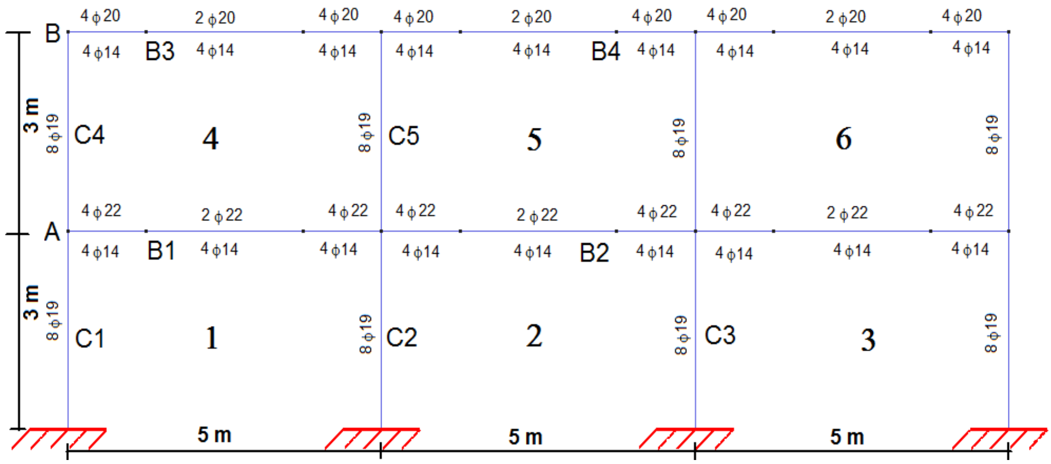


Figure 1- Frame geometry, support conditions, reinforcement, numeration of: beams, columns, joints and bays

2.2. Thermal analysis

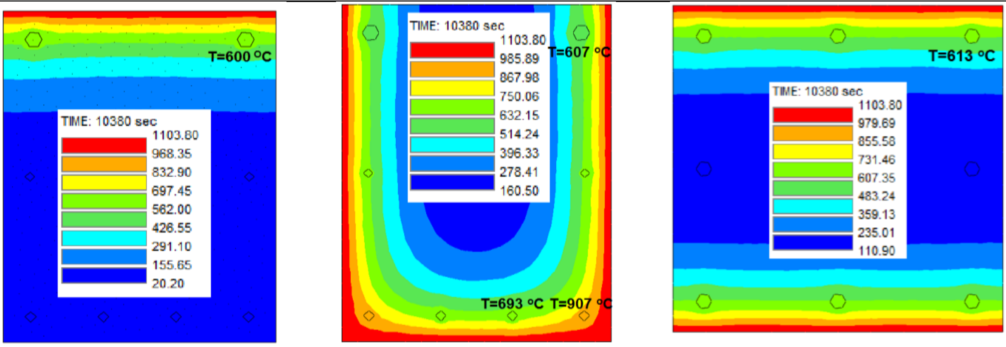
For the concrete the following material thermal properties are used: relative emission coefficient for concrete surfaces ε=0.8, coefficient of heat transfer by convection for exposed surfaces α_c=25 W/m^{2}K and for unexposed surfaces α_c= 4 W/m^{2}K.

The differences in the temperature fields in the cross-sections of beams/columns that are fire exposed on one, two or on three sides of the cross-section can be seen in Fig. 2.

2.3. Structural analysis

2.3.1. Fire resistance

Varying the fire compartment position, eight different fire scenarios are analyzed in order to compare the results and to define the worst fire scenario that leads to the lowest fire resistance of the frame. Compartmentation of floors and both each spans and floors are assumed. The fire resistance for 4 of the analyzed 8 fire scenarios, the bending moment diagrams and the deformations of the structure at the moment of failure are presented in Table 1.



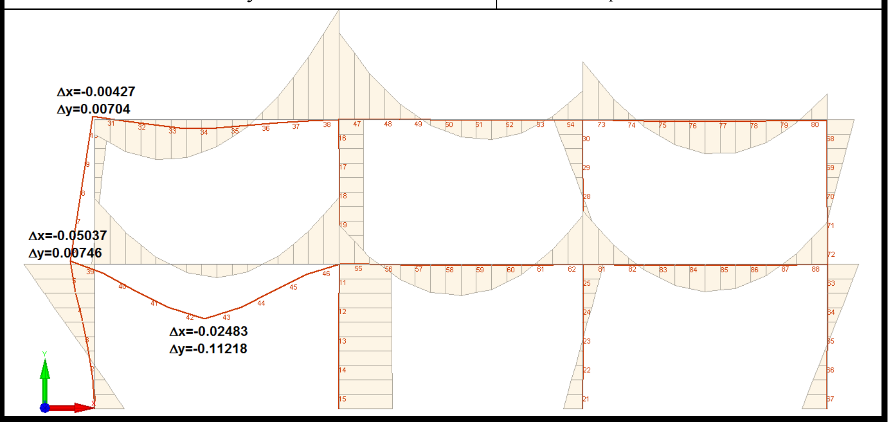
a) b) c)

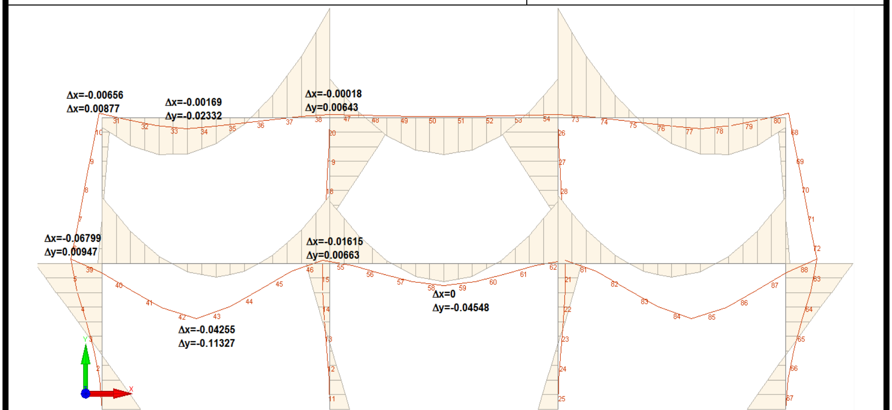
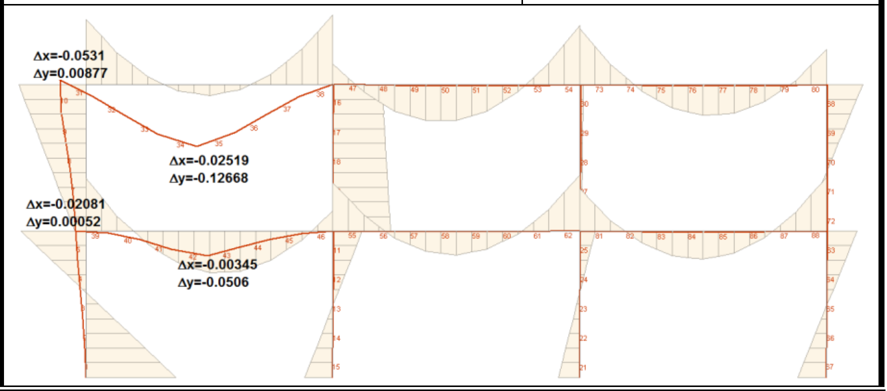
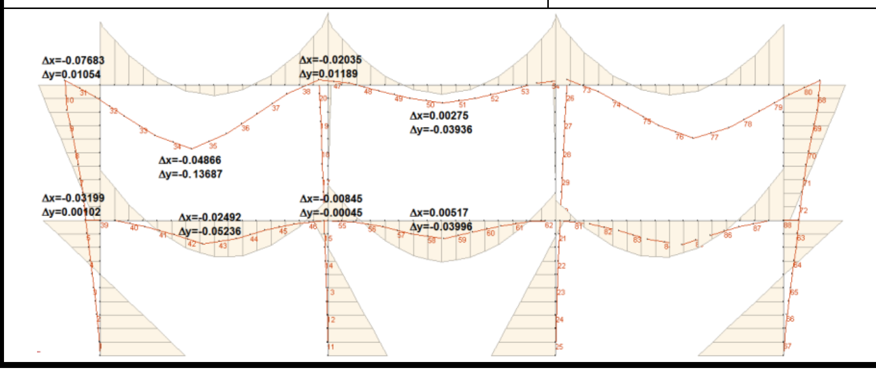
Figure 2 - Temperature fields in cross-sections of elements of the frame structure in Fire scenario VIII, at the moment of failure of structure - t=173.14 min: a) beam B1 b) beam B3 c) column C5

