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2-nd INTERNATIONAL SYMPOSIUM
K-FORCE 2019

BOOK OF PROCEEDINGS

K - F O R C E

Knowledge FOr Resilient soCiEty

UNIVERSITY OF TIRANA, FACULTY OF ECONOMY, DEPARTMENT OF FINANCE
Tirana, Albania

EPOKA UNIVERSITY, FACULTY OF ARCHITECTURE AND ENGINEERING
Tirana, Albania

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

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PREFACE

The Faculty of Economy, University of Tirana, Epoka University in Tirana and the University of Novi Sad, are organizing the Second International Symposium Knowledge For Resilient soCiEty -K-FORCE 2019, within Erasmus + K-FORCE project.

Natural and man-made disasters, including floods, landslides, earthquakes, storm winds, hail, drought, wildfires and building fires, are on the rise in the last decades in the Western Balkans. Human casualties, extensive damages to the urban areas, negative impact on the environment and further weakening of the regional economy are evidence of increasing vulnerability in the region.

Resilient societies are based on knowledge and training, as well as preparedness. Building synchronized regional capacities in higher education, according to regional needs and contemporary trends, is a first step towards building resiliency of our region. In the light of these observations, the K-Force project has contributed in promoting and developing higher education studies in the field of Disaster Risk Management and Fire Safety Engineering.

In line with the overall objectives of the K-FORCE project, this symposium will be dedicated to discussing current issues in education, science and practice in the field of Disaster Risk Management and Fire Safety Engineering. Contributing not only to education, this project has also produced valuable research. The papers included in this collection are some of the outputs of this research. A significant contribution in this book is one student's paper produced by using Student Centered Learning Methodology, a methodology promoted and applied within the K-FORCE new programs of studies. The new knowledge produced following the strong collaboration between project partners will benefit practitioners, scientists and students working or studying in the field of Disaster Risk Management and Fire Safety Engineering.

Editors

ORGANIZERS OF THE SYMPOSIUM

The Faculty of Economy (FE), established in 1952, became part of the University of Tirana (UT) in 1957. At that time, FE offered majors only in two branches: Economics and Accounting. During the years that followed, the Faculty was enlarged, and in 1990 it offered majors in six branches. After 1991, FE was reorganized and restructured radically in form and content. Today, approximately 3000 students are enrolled in Bachelor studies, over 1500 are Master students and approximately 250 are post-graduate students.

Epoka University is an international HE institution located on a smart campus between the international connections and trading crossroads of Durres Port and Rinas Airport in Tirana, the capital of Albania. The University commenced academic activities during the 2007-2008 academic year. All institutional strategies of Epoka University are built on the "Education, Research and Contribution to Society" triangle. Epoka currently offers Bachelor, Master and Doctorate degrees taught in English, in 32 different programs within three faculties: Faculty of Architecture and Engineering, Faculty of Economics and Administrative Sciences, and Faculty of Law and Social Sciences.

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.

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BARRIERS AND OPPORTUNITIES FOR MUTUAL LEARNING BETWEEN RESEARCHERS AND PRACTITIONERS IN SOCIETAL SAFETY

Abstract: Actors within the area of societal safety face increasing challenges in successfully organizing risk management activities, e.g. due to the complexity, uncertainty and ambiguity of the risk problems they face. In such contexts, researchers can provide valuable input in the development of work practices, but at the same time, they are dependent on practitioners to be able to conduct the research used to inform change. Significant opportunities for mutual learning between researchers and practitioners exist; however, there are also significant barriers for such mutual learning to actually take place. This paper reports on an in-depth, 3-year collaboration with the municipality of Malmö, Sweden, on issues related to Risk and Vulnerability Assessment. Based on our experiences, we will present both barriers and success factors, hoping that these can initiate a discussion on how to successfully organize researcher-practitioner collaboration, while fulfilling the set of goals that each of the two parties have.

Key words: Research practice collaboration, success factors, societal safety, risk and vulnerability assessment.

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1. INTRODUCTION

Societal safety concerns the ability of society to maintain vital functions and protect the life and health of its citizens as well as to meet their needs in times of crises [1]. Organizations with responsibilities in the area of societal safety, including both public and private actors, are facing ever-increasing challenges to successfully organize and conduct their work to minimize the occurrence and/or consequence of events that may harm human life and health, the environment, economy, functionality of society or other values. The threats these organizations face, typically require a risk governance approach [2, 3] since single actors neither have the complete overview, nor the overall mandate, to manage these risks; hence, giving rise to a need for actions by, and negotiations between, multiple actors.

In such contexts, there is no obvious best work practice that straightforwardly can be adopted; although, there is plenty of more or less concrete normative advice in the literature. Therefore, a plausible approach is to constantly monitor, reconsider, revise, and adapt work practices in order to strive for increased successfulness and higher effectiveness of risk governance. This can be achieved both by learning from own experiences as well as from the experiences of other actors facing similar risk problems.

However, since most crises in the context of societal safety are rather rare, there is a limit to the potential for learning from past events and incidents [4]. Instead, analytic risk control strategies are often needed which emphasize the need to perform various types of proactive assessments, such as risk, vulnerability and capability assessments [5] or assessing leading safety performance indicators [6]. However, the successfulness and effectiveness of such proactive work are inherently difficult to evaluate due to limited empirical feedback [7].

In order to learn from work practices that can also facilitate other actors' learning, systematic and comprehensive evaluation studies should be devised. Such studies should strive to answer not only whether, or to what extent, a particular work practice has been successful, but also *why* it was successful (or not), since this would enable other actors, possibly operating in different contexts, to adapt lessons learned in their particular context [8]. Although it is possible for each actor to perform such comprehensive and systematic studies independently, there may exist budgetary limitations, motivational limitations, or limitation of competency. This is especially the case for public actors, such as municipalities and other public authorities, where risk and crisis management is not a core activity.

We argue that in contexts such as the one described, in-depth collaboration between researchers and practitioners can be a valuable component in the development of work practices for organizations in the area of societal safety. In addition, the collaboration would enable the researcher to perform in-depth studies in order to make scientific progress as well as to inform the work practices of other actors. Hence, such collaboration constitute a significant opportunity for mutual learning between researchers and practitioners.

However, successfully carrying out in-depth collaboration so that mutual learning can take place can be highly challenging where significant barriers and obstacles exist. The aim of this paper is therefore to identify and reflect on factors believed to enable successful collaboration as well as barriers for successful collaboration. The paper is based on experiences from an in-depth, 3-year collaboration between researchers at Lund University and the municipality of Malmö, Sweden, on issues related to Risk and Vulnerability Assessment. We hope that our experiences can initiate a discussion on how to successfully organize researcher-practitioner

collaboration while fulfilling the set of goals that each of the two parties have; as well as to influence the design of similar collaborations in the future.

2. POTENTIAL BENEFITS OF RESEARCH-PRACTITIONER COLLABORATION IN SOCIETAL SAFETY

Collaborations imply costs for the involved parties – e.g. in terms of additional time and money spent than would have otherwise have been the case. Obviously, to be worth it, collaborations must be associated with more benefits than costs and there must be *mutual benefits* since it would otherwise be difficult to motivate engagement from all actors. Below, examples of what such perceived benefits could be are described. Of course, the exact benefits are unique for each particular collaboration; hence, only generic categories are highlighted here.