The higher the position of the fire compartment is, the fire resistance of the frame is lower. All fire scenarios involving some or all spans of the second floor result with lower fire resistance in comparison to the same fire location but at the first floor [4, 5, 6].

There is a negligible difference in the fire resistance of the frame in case of a whole floor fire compartment and when the fire compartment involves only the outer span or both the outer and the central span of the same floor. Exception to this conclusion is the case when the fire compartment involves only the middle span of the floor. In this case the fire resistance is significantly higher compared to any other possible fire scenario for the same floor [4, 5, 6]. The reason for the highest fire resistance in this case is explained in the sections below.

Table 1- Fire resistance, bending moment diagrams, deformations and displacements in characteristic joints of the frame for all fire scenarios

Fire scenario	Spans that comprise the fire compartment	Fire resistance
	Bending moment diagram and deformation at the moment of failure of structure	
I	Bay 1	t_f=197 min=3.28 h
		

<table>
<tr><td rowspan="2">Fire scenario</td><td>Spans that comprise the fire compartment</td><td>Fire resistance</td></tr>
<tr><td colspan="2">Bending moment diagram and deformation at the moment of failure of structure</td></tr>
<tr><td rowspan="2">II</td><td>Bays 1, 2 and 3</td><td>tf=197.68 min=3.29 h</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td rowspan="2">III</td><td>Bay 4</td><td>t_f=172.82 min= 2.88 h</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td rowspan="2">IV</td><td>Bays 4, 5 and 6</td><td>t_f=173.14 min=2.89 h</td></tr>
<tr><td colspan="2">
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2.3.2 Displacements and deformations

As expected, the comparison of the lateral displacements at the top levels of the fire compartments in fire scenarios IV and VIII, which represent whole floor fire compartments, lead to conclusion that the higher the floor is the bigger the lateral displacements are (see Table 1). The deflection of the outer beam B1 has similar values in fire scenarios I and II (the differences are in millimeters). The deflections of the outer beam B3 in fire scenarios III and IV are slightly greater than of beam B1 in the above mentioned fire scenarios. When the fire compartment is only in the middle span of a particular floor, the lateral displacements of the beams exposed to fire from the bottom side are smallest because of the cold and stiff outer spans of the frame.

3. CONCLUSIONS

The main conclusions obtained from the comparative analyses were already presented and elaborated in the previous sections of this paper. As a result of the analysis, the process of choosing the worst fire scenario for unrestrained RC frame structure with three spans is quite simplified because of these general conclusions:

- The higher the fire compartment is, the lower fire resistance of the structure is reached.
- In all fire scenarios for a particular floor there is no difference in the fire resistance of the frame, except in the case when the fire compartment comprises only the middle span. Then, drastic improvement of the fire resistance is reached and lower lateral displacements occur (because of the high compression forces induced in the middle beams).
- Different levels of restraint from surrounding cold frame elements affect the deflections and the thermal expansions of the fire exposed beams.

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Lars SCHIØTT SØRENSEN

MASTER IN FIRE SAFETY PROGRAMME OFFERED AT DEPARTMENT OF CIVIL ENGINEERING, TECHNICAL UNIVERSITY OF DENMARK (DTU)

Abstract: Since 1999, the Technical University of Denmark (DTU) has offered a Master in Fire Safety as an open education. The master aims at persons who intend to lead and coordinate tasks within fire technology both in private companies and in the public sector. The education went accredited in 2011 and responds to an institute accreditation at DTU since 2014. The education is progressive, which means that the courses built-up upon each other and need to be taken in a special order. If all modules are attended, the duration of the education is typically 4 half years (semesters), where the working load correspond to half time. The courses are, to great extent, taught as remote learning via the Internet containing three meetings with duration of 1½-2 days per course. The typical availability is three courses per semester.

Key words: Master in Fire Safety, Master programme, higher education degree, DTU

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1. TARGET GROUP AND ADMISSION REQUIREMENTS

The target group is civil/structural engineers or building constructors with two years of working experience. Building constructors must pass an access course before start. It is possible for others on a corresponding level – after specific evaluation – to enroll in the courses. If you are not an educated engineer (B. Eng., BSc Eng., BSc Eng. (hon.), MSc Eng.) or building constructor with a passed DTU access course, you can only participate in some specific courses on the master education (appears on the course description). Participation in some supplementing courses before start of the education can be required (Sørensen and Dederichs 2017). A typical student on the master can be employees with working experience as caseworkers or project managers in national or municipal organizations, technical administrations, emergency management agencies, employees with background as designing engineers, product developers or as building material manufacturer.

For applicants not completely meeting the technical and scientific requirement, DTU offers the essential supplementing courses.

For the group of building constructors a transition education is established. Requirement for this group is a supplementary course (access course) on mathematics and physics, containing topics about integrals, differential calculus, differential equations, linear algebra, mechanics, chemistry, thermodynamics, hydrodynamics etc.

For students with a final exam from other schools of engineering or other universities, transfer of credits can be made, so they do not have to attend courses with the same content and level.

The master currently taught in Danish, why there will be requirements of appropriate skills in the Danish language. For many students the master means a career leap. To open the international job market, some of the teaching is held in English. Literature and programs in both English and Danish will occur. Both the structure of the single courses in the education and the professional and pedagogical organization supports the utilization of the student's general, vocational and personal skills and maturity.

2. SCIENTIFIC WORK METHODS – A NECESSITY WHEN PERFORMANCE-BASED CODES ARE INTRODUCED

The introduction of performance-based codes in Denmark in 2004 requires new competences from people working with different aspects of fire safety in the industry and the public sector. This call for an education aiming for reducing problems with handling and analyzing the mathematical methods and CFD models when applying performance-based codes. This is done within the educational program Master in Fire Safety, at the department of Civil Engineering at the Technical University of

Denmark. It went clear, that the students had general problems with academic methods. Therefore, a new educational moment is introduced as result of this investigation. The course positioned in the program prior the work with the final project. In the course a mini project worked out, in which the students provides extra training in academic methods (Dederichs and Sørensen 2009).

3. DEGREES IN THE DANISH HIGHER EDUCATION SYSTEM

Table 1 provides an overview of the ordinary higher education degrees, adult and continuing higher education degrees, Bologna Framework and the European and National Qualification Framework for Lifelong Learning (EQF/NQF). The table also include the Danish qualification levels, corresponding to the European system.