1.1. From the researcher's perspective

Typically, the researcher is primarily interested in making *scientific contributions*. In this regard, collaborations can offer an opportunity to gain access to empirical data in a way that would otherwise be much more difficult to initiate. If managers, key personnel, etc. within the target organizations understand and/or observe the organizational benefits of the collaboration then they can help legitimizing the researchers and make data collection more efficient. In addition, this can potentially also result in collected data becoming richer and of higher quality since respondents may devote more time and effort into e.g. answering questions.

Becoming deeply involved in a collaboration process with practitioners also enable the researchers to move beyond collecting idealized and/or superficial data that they are otherwise sometimes "forced" to use (although this can of course also provide interesting insights). This could for example constitute the use of idealized experiments (not capturing real world complexities), official documentation (typically not able to capture the often-times messy road towards an outcome, or interviews and questionnaires taking place with larger "distance" from the actual work practices. Instead, collaboration processes may facilitate the collection of data that better represents the complexity of real-world risk and safety related activities. Hence, this may increase the validity of the data and provide insights into practical challenges and constraints, which would have otherwise been impossible to gain insights about. Understanding the complex and often messy process to reach an end would also be very difficult without getting deeply involved as the process unfolds. Therefore, yet another purpose of engaging in collaborative processes with practitioners is simply to gain understanding of the practical context and to identify new relevant research questions that could be address in the future.

Finally, sometimes the researchers get an opportunity to use the target organization to test ideas and hypotheses, which means they would have access to a real world experimental test bed. Of course, in such a situation the researcher must be very cautious about potential negative consequences of unsuccessful "experimentation".

In addition, to scientific contribution, a secondary objective may also be to make a direct *practical contribution*, i.e. to assist the target organization in developing their work risk management practices. Such an objective would imply e.g. some action- [9], design- [10, 11]

or evaluation- [12, 13] type of research. This practical contribution is of course one of the main benefits of the practitioners' engaging in the cooperation (see below for an extended description of such potential benefits). From the researcher's perspective, there are also some positive side effects from the practical contribution. In many countries, the "the third task" of universities – creating societal impacts – is stressed. However, although this is sometimes encouraged, the incentives to engage in the "third task" are generally quite small. Furthermore, making direct practical contributions may also legitimize the research activity increasing the potential for satisfaction among research funding agencies. The Swedish Civil Contingencies Agency is an example of funder who actively support researcher-practitioner collaborations.

1.2. From the practitioner's perspective

The primary benefit of a collaboration from the practitioner's perspective is typically to get support in *understanding and improving work practices*. This could be achieved through a design research process where the aim is to develop an artifact (method, technique or tool) that can be used to solve relevant problems in the organization [10, 11]. But it could also be achieved by involving researchers in evaluation of a project or a program within the organizations, either by designing a comprehensive formative evaluation process or more loosely act as the constructively critical sounding board for the practitioner. Furthermore, advice on modifications of practices could also be obtained through an action research process. Note that in design, evaluation, and action research, the researchers are very active in providing normative guidance to the practitioners. However, purely descriptive research can also support development of work practices, with the difference that the practitioners themselves translate the descriptive findings to normative implications. Finally, researchers can also be used to increase the the practitioners' general level of knowledge concerning risk and safety issues, e.g. through lectures and educational workshops, etc. Such activities could run in parallel to scientific data collection.

A secondary objective is that the practitioner may also be interested in *contributing to scientific progress* since new insights may be used by the target organization or similar organizations to design risk management activities in the future. Some organizations, especially larger, public organizations, may also have formal objectives of engaging with researchers, which would further stimulate researcher-practitioner collaborations.

3. CASE STUDY – COLLABORATION BETWEEN MUNICIPALITY OF MALMÖ AND RESEARCHERS FROM LUND UNIVERSITY

1.3. Background

Researchers from Lund University have been involved in a collaboration with the Municipality of Malmö since 2016. The collaboration has been oriented around the performance of Risk and Vulnerability Assessments (RVA), which are conducted due to a regulatory requirement. The aim has been to develop, implement and evaluate a method for RVA and to understand broad challenges and success factors for achieving successful work processes in connection to RVA. In the collaborative process, the researchers have engaged with the coordinating unit in the municipality as well as with representatives from the

municipal departments. Numerous workshops (with method trials and evaluations), interviews, questionnaires and participatory observations have been conducted to collect data. Additional information and results from the collaboration can be found in e.g. [7, 14-16]

1.4. Conditions for successful collaboration

A number of conditions have been identified as beneficial in order to succeed with the collaboration. Note that these success factors have been highlighted throughout the collaborative process where the concrete evidence is varying and sometimes limited. Instead, they represent the subjective views and beliefs of the authors involved in the process after having engaged, and discussed challenges, with representatives from the municipality.

Balanced and continuous mutual benefits

It is important that both parties experience significant mutual benefits and that these are experienced along the whole collaborative process. In contrast to situations where one of the actors only get benefits early (which may reduce the motivation to continue the collaboration) or late (which would create a "risk" since one of the actors would receive no benefits if the collaboration for some reason ends before completion).

In the collaboration with the municipality of Malmö, benefits have been achieved by both actors throughout the collaboration. Early in the process, researchers could learn about the challenges and conditions for the RVA work and later on learn about how the practitioners can make use of the developed RVA and how effects of using RVAs is starting to become visible. Practitioners have received advice on how to organize their RVA work from the early stages of the collaboration and competence development activities have been arranged continuously.

Clear roles and expectations and shared understanding of problem situation

Roles and expectations between the different collaborators must be clear. This could concern transparency regarding what the researchers intend to achieve with the collaboration, what perspectives the researchers have and how the information collected will be used. It also concerns having at least some general agreement concerning the problem picture and what the most imminent issues and challenges for the RVA work are. Here, it is clear that understanding the problem picture requires extensive dialogue between the researchers and the practitioners, who have the more in-depth insights regarding the target organization and its context. Seeking diversity of views is also recommended since a single person only has a partial view of the the conditions and needs of different parts of the organization.

In the collaboration with the municipality of Malmö, the roles and expectations were not always clear. This especially had to do with developing guidebook for the method being developed. The support material related to the method for RVA (which was the main responsibility of the researcher); however, some of the support material was being customized for the municipality of Malmö which meant it was of less general applicability and thus of less relevance for the researchers. One way of addressing this was to involve the researchers as consultants to solve such more technical tasks, which were not to be regarded as research tasks. Furthermore, in the early stages, the researchers assumed a single person's views of the problems as being representative for the organization, which was later on realized not always

to be the case. Hence, actively searching for diversity of views provides a richer picture and hence greater possibilities for successful collaboration.

Creating and maintaining trust relationships

Mutual trust is critical for successful collaboration – both in terms of gaining trust and maintaining it over time. Showing a genuine interest in supporting the target organization and being honest and transparent with what data is collected, how it is being used and what information is presented to other external actors is critical aspects to consider for the researcher. Obviously, research collaborations with public organizations are generally easier, than compared to private, since confidentiality issues due to competition is not a major concern. Still, public organizations may not want to share information that may give them a bad reputation or where the information can be sensitive and exploited by malicious actors – which has become a growing concern in Sweden lately [17].