Table 1. Overview of education levels and frameworks for ordinary, adult and continuing higher education degrees in Denmark end Europe (Sørensen 2017)

Danish Qualification levels	**Ordinary higher education degrees**	**Adult/continuing higher education degrees**	**Qualification Framework for the European Higher Education Area–Bologna Framework**	**European/National Qualification Framework for Lifelong Learning (EQF/NQF)**
Academy Profession level	Academy Profession (AP) degree (90-150 ECTS)	Academy Profession (AP) degree (60 ECTS). Also known as Further Adult Education (VUU) degree	Short cycle	Level 5
Bachelor`s level	Professional Bachelor`s degree (180-270 ECTS)	Diploma degree (60 ECTS)	First cycle	Level 6
	Bachelor`s degree (180 ECTS)			
Master`s level	Master`s degree (120 ECTS)	Master degree (60-90 ECTS)	Second cycle	Level 7
PhD level	PhD degree (180 ECTS)		Third cycle	Level 8

As seen from the table an ordinary Master's degree is awarded after 120 ECTS whereas a Master degree under the continuing higher education is awarded after 60-90 ECTS. All the programmes are research-based, and offered in all scientific fields. The Danish title is abbreviated to *cand* [latin abbreviation of academic area] [field of study]. The English title is *Master of Arts* (*MA) in* [field of study] or *Master of Science* (*MSc) in* [field of study].

The PhD degree is awarded after 180 ECTS. PhD programmes are offered by the universities, and some university level institutions offers degrees in the artistic and cultural field. Detailed descriptions of degree levels can be found in the Danish Qualifications Framework at www.nqf.dk. Please consult the relevant Diploma Supplement for information about the learning outcome of any specific degree.

4. ADULT AND CONTINUING HIGHER EDUCATION

Adult education qualifications are available at levels corresponding to those of the ordinary higher education system, however not for the PhD level:

- The Further Adult Education degree, also called the Academy Profession (AP), is awarded after studies at short cycle level and gives access to diploma programmes.
- The Diploma degree is awarded after studies at first cycle level and gives access to master programmes.
- The Master degree is awarded after studies at second cycle level.

These continuing higher education programmes normally consist of 2 years of part-time study, equivalent to 1 year of full-time study (60 ECTS credits). Certain master programmes require 1.5 years of full-time study (90 ECTS credits). Admission requirements are a relevant educational qualification and at least 2 years of relevant work experience.

5. CONDITIONS AND CURRICULUM (MASTER IN FIRE SAFETY)

The education is divided into 4 semesters and the estimated workload corresponds to half workload, There are three courses per semester. For each course, the student is offered 1.5 days of face-to-face teaching, three times per semester, i.e. a total of approximately 1 week face-to-face teaching per course. The other part of each course is given by Web-based distance learning (Sørensen 2014).

The courses at Master in Fire Safety are offered every second year. On 0. semester, the mentioned access course for building constructors is offered.

Curriculum (2017-2018)

0. Semester – Fall 2016
11E16 Engineering Mathematics and Physics for building constructors

1. Semester – Spring 2017
11B04 Fire Chemistry
11B24 Building Fire Safety Engineering
11B25 Fire Dynamics

2. Semester – Fall 2017
11B01 Structural Fire Safety Design
11B02 Industrial Fires
11B12 Fire Modelling

3. Semester – Spring 2018
11B05 Fire Risk Management
11B13 Technical Fire Dimensioning
11B27 Complex Buildings (optional) or
11B28 Modelling of Buildings on Fire (optional)

4. Semester – Fall 2018
11MIB Fire Engineering Project Task

6. MASTER DEGREE

Master degree at EQF/NQF (European/National Qualifications Framework for Lifelong Learning) Level 7 referring to Second cycle in the Bologna QF (Qualifications Framework for the European Higher Education Area). A completed Master in Fire Safety programme at NQF/EQF Level 7 refer to Second cycle in the Bologna QF, does not give access to further studies within the field at NQF/EQF. Level 8 referring to Third cycle in the Bologna QF (PhD level).

7. COMPETENCES AND PROFESSIONAL STATUS

The Master in Fire Safety program is divided into different parts, according to different types of competences:

General competences (20 ECTS)
- Fire Chemistry
- Fire Dynamics
- Structural Fire Safety Design
- Building Fire Safety Design

Specializations (20 ECTS)
Industrial Fires
Fire modelling
Fire Risk Management
Technical Fire Dimensioning

Optional courses (5 ECTS)
Complex Buildings
Modelling of Buildings on fire

Thesis (15 ECTS)
Fire Engineering Project Task

The Master in Fire Safety is a research-based programme that enables the graduate to take on professional tasks within:

- Fire-safety engineering projects and counseling in engineering consulting companies
- Management of fire construction projects with public authorities
- Product development with manufacturers of building materials (fire properties)
- Fire insurance
- Fire testing of material, products and components
- Fire inspection

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SURVEY ON YOUTH SAFETY CULTURE IN THE WESTERN BALKANS

Abstract: This paper is based on a survey that explored the needs of the Western Balkan's countries (WBC) for Disaster Risk Management and Fire Safety Engineering (DRM&FSE) Master programmes. Aim was to gain an understanding of how safe and prepared for natural and manmade disasters the young in WBC feel. Respondents are the youth from Albania, Bosnia and Herzegovina and Serbia. In total, 1364 participants filled in the survey, among the respondents 27% attended high-school and 72% were university students. The survey discovered the perceptive low level of readiness and preparedness of communities to respond to natural disasters and hazards, with particular emphasis on the lack of safety culture and relevant equipment in universities and schools. The considerable fraction of the respondents expressed their desire to attend a Master programme in DRM&FSE.

Key words: youth, disaster risk management, fire safety engineering, survey, perception, hazard

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1. INTRODUCTION

Disasters that have hit the WBC in the recent years, most notably the floods, landslides and wild-fires have increased the need for researchers and the public to understand how prepared and ready the community is to respond to such unfortunate events. Cvetkovic and Stanisic [1] have managed to demonstrate the correlation between certain demographic and environmental factors, as independent variables and perception and knowledge on natural disasters as well as the familiarity with safety procedures of high-school students from the Belgrade region. The authors have established a correlation between the education of parents and all of three dependent variables (perception, knowledge and familiarity with safety procedures), additionally, they have found an interesting correlation between gender and knowledge on disasters. Furthermore, according to the authors, environmental factors such are the exposure to TV, computer games and radio, as well as education are all correlated with the perception on natural disasters at a statistically significant level.

The Youth Safety Culture survey was conducted by the K-FORCE Project Consortium with the aim to gain an understanding of how safe and prepared for natural and manmade disasters the young in Western Balkan countries feel. An additional aim was to acquire preliminary data about the existing interest among youth for future K-FORCE project activities. The information from the conducted survey will be used to better develop and implement curricula in the field of DRM&FSE at partner Universities in Albania, Bosnia and Herzegovina and Serbia.

1.1. Methodology

The primary target group of the survey was set as High School and University students from Albania, Bosnia and Herzegovina and Serbia. The survey itself was characterised as a mass survey aiming to have as many subjects (answers) as possible, with the questions being simple and easy to understand for young people from different backgrounds. The survey was available in Serbia/Bosnian and Albanian language.

Survey was drafted by European Youth Parliament Serbia (EYP Serbia) and contained three sections:

- previous experience in the field of DRM&FSE,
- safety culture and personal stances and
- future education aspirations.

Subject classification was proposed in regards to the subjects' country and city of residence, age, level of current education (High School or University) and field of education. The survey took between 5 and 10 minutes to fill out and was anonymous.

1.2. Overview and Profile of the Respondents

Survey was completed by 1364 participants. Most of the surveyed participants were from Albania - 486, followed by Bosnia and Herzegovina - 469 and Serbia - 396 participants. The remaining 13 participants came from the other Western Balkans countries where the survey was not directly promoted.

It is to be noted that the survey was filled mostly by the youth living or studying in the biggest cities of the respective countries - 79.4% of the respondents from Albania were based in Tirana, 88.4% of the respondents from Serbia were based either in Belgrade or in Novi Sad (almost equally distributed among the two cities). The highest diversification was achieved in Bosnia and Herzegovina with four cities reaching a significant number of respondents – Teslic (31.1%), Banja Luka (24.3%), Sarajevo (9.6%) and Tuzla (9.6%). Such results were anticipated taking into consideration that the biggest cities in the respective countries are university hubs.

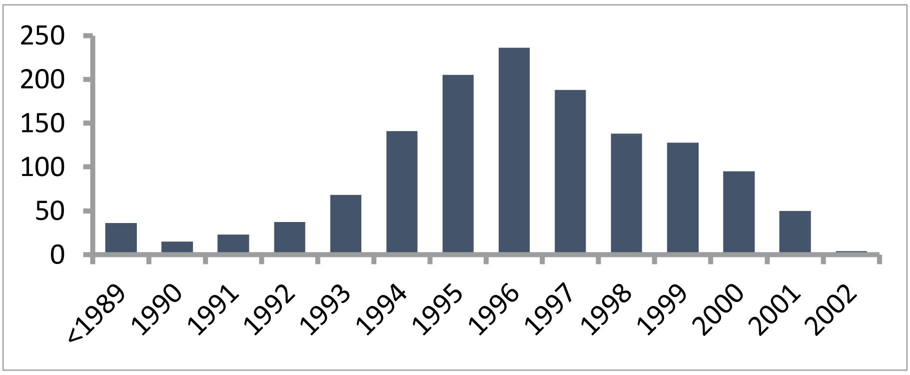


Figure 1 - Respondent' Year of Birth

Age of the respondents was normally distributed with the value 1996 for a birth year being the mode. Sample was bottom-coded for the value 1989 as a birth year. University students participated with 71.7% in the survey while 27.1% of the respondents were high-school students.

Less than one half of the respondents (41.2%) said that they have had the chance to learn about Disaster Risk Management (DRM) and Fire Safety Engineering (FSE) as part of their high school/university curriculum or during a lecture organized at their school/university. Furthermore, 87% respondents who answered affirmatively said that they have either attended a single lecture on the topic or have had a part of the course which referred to this topic. Only 13% of the respondents who answered affirmatively said that they have had a full course on the given topics. The fraction of such respondents in the whole sample is only around 5%.

A larger number of participants -61.5% stated that they have engaged in DRM and FSE via informal and non-formal education. Out of the students who provided an affirmative answer, around one half (49.5%) have read about DRM and FSE, 10.9% attended an open lecture on the topic and 9.1% have learned about it at a conference or a seminar. Additionally, among the respondents who responded affirmatively to the question, 2.9% are a member of an organization direct engaged in the topic and a large number (27.8%) have engaged in one of the other ways – including as volunteers during the disasters, mostly floods that have struck the Western Balkans region in the previous years.

Results show that the higher fraction of youth engages in the topics of DRM and FSE via informal and non-formal education than through the channels provided by the formal education system. Such findings might be interpreted by a desire of the youth to proactively engage on the topic and supplement the perceived lack of formal education, as will be outlined in the further findings.

It should be noted when taking into account the results of the survey that the highest fraction of the respondents, around one half of the whole sample are university students of engineering and technology, thus the external validity of the results to the whole youth population cannot be fully achieved.

Table 1 - Highschool Students Overview

Total subjects:				370		
By area of education:						
Engineering and Technology	Humanities and Social Sciences	General High School studies	Natural Sciences	Arts	Medical Sciences	Not enrolled
39	60	175	85	5	5	1
10.5%	16.2%	47.4%	23.0%	1.3%	1.3%	0.3%

Table 2 - University Students Overview

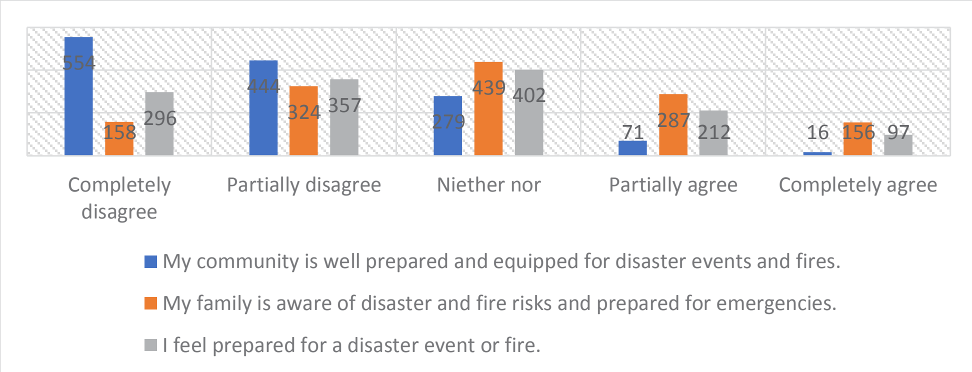
Total subjects:				978		
By area of education:						
Engineering and Technology	Humanities and Social Sciences	General High School studies	Natural Sciences	Arts	Medical Sciences	Not enrolled
617	210	27	98	19	5	2
63.1%	21.5%	2.8%	10.0%	1.9%	0.5%	0.2%

1.3. Findings

An interesting conclusion is identified when it comes to the perception of the readiness to respond to disaster events or fires. Most of the respondents find that they are better equipped and ready to respond in cases of disasters and fires than their communities. On the other hand, it seems to be the conclusion that the respondents believe their families to be better equipped to respond to such crises situations than they themselves are.

One of the possible reasons for the lack of trust in the community response to emergencies could be tracked to the immediate environment of the respondents – their high schools and universities and the lack of organized activities that would address the topic within these communities. Namely, only 5.8% of the respondents have said that there are evacuation exercises organized at their high school/university. In general, only one in nine of the respondents have ever taken part in an evacuation exercise, be it in a high school/university or any other institution. The survey shows that even in high schools/universities where evacuation exercises have happened, in almost one half of the cases they have happened only once, pointing to an ad-hoc approach to this issue, rather than a systematic and comprehensive solution.

Table 3 - Readiness to Respond to Crises



Though the survey does not recognize significant changes in the sample when it comes to the attitudes of university and high school students towards reacting in crises situations, there seems to be one important difference. Though the fraction of the respondents who claim to know how to use the fire extinguisher is similar in both categories (45.4% in the university student category and 40% in the high school student category), the fraction of university students who would try to put out the fire on their own is much larger -73.7% compared to 50.5% of high school students who would have done the same.

What could have been seen as alarming is the attitude towards the safety culture. Namely, when answering if they pay attention to the emergency signalization and evacuation plan when entering a public building or cafe/restaurant, only one in four of the respondent stated that they partly or completely agree with the statement. Furthermore, only slightly more than a third, 37.6% of the respondents either partly agreed or completely agreed with the claim that they would know how to safely exit any building in case of an emergency.

Table 4 - Level of equipment of high schools/universities to deal with emergency situations

In my School/University we have a:				
Fire extinguisher	Fire alarm	Fire suppression system	Evacuation plan and signs	Fire stairs
1157	610	234	529	260
84.8%	44.7%	17.2%	38.8%	19.1%
Emergency exits	Regular evacuation exercises	None of the listed	I don't know.	
410	28	24	201	
30.1%	2.0%	1.8%	14.7%	

The results of the survey show that most of facilities do have a fire extinguisher, while slightly less than one half has a fire alarm and even less, around one sixth has a fire suppression system. According to the respondents, around 40% of their high schools and universities have an evacuation plan and signs, less than a third has emergency exits while one in five has fire stairs.

Though this insight might not fully correspond to the actual situation on the ground, as it could be the case that certain features or systems (e.g. evacuation plan and signs or fire alarms) do exist and that the students are just not informed about it, even so, having the features/systems without students recognizing them is probably as ineffective as not having them at all.