Upscaling and long time perspective

It has been seen as important to initiate the collaboration in small scale and then scale up the efforts. The collaboration needs to be anchored on the "right levels" of the organization since this can support the promotion of the collaboration with other parts of the organization – rather than the researchers having to do all of the anchoring work on their own, which is believed to be both a challenging and comprehensive task. Furthermore, the researchers should be aware of the fact that both anchoring, development and implementation of e.g. a RVA method can take a long time in large organizations, which means that both the researchers and the practitioners must adopt a long time perspective before they can expect to see significant positive effects. A natural part for the researcher, as well as the practitioner, is having long-term idea of how to fund the project.

1.5. Barriers for successful collaboration

Several barriers and challenges also exist to achieve a successful researcher-practitioner collaboration – in addition to not adhering to the success factors previously described.

Time consumption

Obtaining in-depth knowledge of a large, public organization takes long time and hence requires a strong commitment from both the researcher and the practitioner. In order to be able to study the effects of implementing an RVA process, which has been one of the interests in the present collaboration, there is a need to solve numerous practical issues (such as developing tools, guidance, templates, educating employees, answer questions, etc.). Many of these practical issues, which are time-consuming to address, are not really within a research scope; however, it is instrumental in getting to the next stage of the research process. It is therefore tempting for a researcher to keep a "longer distance" to the practice, and rather limit the study to conduct interviews as an "outsider" or conduct document analyses. Although this can also provide valuable insights, it cannot replace the more in-depth knowledge gained through close interaction.

Translating theory into practice

Research on risk management and governance include many theories and normative advice on how to use key concepts, how to conduct RVA and how to organize risk management processes (see e.g. [3, 18]. However, in many cases it is not straightforward to apply such advice in a particular context and the efforts of translating theory into practice is sometimes underestimated by the researcher. The organizational context, current work practices, historical developments and level of knowledge in the organization cannot be disregarded. To mention one example, in [19] a risk management theory addresses the proper relation between an analyst and a decision maker arguing how each of the two parties should act in a decision situation. In reality, though, making decisions in a political organization is typically more complicated where there are many employees at different hierarchical levels (political, official, municipal, departmental, unit, etc.) that may be the decision-maker depending on what the decision concerns. There may also be occasions where the analysts themselves make decisions (especially concerning small-scale measures). Hence, making use of advice from idealized cases described in the risk management literature is not always straightforward.

Secrecy and confidentiality issues

Information security is a growing concern for Swedish public agencies considering the increased awareness of threats from malicious actors that may exploit sensitive information. Increased attention to civil defense and heightened alert makes public agencies more reluctant to share information with external actors [20]. In addition, even though primary data can be collected there are limits to what information can be published in scientific journals reducing the potential scientific contributions of the researchers. Often, this can be circumvented through formal agreements and open discussions and at least when it comes to the collaboration with the municipality of Malmö, sensitive results, such as detailed results from the RVAs, have never been in the interest of the researchers to publish.

4. CONCLUDING REMARKS

The present paper has summarized some of the success factors and barriers for achieving mutual learning through researcher-practitioner collaboration. The findings are based on experiences from a 3 year long collaboration between Lund University and the municipality of Malmö regarding developing and implementing Risk and Vulnerability Assessment processes. Further research should aim to examine the validity of these claims, e.g. through comparisons with other collaboration.

It is worth highligting that one of the most interesting lessons learned from the collaboration is that many of the identified main obstacles for achieving successful RVA-processes had to do with broader aspects than those where the risk science can provide good input. Risk science can provide the baseline for how to define and operationalize risk concepts, main components of a state-of-the art RVA method, etc. This is important; however, succeeding with implementing RVA processes have more to do with integrating RVA into other work processes, managing staff turnover, showing the value of engaging in RVA work,

etc. These insights call for a multi-disciplinary approach for fully understanding and addressing challenges in practice in the area of societal safety.

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INFORMATION INFRASTRUCTURE OF SMART CITIES, EXPERIENCES FROM NOVI SAD

Abstract: Modern built environments, highly technologically equipped, populated by persons with well-defined life routines, are recognized as a unique phenomenon, one of the identifiers of this entity is the Smart City. The aspects of seeing this phenomenon are diverse, as are the contexts in which it can be placed. It can be the subject of interest of citizens themselves, government institutions, service or emergency services, the media, non-governmental organizations, corporations, supply organizers and many other aspect-driven stakeholders. Also, the subject of interest can be identified through the context of the implementation of administrative procedures, hazardous situations or entertainment activities, situations resulting from urban climate or settler activity, etc. To enable the existence and cohabitation of all of the above, an integration platform is needed that creates a data structure or, better, an infrastructure equivalent to this phenomenon. A platform that allows this community to be viewed as a data producer and information user.

Key words: Smart, Cities, Platform, Technology

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1. INTRODUCTION

The urban environment, where the acquisition of data related to citizens, their assets and infrastructure of living and coexistence is made possible, is today viewed as a "Smart City" (Figure 1.) context model. This includes data collected from citizens, devices and property that is processed and analyzed to monitor and manage traffic and transportation systems, power plants, water supply networks, police, information systems, schools, hospitals and the like. Particularly emphasized is the integral risk management, both in the case of the realization of an individual risk and in a multi-standard context.

The infrastructure to support this concept should include:

- Mass variable acquisition systems for environmental variables.
- Mass variable infrastructure of environment variables.
- Definition Data structure for working with environment variables.
- Extract and understand sets of objects of interest, described by the acquired environment variables.

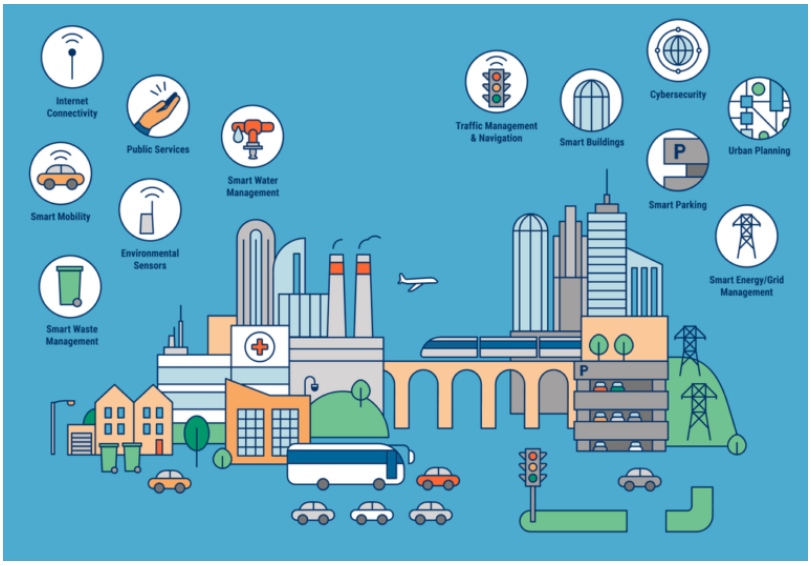

Figure 2 – Smart City (www.cbinsights.com)

Although the concept of building the information infrastructure of the "Smart City" abstraction is a relatively old idea, we have more modern unifying IT platforms, which can be used. When looking at the characteristics of smart city, we can consider the following aspects:

- Smart economy
- Smart mobility
- Smart environment

- Smart people
- A smart lifestyle
- Smart management

The field of smart economics includes projects related to business improvement through innovation. Emphasis is placed on strengthening entrepreneurship and consumer relations. This results in increased productivity and recognition of local firms in the domestic and international markets.

Smart mobility projects contribute to a sustainable, innovative and secure transport system, and in particular to the public transport system.

In the area of smart environment, projects for the protection of water, soil and all natural resources are considered.

Projects in the field of smart citizens are related to education as well as specific forms of education for citizens of all ages. Special emphasis is placed on educational programs that develop citizens' digital skills.

The smart lifestyle area includes projects related to quality of life. It is primarily about improving the health culture and quality of health of all citizens.

The area of smart government includes projects that make public administration transparent and make public and social services accessible to citizens.

In any smart city project or initiative, at least one of the six characteristics above must be present and form the basis of development. Of course, the most successful strategies adopt a multi-dimensional approach to maximize synergy and minimize the negative spillover effects. For example, to prioritize a smart economy strategy that is harmful to the environment.

2. INTELLIGENCE AND DECISION SUPPORT SYSTEMS FOR SMART CITIES BASED ON SERVICE ARCHITECTURE

Information Infrastructure of Smart Cities is particularly interesting in the aspect of integrated risk management. This is the scenario we are interested in:

- An event with catastrophic consequences occurred (real time or off line).
- The person in charge of integrated incident management should have “everything needed to make decision”.
- What needs to be provided, in terms of the functionality of a service oriented information system.
- The chosen methodology should be based on standards.
- Situations of interest to be viewed in 2D and 3D space, and be processed services characteristic of 2D, 3D and temporal data.
- Implementation to follow the relevant directives on a real space-time system.

Intelligence and decision support systems in the area of risk analysis with catastrophic consequences depend on multidimensional spatial and spatial based data. The sources of such data are heterogeneous and often anachronistic. Data formats are based on different standards: ISO, OGC, Industrial, National, Traditional, Informally agreed, or even no standards or arrangements .

Data is the product of modern, technologically advanced systems (sensor systems, GIS, various expert systems), of traditional, often outdated systems. Also the data infrastructure partly exists (2D SDI), partly does not exist (3D SDI).

It is necessary to ensure the interoperability of this data, and a way to market it in a technologically modern and highly usable way.

A particular case that has to be addressed is 3D spatial and spatially based data, their formats, appropriate data structures, interpretation and presentation, services for handling them; in other words 3D SDI [6].

The construction of spatial data infrastructure has been an important and actively followed topic in geographical research for years. A special part is the services required for 3D spatial data infrastructure, as well as the aspects that must be considered in order to build this type of infrastructure. It also concerns policy and decision-making, as well as the harmonization of technologies to reduce time and cost in the construction of spatial services for internal use, as well as for public information services. At European level, the new INSPIRE Directive 2007/2/EC intends to lay down general rules for the implementation of national spatial data infrastructure for environmental policy purposes. From a technical point of view, FDIs should rely on standards adopted by, among others, OGCs (WMS, WFS, WCS, OpenLS ...) [1].

Particularly important services are Data Interoperability Services Interoperability is the ability of two or more autonomous, heterogeneous and distributed digital components (systems, applications, procedures, or datasets) to communicate and cooperate with each other despite any differences in language, context, format or computer platform.

In the absence of interoperability, the following disadvantages are explicitly emphasized:

- Expensive conversions and data sharing
- Data redundancy
- A difficult and complex problem of updating data
- Lack of data

Interoperability is achieved through the Web service. The solution is actually the following combination:

- Service Oriented Architecture (SOA) and Web Services.
- Independent components, based on open transport protocols and XML based standards for data exchange.
- Available over TCP/IP.
- Standards provide interoperability (interface semantics, data coding ...).

Interoperability plays an important role in Web applications. They would be significantly immobilized without the ability to visualize patterns (patterns) in a critically short time. Since many systems are based on closed systems, it is difficult to achieve interoperability and solution to problems arising from syntactic, structural, and semantic heterogeneities between data sources [9]. Today, many researchers agree that adopting open standards is an important approach for realizing the interoperability of geographic information systems and sharing real-time spatial information through the Web [4].

3. INTERNET OF THINGS (IOT) INTEGRATION CONCEPT

The Global Standards Initiative on the Internet of Things (IoT-GSI) has defined IoT as "an information society infrastructure." IoT allows objects to be spotted or controlled remotely

through existing network infrastructure, allowing for the immediate integration of the physical world into computer-based systems, resulting in increased efficiency, accuracy and economic benefit, with reduced human intervention. When IoT is amplified by sensors and actuators, technology becomes an instance of a general class of cyber physical systems, which also includes technologies such as smart grids, virtual power plants, smart homes, intelligent transportation, and smart cities. Each thing is uniquely recognizable through a nested computer system, but is also capable of interoperability within the existing Internet infrastructure.

Internet connected computers become Internet connected things. The basic features of Internet based things systems are:

- Everything communicates: smart things have the ability to communicate wirelessly between themselves and between interconnected objects within an ad-hoc network;
- Everything is identified: smart things are identified by a digital name;
- Everything reacts: smart things can interact with the local environment through readings and activations of existing opportunities.

Like any other technological phenomenon, the Internet of Things is inherently neutral, neither good nor bad. This means that the problems that arise from it depend primarily on how society relates to technology, what choices it makes and what decisions it makes in this regard. In this context, the challenges of R&D to create a "smart world" that connects real, digital and virtual are enormous.

3.1. Semantic sensor networks and observational data

The concept of observational data is treated as data obtained by reading a property of a real-world entity. The result of the observation is the value of this property [5]. Sensors across the city also make observations, making content annotations. Annotations allow for interoperability and detection, making data easier to understand and therefore use.

The W3C Semantic Sensor Network (SSN) is an ontology that aims to describe sensors, observations, and related concepts, such as sensor capabilities and measurement processes. SSN is able to annotate the data so that we can determine which sensor that data is coming from, using which measurement process to read a particular property of the entity of interest. Although they are unable to describe the sensor network behind the data collected, SSN is not based on a standard approach like the W3C PROV-O. SSN is an ontology and does not care about how data is transferred from their collections in terms of formats and datasets. BOnSAI and SMDO (Seasame Meter Data Ontology) are also network sensory ontologies that focus on smart buildings[2].

O&Mis an XML implementation from OGC (Open Geospatial Consortium) that defines a scheme for modeling observations and their results [8]. Some authors proposes an ontology of measurement and observation that uses O&M definitions. The OBOE (The Extensible Obeservation Ontology) is an ontology for observing ecological data, and provides a data model that captures measurement semantics and can be used to integrate data more efficiently [7]. To meet OBOE goals, the ontology contains concepts and relationships to describe observational datasets[10].

HASNetO (Human-Aware Sensor Network Ontology) is an ontology for describing scientific activities related to the collection of observational data, e.g. data obtained by reading

the fire [11]. HASNetO uses three ontologies to accomplish goals: W3C PROV-O, VSTOI (Vertical Solar-Terrestrial Observatory - Instrument Module) [12], and OBOE. By using PROV-O, HASNetO is able to determine the origin of the read data. HASNetO connects VSTOI and OBOE concepts with PROV concepts, allowing the origin of data collection activities to be traced using the W3C standard.