In all three countries, the vast majority of the respondents (between 80% and 90%) have recognized floods as the main risk hazard. In Bosnia and Herzegovina, two thirds of the respondents have counted in landslides among the major hazards, followed by wildfires and earthquakes in the third and fourth place with around one third of respondents identifying these among the key risk hazards. In Serbia, around one half of the participants selected building fires and landslides each among the greatest risks with all the other risks having less than one third of the respondents. In Albania, around two thirds of the respondents selected wildfires and building fires as the key concerns, while slightly more than one half selected landslides. Results obtained from this question are not entirely surprising taken into account that the countries in the region have been hit by floods in the recent years and suffered significant damage, both in terms of human life loss and economic damage

Around one quarter of the respondents stated that they know a university program focusing on DRM and FSE (results do not include respondents from Novi Sad, considering that many of the students attending such program at the Novi Sad university were among the respondents of the survey). Around 30% of the respondents have said that they would be interested in studying DRM or FSE at University, while 20% stated that they would be interested in obtaining a Master's degree in DRM and FSE. On the other side, more than 40% would be interested in attending an elective course on the topic of DRM and FSE and around 60% said that they would attend a free course on the topic.

2. CONCLUSION

The survey has demonstrated high awareness among the respondents when it comes to disasters and hazards. It has revealed that the sample of young people who have filled in the survey find their communities inadequately prepared to fight disasters and relay on their families for support in the cases of disasters. The survey has also highlighted the lack of the safety culture, which could be seen through the low-level readiness, and relevant equipment of the educational institutions (high schools and universities) needed to fight such hazards, which is exceptionally alarming.

There seems to be a consensus when it comes to the main threats across the region with floods, landslides, wild fires and building fires counted among the key concerns. This finding also reflects the most recent disasters that have hit the countries in question. The survey has discovered the willingness among most of the respondents to engage in courses related to DRM and FSE while a significant number, around one fifth expressed interest in doing a master's degree in the field. Such results indicate that there is a potential to create and leverage the human capital and improve the safety culture in the future years in order to provide an adequate answer to the challenges that the region would face in this area.

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KNOWLEDGE LEVEL ASSESSMENT IN THE FIELD OF FIRE PROTECTION IN SECONDARY SCHOOL STUDENTS

Abstract:

The aim of the paper is to point out the importance of developing an organized education system in the field of fire protection, because this is the only way to ensure greater safety and raise the awareness of young people about the significance of fire protection. Student opinions were analyzed through research results based on surveys and education, conducted among secondary school students. The results show that the young are very aware of the necessity for having education in the field of fire protection in order to increase the level of their safety.

Key words: education system, fire protection, safety, awareness

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1. INTRODUCTION

A disaster is any natural or technical-technological event that can endanger the health and lives of a large number of people, causes great material losses and disrupts the living environment. It is an event that endangers people and their goods or infrastructure to such an extent that it is not possible to cope within the normal responsibility and cooperative framework of institutions.

In most cases the occurrence, scope and duration of natural disasters cannot be predicted in advance, but there are some phenomena for which, based on experience, statistics and methods of modelling as well as the place where they usually occur, it is possible to expect that they could occur.

After the Global Assessment Report on Disaster Risk Reduction (GAR), a biennial review and analysis of natural hazards published by the United Nations Office for Disaster Risk Reduction, for the period 1990-2014, on the territory of the Republic of Serbia, typical natural hazards identified were those of floods and earthquakes. The vulnerability of other natural disasters (escarpments, landslides and erosions, stormy wind, snow blizzards, snow drifts and ice, hail, droughts, forest fires, epidemics and pandemics) could also occur as well as of technical and technological dangers. According to the same document, in the reporting period, most of the victims were in fires (66.7%) [1].

Disaster risk reduction is the concept and practice of reducing disaster risks through systematic efforts to analyze and reduce the causal factors of disasters. It includes reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events. Disaster Risk Reduction involves every part of the society, every level of the government, and every segment of the professional and private sector.

The Disaster Risk Reduction and Emergency Management System in the Republic of Serbia was established by the Law on Emergency Situations in 2009 [2] and the National Strategy for Emergency Response and Emergency Situations from 2011 [3].

The Serbian Government adopted the Decision on appointment of the members of the National Emergency Management Headquarters (NEMH) on its regular session on 12 May 2011. The inaugural session of the NEMH was held on 3 June 2011. The Serbian Government proclaimed the National Platform for Disaster Risk Reduction on 24 January 2013. The NEMH is acting as the National Platform for Disaster Risk Reduction in the international community [4,5].

In 2014, only months after the disaster caused by immense floods, the Government of Serbia passed the National Programme for Risk Management of Natural Disasters [6]. In order to increase the resilience to natural disasters and other hazards, and the ability to quickly restore the state prior to the natural disaster or other hazard, the

Action Plan for the implementation of the National Program for Risk Management of Natural Disasters was adopted [7]. The Action Plan is in line with the Sendai Framework for Disaster Risk Reduction, which was adopted for the period 2015-2030.

One of the main objectives of the International Strategy for Disaster Reduction (ISDR) is to "reduce risks and make all communities resilient to the effects of natural, technological and environmental hazards". The strategy also aims to proceed from protection measures to the management of risk through the integration of preventive actions into sustainable development (ISDR, 2003). The aim of enabling all communities to become resilient to the effects of different hazards was announced in the Inter-Agency Task for Disaster Reduction in April 2000 in Geneva. There is a need for shifting the approach from disaster recovery to disaster reduction and for "focusing on human security, people education and training" with the objective of improving community disaster preparedness. This need is receiving increasing attention at present [8].

The role of education in the issue of natural disaster risk reduction has been confirmed in the majority of relevant references: e.g. Agenda 21, Hyogo Framework for Action 2005-2015, UN Decade of Education for Sustainable Development 2005-2014, the UN campaigns "Disaster Reduction Campaign on Disaster Prevention, Education and Youth" (2000), and "Disaster Risk Reduction Begins at School" 2006-2007 [9].

Education, raising public awareness and training are linked to virtually all areas in Agenda 21, and even closer in the programme area 36.2. Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. While basic education provides the underpinning for any environmental and development education, in later phases it needs to be incorporated as an essential part of learning. Both formal and non-formal education is indispensable to changing people's attitudes so that they have the capacity to assess and address their sustainable development concerns [10].

The Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters adopted by 168 Member States of the United Nations at the January 2005 World Conference on Disaster Reduction resolved to "use knowledge, innovation and education to build a culture of safety at all levels" as an action priority. An indicator of achievement would be the "inclusion of disaster risk reduction knowledge in relevant sections of school curricula at all levels" [11].

To effectively reduce disaster risks for communities, the United Nations Children's Fund (UNICEF) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) recognise the important role education plays in reducing vulnerability and building resilience. Education can be instrumental in building the knowledge, skills, and attitudes necessary to prepare for and cope with disasters, as well as in helping learners and the community to return to normal life. This report is a mapping of countries that have included elements of disaster risk reduction into their education system. It captures national experiences whilst noting key challenges in countries where disaster risk reduction is less clearly prioritised or where specific teacher training does not exist [12].

In Serbia, on the October 2014 session of the National Emergency Management Headquarters the decision was made that the Ministry of Education, Science and Technological Development in the National Progress Report – 2013-2015 24/54 should implement disaster risk reduction in existing curricula of primary and secondary schools [8].

The Ministry of Education, Science and Technological Development through national programmes for the encouragement of innovation including financing of innovation projects funded by grant budgetary resources and those innovative projects aiming to develop products, methods or services that can prevent, predict or reduce the effects of natural and other disasters such as earthquakes, floods, fires, etc. It is important to define school curricula on disaster risk reduction and recovery concepts for all levels of the education system and implement them as soon as possible.