Regardless of the format, no encoding provides an effective mechanism for annotating observational data in a way that supports observations as contextual measurements collected. CSV (comma separated values) lacks the ability to display the semantics that are associated with the data it contains, and thus it is difficult to interpret the data embedded in the CSV file. For example, it can be difficult to determine whether two entries are observationally identical (measured under the same conditions, using the same sensors, in the same area, etc.).

W3C at Web Working Group elaborates techniques to enable access to CSV metadata by describing the content of metadata in a separate JSON file that uses RDF vocabulary. It also proposes contextualized CSV as a format that addresses both content and content restriction in observational data[3].

3.2. HASNetO-SC

Although large enough to provide scientists with enough to monitor their activities, HASNetO (Human-Aware Sensor Network Ontology) faces challenges in dealing with data collected in large and complex environments such as urban environments. One of these challenges is that the data collected has been used not only by the city administration or the people involved in the measurements but also by citizens. Therefore, HASNetO-SC (HASNetO-Smart City) is proposed. The main objective of HASNetO-SC is to provide an efficient way of collecting, preserving and disseminating urban data with an appropriate level of contextual metadata to understand the data itself.

HASNet-SC focuses on smart-city features that have the greatest potential to provide data that can be collected empirically and effectively:

- Smart people
- Smart mobility
- Smart environment
- A smart lifestyle

This extension virtually refines the VSTOI concepts that are integrated into HASNetO to better suit urban data collection.

3.3. Contextualized CSV (CCSV)

CCSV is a CSV extension an addresses content and content restrictions when handling observational data. In this approach, content and contextual metadata are required to obtain a connection between data and metadata. From a smart city perspective, it is necessary to classify the Turtle preamble of the CCSV dataset with the ontological concept of HASNetO-SC

The introduction contains the following descriptions:

- Knowledge based: To enable multi-contextual data collections and make solutions more scalable, the data set is enabled to determine what knowledge to use for validation.
- Implementation: The implementation of information enables the linking of the data transferred by the CCSV dataset to the metadata information: (1) instruments and detectors (sensors), (2) platforms, (3) all attached information, precision, location, platform, etc.
- Data collections: The use of data collection information in a CCSV introduction enables the architecture of the knowledge of a data set: it is able to know whether a particular data set is produced under the same context, or provide the user with sufficient contextual information to determine if the data is within different sets can be compared, merged or analyzed.
- Data Set: Datasets are not scientific constraints on data, but rather are data collection activities. This description links the datasets to their respective data collections.
- Measurements: Describes all measured characteristics. For each type of measurement we associate a unit description and the measured characteristics.

4. HARDWARE PLATFORM

We are witnessing an increasing concentration of populations of different levels of vulnerability, so as to better monitor environmental parameters; we need data from as many measurement sites as possible. The greater number of measuring points, with the highest accuracy and precision of the acquisition, enables us to make better predictions as well as to apply certain system management measures and also to prevent and reduce damage in the event of a hazard.

Many acquisition points require a low station price to make the whole system cost effective. The requirements are: a modular system, cheap and affordable hardware, easily upgradable software - open source, easy and inexpensive maintenance. A modular system implies that multiple parts, logical entities, which are interconnected, make up the system. Each part has a specific role and function to perform and can be easily replaced. This gives us greater functionality, easier upgrade, easier maintenance.

There are several microcontrollers in the market today from different manufacturers, which can meet the previously set requirements. Each manufacturer offers hardware and software with which to program the microcontroller. One of the characteristic platforms that meets the requirements is the Arduino platform. Arduino originated at the Ivrea Interaction Design Institute for the needs of students to serve as prototype boards for various projects. Thanks to the ease of use and openness of hardware and software, it expanded very quickly and a large community of Arduino users was created. A large community of users influenced the emergence of a wide variety of board models, as well as shields (shield - hardware upgrades to the baseboard) that provide additional hardware features. The most important advantages of the Arduino platform are:

- Affordable hardware
- Arduino software (IDE) works on all major platforms (Win, Linux, MAC OSX)
- Simple and easy programming with IDE

- Open source hardware

The choice of Arduino board model depends on the type of memory on the board itself, depending on the need of the IoT node being implemented. Based on how the data is stored and how it is applied, it differs:

- Flash memory - When we develop the code ourselves, and when we prepare it for transfer to the Arduino board, we load the program into this type of memory. This is permanent memory, which means that if we turn off the power, the contents of this type of memory remain unchanged. The size of this memory also dictates the potential size of the code we load onto the tile, bearing in mind that a certain portion of that memory (2K-8K) is busy when loading our program itself, since it usually takes up a bootloader, that is, a program that allows communication computers and Arduino boards.
- SRAM memory - Simply checked, Static Random Access Memory (SRAM) is the memory that stores our program variables and data while executing a program. If, for any reason, the board itself fails, this information is usually deleted.
- EEPROM memory - Electrically Erasable Programmable Read Only Memory (EEPROM) is a permanent memory field. Because it is permanent memory, it is most commonly used to store the board configuration or other data that is necessary for system operation when the board is put back into function.

Aside from the memory difference, there are multiple models of Arduino boards with different hardware accessories. For the purpose of measuring sites in the IoT platform, the optimal model is the Arduino YUN board. The Arduino Yun is a microcontroller based on Atmega32U4 and Atheros AR9331. The Atheros chip serves to provide the network functionality of the complete device. Atheros chip controls Ethernet and wi/fi port as well as SD card for storage and usb port. Ar9331 is a SoC (Solution On Chip) solution whose main application is on router platforms. Atheros chip supports Linux distribution OpenWRT which provides software support for controlling the network part of the device.

The Arduino is basically a microcontroller, for every chip maker it also offers a set of instructions that can be programmed at assembly level. As this kind of programming is not easy, it was necessary to create a development environment that is closer to higher-level programming languages, so the IDE (Integrated Development Environment) was developed as an essential tool for working with Arduino microcontrollers. This development environment is basically WinAVR which is the version of the famous GCC compiler most commonly used to translate programs written in C / C ++, and it can be used on all known operating systems. The Arduino IDE can be downloaded from the official website of the Arduino platform and is completely free of charge. The development environment itself is designed to bring programming closer to users who have not yet encountered it. Because the Arduino is a microcontroller and its architecture is AVR, the development environment uses all libraries as a standard C ++ compiler for the PC (x86) platform. It uses features and libraries that are customized for it, its input / output pins, and communication interfaces. Like any complete development environment, the IDE has the ability to validate spelled code and upload it to the Arduino platform. The code itself is called "sketch" in the Arduino environment, and the syntax of the programming language itself is very similar to the syntax of the C and C ++ programming languages.

5. ENVIRONMENTAL MONITORING SYSTEM IN NOVI SAD

Environmental monitoring represents, describes the processes and activities that are necessary for characterization and monitoring of environmental quality, such as sampling and analysis of certain environmental media (soil, water, plants, etc.) to control the quality. With the development of technology such as wireless communication, IoT, more cities are using those technologies to share data and implement systems such as the environmental monitoring system.