2. FIRE PROTECTION

In Serbia, for the last ten years, the number of fires and direct material damage are increasing, as well as the number of the injured and dead. Thus, the tendency of an increasingly serious threat to people, economic and other potentials of the country is shown. Taking into account the indicators of the causes of the fire, over 80 % of all fires arise as a result of the "human factor", i.e. they are the consequence of irresponsible behavior, negligence, non-compliance with legal regulations, lack of knowledge, carelessness and the like. Inadequate organization and insufficient capacity of all subjects for timely detection and fire extinguishing, lack of financial resources of most work organizations, as well as of those engaged in improvement and fire protection also contribute to the unfavourable situation.

Fire protection is a complex issue requiring an integral approach, especially as fires know no boundaries, neither municipal, nor state, nor international. The organization of the control over implementation of fire protection regulations and measures is carried out through the Ministry of *Interior* of the Republic of Serbia, which monitors the legality of the work of organizations and bodies and performs inspection supervision.

The fire protection system is regulated by the Fire Protection Act [13]. The fire protection system includes a set of measures and actions for planning, financing, organizing, implementing and controlling fire protection measures and actions, dealing with fire prevention and spreading, fire detection and fire fighting, saving people and property, environmental protection, identifying and removing causes of fire, as well as assisting in the elimination of consequences caused by fire.

Fire protection is realized by organizing and preparing fire protection entities for fire protection implementation; providing conditions for the implementation of fire protection; taking measures and actions for the protection and rescue of people, material goods and the environment in the event of fire; and control over the application of fire protection measures.

Regarding the obligations of fire protection entities (Article 6) based on the Law, and according to Article 6a "in order to acquire the knowledge, skills and habits necessary for the improvement and consolidation of positive attitudes and behaviour relevant to fire protection of children and pupils, competent school and pre-school institutions are obliged to establish and implement an educational programme on fire protection within the school and pre-school curricula". The supervision over the establishment and implementation of the educational fire protection programme is carried out by the ministry responsible for education affairs.

Based on the *Principles* of *Awareness Raising* (Article 10), fire protection entities encourage, direct and provide awareness raising on the importance of fire protection through the education system, scientific research and technological development, training in the process of work, and public information.

It is difficult to foresee the possibility of fire breaking as well as the place of origin, which certainly goes beyond the scope of regulations and requires a scientific-professional approach with the integration of knowledge from different scientific fields. Educational and informing activities should provide the widest capacity, information and self-awareness of all subjects and potentials of the society in preventing the crisis situations regarding fire outbreaks, and preventing their occurrence. Such a standpoint, activities, material investments, and associated personnel potential, make the risk of fire and its effects reduced and contribute to increasing the safety of the entire community.

3. WHAT SYSTEM OF EDUCATION TO APPLY

The education of the population in the field of fire protection is the everyday need of every society, and the way it is designed, legally regulated and practically implemented is an indicator of the degree of civilization development of that society. Small children are educated on this subject in order not to cause a fire, but also to safely leave the burned area in case of fire, as well as to inform adults about the details and the need for further reaction. Young people and adults, who are not professionals in the field, are expected to take a more active role (extinguishing the initial fire, proper informing the competent services, etc.).

At the time of the Socialist Federal Republic of Yugoslavia (SFRY), education on emergency situations was incorporated in the school system from the primary school to the university, either through thematic units that were thought within certain courses (chemical poisons in Chemistry, first aid in Biology, etc.) or within the scope of the course of the National Defense and Social Self-Defense, which was an integral part of the secondary school and university education.

Over the past 30 years, we witnessed the breakdown of the system developed by the SFRY, but we did not get a functional replacement. In pre-school institutions, children receive basic knowledge in this field, which is sometimes very good and interestingly interpreted (training for the use of water bombs), but it is not systematically organized. In primary school education, in textbooks for the fourth grade course Nature and Society, a well-presented thematic unit related to the flammability of materials and fires was introduced [14,15]. Similarly, topics related to environmental protection, traffic safety, renewable energy sources and recycling were introduced into the education system. It is considered to be an appropriate way of education at the primary school level; although it could be discussed how often this approach should be applied – if not more frequently, then at least once again in the eighth grade of the primary school.

Secondary school education is not homogeneous as primary school education, since it depends on the type of school in question: grammar school, technical schools, economics schools, medical schools or art school. Therefore, in the first grade, a thematic unit related to fire protection could be linked to a general course that everyone attends, such as Chemistry, whereas in other grades, during the school year, one of the periods of the class master would be assigned to an expert (one of the school teachers, e.g. chemistry teacher, or person in charge of fire protection), to carry out training and evaluation of knowledge.

At higher education institutions, a lecture on this topic should be made mandatory in each academic year, if the training in fire protection has not become a compulsory part of the preparation for student internship.

Considering that for the employed, training at the workplace is mandatory, for the rest of the population (unemployed, pensioners) there are short form thematic materials broadcasted by Radio Television of Serbia [16] in adequate terms, thematic lectures organized by professional institutions (firefighters associations, civic associations, educational institutions), and websites of the competent ministry, provincial and municipal bodies.

4. PRACTICAL PART

In view of the aforementioned, and bearing in mind the fires in Novi Sad in the Lounge Café (February 17, 2008, 8 dead) and the Contrast Disco Club (April 1, 2012, 6 dead), the Firefighting Association of the city of Novi Sad, led by its secretary, Ms Ljubica Krnjajić, launched the “Project for education of pupils on fire protection”, with the support of the City Administration for Culture and Education of Novi Sad and the active participation of the Higher Education Technical School of Professional Studies in Novi Sad.

The target group of this project is secondary school and university students since according to the two above-mentioned dreadful fires they are seen as the potentially most vulnerable group, which needs to be quickly and qualitatively educated, bridging the gap until a functional system is developed. Activities on the project started in May 2012, covering several secondary schools in Novi Sad (“Pinki” Traffic Secondary School – 1113 participants, “Isidora Sekulić” High School – 533 participants, “Pavle Savić” “April 7” Medical School– 1291 participant) [17], in Srbobran (“Svetozar Miletić” High School and Economic School – 156 participants) [17] and in Srpska Crnja (“Đura Jakšić” Secondary School – 141 participant) [18].

Prior to the education, the students were surveyed using a questionnaire with 10 questions (Table 1), then they had one school period of 45 minutes of education, and finally, they were re-interviewed with a questionnaire having 16 questions (Table 2). The questions 1-10 of the latter questionnaire are the same as in the first questionnaire, while the questions 11-16 are somewhat more difficult, hence it is expected that only very attentive listeners can give answers. The first survey was anonymous, whereas the participants were asked to sign the second survey sheet.

The surveys and education were conducted by the students of the Fire Protection study programme of the Higher Education Technical School of Professional Studies in Novi Sad, within the practical preparation of their final thesis in basic professional studies. The 45 minute education has the following structure: 1. Introductory part – introduction of the lecturer and viewing footage on the fire in the discotheque (10 minutes); 2. Fire protection lecture using a Power Point presentation (30 minutes); 3. Questions from the audience (5 minutes).

The content of the Power Point presentation is very similar to the content of the Firefighting Association of Serbia programme from 1985, with minor differences, and it is reduced to the basics of fire protection that each citizen should know, including the following thematic areas: what is fire and how it occurs; why it is important to prevent a fire; what and how burns; what to do in case of a fire; behavior of people in a fire; brain functions during a fire; how to extinguish a fire (use of a fire extinguisher); how to recognize a fire in a building (signals); how to evacuate from a building; how to get a safe school.