Most environmental monitoring systems use a distributed sensor-based framework (WSN), and IoT connects them to the Internet to make data available at all times. The main roles of these systems are monitoring. time series data tracking and recording. Each IoT integrated device has the following features:

- The device is located in a monitored environment and is able to send data to the Internet or to other devices
- The unit can be programmed to behave as required
- The device receives information from the Internet
- A device is part of a set of devices that can communicate with each other

Further in this chapter, systems for monitoring of excess inland waters (Figure 2), meteorological values and urban heat islands developed by experts from the University of Novi Sad will be presented [52].

WAHASTRAT system was developed as an IPA (Instrument for Pre-Accession Assistance) project Serbia and Hungary, in order to monitor the state of water in the region of Bačka.

Figure 2 – WAHASTRAT acquisition station (wahastrat.vizugy.hu)

Based on WAHASTRAT system of automatic monitoring stations (WH1 to WH8), data series of environment variables were generated: soil moisture, speed and wind direction, air temperature, air humidity and atmospheric precipitation. Whereby the moisture content in the soil describes the 6 measured values each distributed to 10cm vertically. Typology of data is real scalar in floating point format, for all monitored environment variables, except for the moisture content in the soil, which is represented by a vector of real-type. Data is stored after acquisition (local buffer of maximum 2 11 addressable location 10bit data) at intervals of 1 hour, sent with GPRS-a, the point of concentration is carried out transformation in the relational model. Web services, based on data stored in relational database, allows expressive visualization in tabular form series of two-dimensional model. Both forms of expressive renderings are suitable for data interpretation, its bringing into context, understanding of the information and decision-making.

When station is awaken, the cell switches from sleep mode to active mode. Configuration is received after connecting to the server. If the configuration parameters are valid, the data transmission is valid. In the event of a network failure, the data is stored in the internal memory of the station and sent in the next session. The data being sent is defined as a raw data structure. The server application validates, formats, and stores the data in the database.

WAHASTRAT system specification:

- Decagon EC-5 sensor for volumetric water content determination
- Davis sensors
- Solar power
- Non-maintenance battery - can supply the station for 30 days when there is little or no sunlight
- GSM modem
- Communication between the station and the server is done via HTTP protocol
- Microsoft SQL database
- The application exports the data to a Microsoft excel document

6. CONCLUSION

The goal of smart cities is to unite the spirit and wit of those who live in it and make it a place to live happy and satisfied citizens. Furthermore, the Internet of Things has many applications and affects the development of cities. The key objective is to provide cities with a comprehensive governance platform so that local governments and citizens receive the highest value. The idea is to modernize existing public services. It gives cities better control and overview of the situation and saves them many.

The Internet of Things makes the city a source, and also a provider of information. A number of applications of the Internet of Things are being found within smart cities solutions. Due to the benefits of globalization, a large number of studies envisage the mass connection of sensors to the Internet of Things. In other words, in the near future, a large number of sensors/devices will have a global impact on the human environment.

As urban areas are complex, three-dimensional environments that are constantly evolving, the problem is how to use remote sensing technologies with a large number of in situ observations to get a complete picture of the city. When this is done a general outline of a city or parts of it can be integrated with these individual measurements into the concept of a smart city.

With the expansion and growth of cities, making them smart has become crucial to increasing the quality of life for citizens. IoT was presented as the best approach to make the city smart. It can be applied in various scenarios such as the above mentioned environmental monitoring, gas concentration, water and air quality, etc. A number of related facilities are required to achieve these goals. In addition, related ICT industries need to be explored and developed in parallel to promote IoT technologies.

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INTEGRATED SPATIAL PLANNING IN FUNCTION OF FLOOD MANAGEMENT IMPLEMENTATION IN BALKAN REGION

Abstract: The spatial planning system is very important mechanism for flood management implementation. At the same time, systemic measures of spatial regulation defined in flood management should be necessary part of database of spatial planning for all level of spatial documentation. It implies integrated spatial planning approach and providing new database relevant for planning in conditions of climate change, such as river basin management, integrated flood management, flood risk assessments, risk maps etc. This paper illuminates some aspects of integrated planning in function of flood management implementation, shows the problems in Balkan region in domain of integrated planning practice and gives some guidelines in aim to improvement.

Key words: flood management, integrated planning, Balkan countries

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1. INTRODUCTION

The floods are the most common risk of natural disaster that humanity faces in a climate change. Some European countries have taken significant steps in accordance with the EU Floods Directive. They provided system of integrated flood management which consist of spatial, technical and organizational measures and include documentation base from regional to the local level such as Basin or Catchment Flood Management Strategy, Basin or Catchment Flood Management Plan, Local Flood Management Plan and Project Plan [5]. Those documentation should be part of planning database for all spatial levels. At the same time, the spatial planning with its measures of spatial regulations is the mechanism for flood risk management implementation. Integrated planning as the most effective approach to sustainable and resilient spatial development have been considered and found their place in spatial planning particularly in EU countries. The problems with great floods that Balkan region faced with during last two decades showed many weaknesses in practice of integrated spatial planning and flood management and the necessity for improvement in this field. Therefore, this paper will try to light the role of spatial planning in flood management in accordance with the recommendations of World Meteorological Organization (WMO) [4],[5]. The aim is creating guidelines for integrated approaches of spatial planning for Balkan countries in domain of implementation of flood risk management. The space of Bosnia and Herzegovina will be especially pronounced in terms of legal regulations and spatial planning methodology.

2. FLOOD MANAGEMENT AND INTEGRATED PLANNING APPROACH

Flood control have played an important role in protecting people and socio-economic development from flooding in the past. Some protection measures have largely relied on technical elements, such as embankments, bypass channels, dams and reservoirs. Such technical flood control measures sometimes were followed with non-technical measures such as flood forecasting and land use regulations but it was partial and non comprehensive. In the last few decades flood management is recognized as the highest model of comprehensive, sustainable, resilient and responsible human answer to the challenges of floods in condition of climate change. The flood management requires planning process which should involve all organizations, institutions or communities that could affect or be affected by the hydro logical processes of the river basin. These include different documentation (strategies, management plans, maps of risk and hazard of floods for all spatial levels etc.). Integrated flood management (IFM) is a process that promoting an integrated – rather than a fragmented – approach to flood management within the framework of Integrated Water Resources Management (IWRM). It integrates land and water resources management in river basins and coastal areas in order to maximize the efficient use of floodplains while minimizing loss of life and property from flooding. [5].

Taking a wider view of the interactions between land and water environments within a river basin, and of the broader socioeconomic, physical and environmental implications of floods, the IFM approach provides a sound conceptual basis to bring about a convergence between land-use planning and flood management [5].

2.1. Relation between spatial planning and flood management

Taking a closer look at the strategies and options for flood management, it becomes apparent that land-use planning and measures of spatial regulation play a central role in reducing flood risk. All that measures can be classified into three main pilots of flood management strategy: reducing flood hazard, reducing flood vulnerability and exposure and preserving the natural resources of floodplains [5]. Therefore, there is an interaction between spatial planning and flood management, and it is desirable that the spatial planners are involved in the development of flood management, such as spatial plans

must be harmonized with the flood management database. In this sense, the measures in flood management which are connected with land-use and space should be defined in plans for all spatial levels in accordance with the system of planning. The measures in domain of the spatial regulations on the level of river basin or wider territory with a few urban areas, such as afforestation, permeable pavement, room for the river, dams, dykes etc. should be defined in the strategic plans (Spatial plan of region or district). The necessary part of database for strategic spatial planning should be River Basin Strategy or Flood Management, Forestry Management, River Management, Coastal zone management etc. The state is responsible for this level of spatial documentations and its obligatory is also to provide all relevant database, including this documentation. Very often, international cooperation is necessary for creating flood management or strategy for river basins. The measures in domain of local community government such as land-use, zoning, infrastructures technical measures, building restrictions etc. should be defined in the urban plan (general plan) and regulatory plan (plan of detail regulation). All the measures of the local level should be harmonized with the strategic plans (and flood managements recommendations) and with the local conditions. Maps of risk of floods are necessary for this level of planing. It is also desirable that municipalities provide flood risk assessments, flood plain regulations, maps of landslides, etc. documentations in aim to complete and update a database for integral urban planning.

2.2. Principles of integrated planning approach

Integrated planning is an essential mechanism for integration and interaction of all levels of planning and all aspects of the space in order to complete deliberations on who, what and how to do in an urban area. The main principles of integrated planning approach are relayed with the improvement of planning methodology from land-use planning toward to the process of strategic planning [6]. They are recognized in multidisciplinary and integrated analysis of all relevant aspects of space, interaction of all planning steps, connection and harmonization of all spatial levels in planning documentations and participation. Update spatial database (cadaster, natural resources, environment studies, flood management plan, map of risk of floods, renewable energy resources, maps of landslides, map of seismology risk etc.) are of great importance for integrative planning. They allow the comprehensiveness of analysis aimed at sustainable and resilient spatial development. This planning approach requires new education and skills of regional and urban planners [6]., adequate professional capacity of all actors which deal with process of spatial development, adequate regulatory framework [2] and institutional and financial support.

3. GUIDELINES FOR INTEGRATED SPATIAL PLANNING IN BALKAN COUNTRIES IN ACCORDANCE WITH FLOOD MANAGEMENT

National and regional spatial levels should be covered by strategic spatial plans (spatial planning), while the lower spatial levels (municipalities and cities) should be defined by urban planning. River basin is the widest territory of flood influences and very often requires strategic national or international measures which are most efficient in the field of flood protection. Those measures require state intervention, and often interstate cooperation on the management of the river basins, as it is the case with the Sava basin in the middle of the Balkan region [1]. The spatial plans of the states or regions, could define general spatial solutions for flood protection which are guidelines for plans of detail regulation after such umbrella documentations. The current methodology of spatial planning on the Republic of Srpska defined by law has a few steps: preparatory phase and collecting spatial information basis, analysis and assessment of the existing condition, the problems and aims of planning, program development, conceptual planning phase, implementation and monitoring [2]. In practice, it is evident that the implementation and monitoring phase are not developed enough although those phases are especially important when it comes to the impact that climate change might have on the planning solutions [3]. As a matter of fact, the planning solutions should include potential dangers

and risks which can be the result of the climate change. This may require additional analyses and application of new methods and techniques in planning. Prior database, such as the strategic study on the river basin and flood management, forest and nature, and flood risk maps, should be provided. That would enable creation of satisfactory strategic spatial-planning documentation (spatial plans of countries, regions/cantons, municipalities) which can be a prerequisite for creation of urban and technical documents for building hydro-technical structures.

We should also stress that studies on river basin and flow management, then on water, forest and nature management at national and regional level, should include the aspects regarding flood protection as a base of spatial-planning documentation. These documents, through the space analysis and its features, should give guidelines (in terms of locations, their facilities for a certain kind of regulation and types of structural intervention) for defining flood protection measures. They should be recognized and defined in the form of rainfall-runoff reductions, water retention, forestation, reduction hydraulic load, rooms for the rivers, coastline stabilization, wave reduction, local retention, drainage, levees, zoning measures, setback lines and building restriction. Flood protection in urban areas should be defined in plans, and all strategic elements of the flood protection measures should be taken from the spatial plans from the broader territory. On the urban level, adequate zoning of the space purpose conditions for building structures and infrastructure (leveling of roads, planning and designing of infrastructure especially hydro-technical structures, drainage systems, position of structures, line cables, ground floor level building, structure installations) should be performed in order to provide necessary planning and building flood protection measures. That implies drawing up of new topic maps in all spatial-planning documents which would show the areas of risk (including floods) due to climate change. Planning building conditions in the inhabited zones should take into consideration flood and wind risks, terrain instability, natural resources of renewable energy sources and possibility of their use, energy efficiency in planning and building etc. All this are still not included in the spatial-planning documentation on the comprehensive way. Actually, there is lack of database in this domain in Balkan region. At the same time, planning practice in Balkan countries in the period of transition is not enough multidisciplinary and participatory process. In order to have the planning methodology improved in the spirit of climate change and flood protection, it is, also necessary to change and amend the laws in the field of spatial planning in the majority of countries in the Balkan region. In RS that would be the amendment to the Law on Spatial Planning and Building and to the Rules on the content of planning documentation. They should include database of planning with flood management plans, updated information about climate change, engineering-geological maps with new zones of landslides formed after floods, maps of flood and other risks, and of potentially other consequences in conditions of climate change.

4. CONCLUSION

There is interaction between flood management and spatial planning. Flood management with its data and maps of risk and hazard should be part of database for spatial planning. At the same time, spatial planning with its measures of spatial regulations is the mechanism for flood risk management implementation. In order to implement all measures from flood management that have a spatial component, it is necessary to have all the planning documentation from strategic plans to urban level of regulation. More active inclusion of spatial planning into the issue of flood management in the light of climate change requires improvement of spatial planning methodology in aim of more integrated approach and change of laws dealing with space. Integrative spatial planning with an aim of having adequate flood protection, has still not been quite practice in Balkan region. There is, also lack of database in domain of flood management in Balkan region. Therefore, society should take all necessary actions through state, scientific and other professional institutions to improve these areas.

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RC BEAM EXPOSED TO DIFFERENT FIRE MODELS

Abstract: Simply supported reinforced concrete beam exposed to the standard ISO 834 fire curve and the parametric fire curve, is analyzed in this paper. Due to the exposure of the RC beam with thermal load only from the bottom side of the element, the temperature differences between the bottom and the top part of the cross section are considerably high. After 120 minutes the temperatures of the cross section are lower in case of parametric fire curve. Despite the strict fire resistance requirements prescribed by the codes, the results obtained with the parametric fire curve are more valid. With usage of this curve, the response of the fire exposed structural elements is more realistic.