5. RESULTS

When comparing the results of the survey before and after the education, it can be seen that the level of knowledge of students even after this short education has increased significantly, considering the questions 1-10 and to some extent the seriousness, having in mind the free form of answer number 4 to question number 8 (in the first survey there were a number of malicious responses to this question, while their number in the second survey was negligible). It is also noticeable that the students of the older grades show a higher level of knowledge and seriousness in relation to those from the first and second grades.

The analysis of circled answers to questions, sorted by the number from the survey, led to some observations on the knowledge and understanding of students about fire protection, which are summarized below.

Table 1. The questionnaire to assess the level of knowledge prior to the education

	Gender: Male Female	Grade: I II III IV			
1.	Are there marked evacuation routes in your school?	Yes	No	Don't know	
2.	On what phone number can you call firefighters in case of fire?	93	193	195	None of these
3.	Who should organize evacuation in case of fire in your school?	1. Principal 2. Class master 3. Teacher who happens to be in class or in the vicinity 4. School caretaker or security officer			
4.	Do you know where fire extinguishers are in the school?	Yes	No		
5.	Is it important to know how to use a fire extinguisher?	Yes	No	Perhaps it is.	
6.	Are there wall hydrants in the school?	Yes	No	Don't know.	
7.	Do you think it is necessary to introduce lectures on fire protection basics into curricula?	Yes	No	Don't know.	
8.	What would you do in case of fire?	1. Leave the room and call firefighters. 2. Try to extinguish the fire with a fire extinguisher or handy tools. 3. Activate a manual fire alarm. 4. ____________________________			
9.	If you hear a fire alarm, but do not see any signs of a fire, what would you do?	1. Ask what is happening. 2. Act in accordance with the displayed fire safety guidelines. 3. Ignore the alarm.			
10.	Is it safe to use a lift in case of fire?	Yes	No	Don't know.	

1. The fourth grade students are much better informed than younger students about the existence of evacuation routes in the school building. 2. All students are equally familiar with the telephone number of the fire fighting and rescue service. 3. Pupils generally consider that in case of school evacuation, they should be led by the teacher who is in class, which is correct thinking. 4. Most students know where fire extinguishers are placed. 5. The majority believes it is necessary to know how to use a

fire extinguisher. 6. In proportion to the length of time spent at school, students know that there are hydrants in the school. 7. The fourth grade students showed highest maturity, most responded that it was necessary to introduce fire protection into curricula, then followed the third grade students, while the first and second grade students in most cases responded negatively. 8. Prior to the training, the dominant answer was *I would leave the room and call firefighters*, but after the training, the number of proactive responses increased *I would try to extinguish the fire with a fire extinguisher or handy tools*, and almost equated with the number of answers under 1., to this question. 9. Prior to the training, the dominant answer was *I would ask what is happening*, and afterwards they selected the correct answer *I would act in accordance with the displayed fire safety guidelines*. 10. A larger number of students know that the lift must not be used during a fire.

11. When asked *If a fire breaks out on an electrical device, what would you use to extinguish it?* considering the picture in the presentation, where a toaster is extinguished by a towel, most of the answers were under 3 – blanket. During the presentation, when fires on electrical devices were discussed, it was mentioned that if the device is disconnected from the electricity supply it can be extinguished with water, so there were answers *with water*, but they added *after turning off the device*. Answer number 4 *with the powder* was given by few students, because probably the rest did not know what it meant, so the answer should be changed to *with powder extinguisher*. 12. To the question *What causes most casualties in fires?* most students answered correctly *combustion products (CO)*. 13. To the question *Can a cigarette cause a fire?* almost all of them answered affirmatively. 14. When asked *If you are in a burning multi-storey building, you will exit…* the majority responded *using evacuation routes*, which means they understood the rules of evacuation from the facility. 15. When asked *Who can use a fire extinguisher and a hydrant in the school?* most responded that everyone could use it, which is the correct answer. 16. At the end of the survey, the final question was *How is your school informed, or alarmed in the event of a fire?* most students answered correctly, because this topic was especially emphasized during the lecture.

Table 2. The questionnaire for assessing the level of knowledge after the education

11.	If a fire breaks out on an electrical device, what would you use to extinguish it?	1. Sand 2. Water 3. Blanket 4. Powder
12.	What causes most casualties in fires?	1. Fire (heat, flame) 2. Combustion products (CO) 3. Structure collapsing
13.	Can a cigarette cause a fire?	Yes / No / Don't know
14.	If you are in a burning multi-storey building, you will exit ...	1. Jumping out of the balcony. 2. The same way you entered (familiar way). 3. Using the marked evacuation route.
15.	Who can use a fire extinguisher and a hydrant in the school?	1. Auxiliary staff 2. Teachers 3. Everyone 4. Principal
16.	How is your school informed, or alarmed in the event of a fire?	1. One long bell ringing 2. Shouting (fire, fire!) 3. Triple bell ringing

6. CONCLUSION

The introductory part of the paper provides an overview of the relevant international documentation pointing to the necessity to develop a system of education in the field of fire protection within the education system of the Republic of Serbia.

Furthermore in the paper, the current state of affairs in this area (in legal regulations and in practice) is presented, as well as a pilot project in a practical attempt to solve the problem described, aiming to increase the resilience of the society to fire as a form of emergency situation.

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THE INFLUENCE OF AGGREGATE TYPES ON THE CONCRETE FIRE RESISTANCE

Abstract: The paper presents the basic principles and methods for calculating concrete structures exposed to fire in accordance with European regulations, and describes the development of degradation of concrete in the function of temperature increase. It has been shown that the choice of applied types of aggregates and additions has a significant effect on the concrete fire resistance. In this sense, it was concluded that the concrete with dolomite aggregates, limestone aggregates, recycled aggregates of brick, tile and granulated slag, have an advantage in comparison with the aggregates with higher quartz content.

Key words: concrete structures, design, concrete, aggregate, addition, steel for the reinforcement of concrete, characteristic strength, fire resistance, experimental research

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1. INTRODUCTION

Because concrete composites are materials with the highest application in contemporary building structures, it is of great importance to know their fire resistance.

According to the decision of the European Commission (94/611/EC), which was published in the official journal of the European Community No. L 241/25, according to EN 13501-1 [5], the concrete is classified as Euro Class A1, which does not require a fire resistance testing. It is assumed that such a concrete consists of natural aggregates, conforming to EN 12620 for normal-weight aggregates and heavy-weight aggregates and EN 13055-1 for light-weight aggregates, cement conforming to EN 197-1, water conforming to EN 1008, admixtures conforming to EN 934-2, additions conforming to EN 12620 for powder aggregates, EN 12878 for pigments, EN 450 for flying ash, EN 13263 for silica fumes or other inorganic component materials conforming to EN 206 [6]. However, it is noted that the stated fire resistance refers to temperatures up to 100°C, and it is known that in the conditions of fire significantly higher temperatures can develop.

2. EUROPEAN REGULATIONS FOR THE FIRE DESIGN OF CONCRETE STRUCTURES

In terms of designing concrete structures, in accordance with European regulations, the standard fire conditions for concrete structures are defined in the range from 20°C to 1200°C, which also applies for the properties of the material. In respect to this, the characteristic values of compressive strength of concrete and tensile strength of reinforcement, bars, wires and strands for prestressing are corrected by appropriate coefficients.

In Fig. 1, the subject code correction coefficients for characteristic strengths at elevated temperatures are presented.

Also, according to EN 1992-1-2:2004, the verfication methods for load-bearing capacity and behavior of elements of reinforced concrete and pre-stressed concrete structures exposed to fire are defined. Practically, the simplest are the applications of constructive measures, which satisfy the majority of the needs of the application of the subject standard, and are based on the procedure for the application of tabulated data, which allow for the required fire resistance, expressed in terms of 30-, 60-, 90-, 120-, 180- or 240-minute fire resistance, to determine the minimum dimensions of the cross-section of the element and the minimum axis distance of reinforcing or prestressing steel from the nearest exposed concrete surface.

In addition to the above mentioned, the simplified calculation method and the advanced calculation method have been defined. The simplified cross-section method determines the temperature profiles in the cross-section (the distribution of the temperature in the cross-section of the element), reduces the cross-section, strength and short-term module of elasticity of concrete and steel, and with such reduced cross-section defines ultimate load-bearing capacity of the structure and compares this capacity with the relevant combination of actions. Advanced calculation methods are based on detailed thermal and mechanical analysis of structural members, parts of the structure or the entire structure, in order to assess its behavior under fire conditions [7].

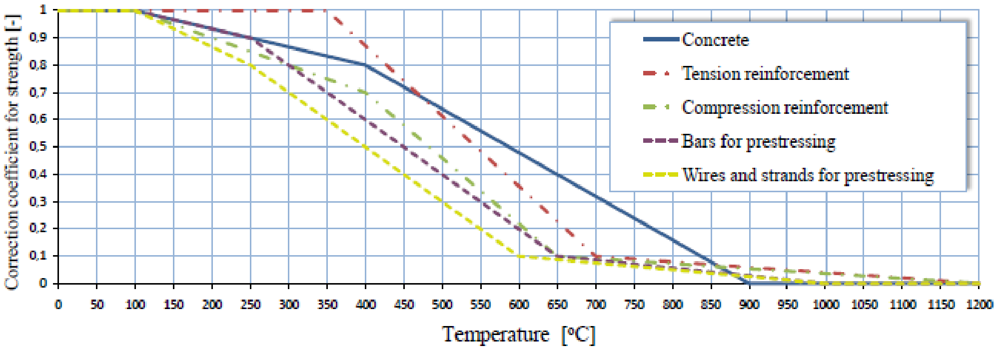

Figure 1 – Correction coefficient for characterstic strength of material at elevated temperatures, EN 1992-1-2:2004

3. BEHAVIOUR OF CONCRETE UNDER FIRE CONDITIONS

In the action of high temperatures on concrete, the thermal incompatibility of cement stone with grain aggregates and reinforcement is especially evident. Elevating the temperature, water from cement stone is lost, which leads to its shrinkage, and at the same time increasing the temperature causes an increase in the volume of the aggregate grain. Due to these processes the bond between the cement stone and the aggregate is weakning, there are cracks and spalling, and at the same time the connection between the concrete and the reinforcement is weakning. Namely, already at a temperature of 40°C, free water from capillary pores begins to lose, and to a much lesser degree, physically bound (gel) water also. Furthermore, with the long exposure of concrete to a temperature of 100°C, all free capillary water is lost, at 200°C, all physically bound water is lost, while chemically bound water in cement hydrates is lost at 400°C.

When the temperature of reinforced concrete reaches 250°C, the yield strength of steel bars is reduced, and at 500°C it is reduced so much that there is a risk of structure collapse. Also, at such high temperatures, the transformation of certain aggregate particles occurs (more detailed in Chapter 4) i.e. resulting in the loss of their strength. However, in these chemical reactions, heat energy is consumed, and the advancement of the high temperature towards the interior of the element is slower (to which certainly contributes to the relatively high thermal capacity of the concrete), i.e. damages are mainly in the surface layer of concrete and surface zones, if any, which are less compact - segregation sites, concrete pour break, and also in the reinforcement bar zone. Therefore, due to different temperature gradients, the heated surface layers crack and separate from the cooler inner parts. In the long-term effect of fire exposure, after damaging, separating and spalling of the surface layer of concrete – Fig. 2, the fire acts directly on steel, which then represents a very good conductor of heat to the interior of the element, which further leads to serious damage and, finally, demolition of structures – Fig. 3 [11,13,17].

Presented concrete behavior in the event of fire refers to conventional concrete. It is noted that concrete structures, whose functionality is related to the resistance to the action of temperatures higher than 100°C, are designed to be so called fireproof or refractory concrete.

Figure 2. – Separation of the surface overburned layer exposed to fire [2]

Figure 3. – Colapse of floor construction, exposed to fire [19]

4. INFLUENCE OF AGGREGATE TYPE ON CONCRETE FIRE RESISTANCE

Research [3,4,8,9,10,14,15,18] indicate that, in addition to other parameters, the applied type of aggregate in concrete can have a significant impact on its resistance under extreme high temperature conditions.

Aggregates, obtained from of igneous rocks (granite, dacite, senitite, diorite, adensite, gabar, basalt, diabase), are generally characterized by good resistance to the action of elevated temperatures, although they contain mineral quartz. However, given the fine-grained structure with well distributed mineral content and proportionally relatively low content of quartz, this circumstance has no significant influence (Mineral quartz, has a significantly higher coefficient of thermal dilatation from the other mineral components of igneous rocks, so that for example, quartz expandes four times more than feldspars, and twice as much as hornblende, which will subsequently be discussed [13]).

The effect of high temperatures can affect the chemical degradation of aggregates of sedimentary rocks - primarily limestone and dolomite, since their mineral components - calcite ($CaSO_3$) and dolomite ($CaSO_3 \cdot MgCO_3$), at temperatures around 870°C (for calcite) and 800°C (for dolomite), turn into CaO and MgO oxides. However, for the complete decomposition of one carbonate rock, a long-term effect of high temperatures is required, so possible chemical changes in short-term fire exposure do not affect the physical state of the material, while in the case of intense fire exposure, they are mainly reflected only in surface degradation [13].

From the aspect of resistance to fire, the least favorable aggregates are obtained from rocks of metamorphic origin, primarily of quartzite rocks. Namely, due to a significant content of quartz (quartzites are monomineralic rocks, constructed almost entirely of the mineral quartz SiO2 - over 98%), which in conditions of intense heating is considered most critical mineral of solid rock, at elevated temperatures (over 500°C) they show signs of degradation - cracking. Namely, quartz, at a temperature of 50°C, increases its volume by 0,17%, while the largest expansion in the temperature range of 573°C, when polymorphic transformation from the so-called normal α quartz becomes high-temperature β quartz [1].

Experimental investigation, carried out on concrete made with aggregates of different origin, has shown that longer exposure of concrete to a temperature of 250°C does not cause detrimental effects in terms of concrete strength, made with limestone aggregate, and especially with a dolomite aggregate, but in the case of concrete made with quartz aggregate, a critical temperature is about 100°C [3]. Also, experimental research of I. Netinger et al. [15] show that concrete with a river aggregate, compared to the reference concrete made with crushed dolomite and recycled aggregates of brick, tile and granulated slag, show a more pronounced decline of mechanical properties after reaching a temperature of 400°C. In addition, it is noted that the use of addition - silica fume, fly ash and ground granulated blast furnace slag, in the concrete composites, increases the concrete fire resistance [3,12,14,15,16].

5. CONCLUSIONS

The concrete structures fire resistance, can be, in addition to a number of constructive measures, also improved by the appropriate choice of component materials, which are used in in the concrete.

The research has shown that the thermal incompatibility of cement stone with a grain aggregate and reinforcement is particularly evident in the action of high temperatures on concrete. In this sense, dolomite aggregates, limestone aggregates, recycled aggregate of crushed brick and granulated slag, may be preferred. As the least favorable aggregates from this aspect, are the grains with higher participation of quartz minerals. It is also confirmed that the use of additions such as silica fume, fly ash, and granulated slag, have a favorable impact on improving the concrete fire resistance.

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