Key words: heat transfer, Eurocode 1, fire models, ISO 834 fire curve, parametric fire curve

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1. INTRODUCTION

Fire is an extreme loading condition for structures, which can lead to significant effects on people, property and the environment. It is important to have a basic understanding about how a fire occurs and behaves within a building. Essentially, fire is a chemical reaction. A carbon-based material (fuel) mixes with oxygen (usually a component of air) and comes in contact with something hot enough to heat this mixture so that combustible vapors are produced. Depending on the combustibility of the ignited fuel, the fire may start as a slow-growth scenario with a long smoldering period or it may grow rapidly with almost no smoldering time. In either instance, once visible flames appear, the fire's destructive forces increase exponentially. The flaming stage of a fire will start with a rapid rise in heat levels, initially along the room's ceiling, and then throughout the entire space. The fire can then spread through open doorways and wall penetrations, or through concealed wall and ceiling cavities to other spaces in the building. Ultimately, if not suppressed, the fire can lead to a total loss of the building and its contents, not to mention the loss of lives. Part of the fire safety design of a built environment arises out of the need to provide design strategies that minimize the occurrence and spread of fire and its impact on life, property and the environment. Fire safety of structures is one important component of an overall fire safety design strategy. The role of fire safety of structures is to ensure that elements of a structure, (separating and structural elements) within a built environment, are capable of preventing or delaying fire spread and structural failure, so that the fire safety objectives, such as safety of life (for occupants and firefighters), conservation of property, continuity of operations, preservation of heritage and protection of the environment, are not compromised. Traditionally, most designs for the fire safety of structures have been based on prescriptive requirements set by building regulations, building codes and associated standards. In prescriptive regulations, this is also known as fire resistance, [3].

2. FIRE MODELS ACCORDING TO EUROCODE 1

A structural fire design analysis should take into account the following steps as relevant:

- selection of the relevant design fire scenarios;
- determination of the corresponding design fires;
- calculation of temperature distribution in the cross section of structural elements;
- calculation of the mechanical behaviour of the structure exposed to fire.

The simplest way of presenting the standard fire exposure is by using nominal fire curves. Several types of nominal fire curves, presenting the fire action, are available for use in the design process. The most commonly used curves are ASTM E 119, ISO 834 fire curve, hydrocarbon and external fire curve. Nominal fire curves have similar properties.

The mathematical functions that describe the temperature-time development are simple relations that provide the temperature of the gases in the room depending only on one variable, time. Nominal curves represent the temperatures of fully developed fires and are uniform within the fire sector. In large spaces, this is obviously not true, since the temperature of the gases is not the same at each point and is a function of the spatial coordinate selection of the

relevant design fire scenarios. Nominal fire curves are monotonically increasing functions over time. The cooling phase is not taken into account. In determining the fire resistance, the load bearing capacity in a given period of time should be provided, without taking into account the events after that required period. The large-scale experimental tests have determined that the cooling phase is of great importance for the behavior of structures, especially in the conditions of restrained thermal expansion, [1], [3].

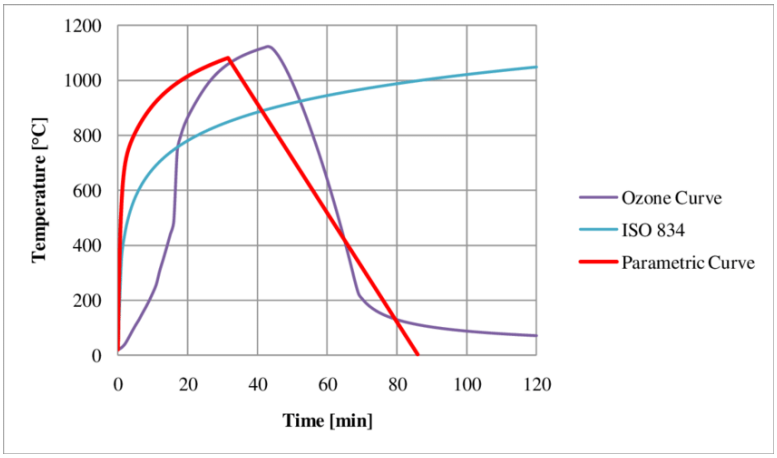

Figure 1 – Fire Curves

Parametric fires provide a simple means to take into account the most important physical phenomenon, which may influence the development of a fire in a particular building. Like nominal fires, they consist of time temperature relationships, but these relationships contain some parameters deemed to represent particular aspects of reality. In almost every parametric fire which can be found in the literature, the parameters taken into account, in one way or another, are: the geometry of the compartment, the fire load within the compartment, the openings within the walls and/or in the roof and the type and nature of the different construction elements forming the boundaries of the compartment. According to Eurocode the parametric curves are valid for fire compartments up to 500 m^2 of floor area, without openings in the roof and for a maximum compartment height of 4 m. It is assumed that the fire load of the compartment is completely burnt out. If fire load densities are specified without specific consideration to the combustion behaviour, then this approach should be limited to fire compartments with mainly cellulosic type fire loads. The temperature-time curve in the heating phase are given by following equation:

$$\Theta_g = 20 + 1325\ (1 - 0.324\, e^{-0.2\, t^*} - 0.204\, e^{-1.7\, t^*} - 0.72\, e^{-19\, t^*}) \quad (1)$$

$$t^* = t \cdot \Gamma \quad (2)$$

$$\Gamma = [O/b]^2 \ / \ (0.04/1 \cdot 160)^2 \quad (3)$$

$$b = \sqrt{\rho\, c\, \lambda} \tag{4}$$

Where, Θg is the gas temperature in the fire compartment, t is time, ρ is density of boundary of enclosure, c is specific heat of boundary of enclosure, λ is thermal conductivity of boundary of enclosure and O is opening factor. In case of Γ=1, equation (3) approximates the standard
temperature - time curve. For the calculation of the b factor, the density ρ, the specific heat c and the thermal conductivity λ of the boundary may be taken at ambient temperature.

The maximum temperature Θmax in the heating phase happens for $t^* = t^*$max.

$$t^*_{\max} = t_{\max} \cdot \Gamma \tag{5}$$

$$t_{\max} = \max\left[\left(0.2 \cdot 10^{-3} \cdot q_{t,d} / \mathrm{O}\right); t_{\lim}\right] \tag{6}$$

Where:

qt,d - is the design value of the fire load density related to the total surface area At of the enclosure. The following limits should be observed: $50 \le q_{t,d} \le 1000$ [MJ/m2];

qf,d - is the design value of the fire load density related to the surface area Af of the floor.

The time $t$max corresponding to the maximum temperature is given by $t$lim in case the fire is fuel controlled. If $t$lim is given by (0,2 10^{-3} qt,d / O), the fire is ventilation controlled. In case of slow fire growth rate, $t$lim = 25 min; in case of medium fire growth rate, $t$lim = 20 min and in case of fast fire growth rate, $t$lim = 15 min.

The temperature-time curves in the cooling phase are given by:

$$\Theta_g = \Theta_{\max} - 625\ (t^* - t^*_{\max} \cdot x), \qquad \text{for} \quad t^*_{\max} \le 0.5 \tag{7}$$

$$\Theta_g = \Theta_{\max} - 250\ (3 - t^*_{\max})\ (t^* - t^*_{\max} \cdot x), \qquad \text{for} \quad 0.5 \le t^*_{\max} \le 2 \tag{8}$$

$$\Theta_g = \Theta_{\max} - 250\ (t^* - t^*_{\max} \cdot x), \qquad \text{for} \quad t^*_{\max} \ge 2 \tag{9}$$

Where: x=1 if $t$max>$t$lim, or x=$t$lim·Γ/t^*max if $t$max=$t$lim, [1], [2].

3. HEAT TRANSFER

Thermal stresses appear in every structure that experiences a temperature gradient from some equilibrium state, if it is not free to expand in all directions, or if the temperature field is not uniform. The temperature distribution can be calculated once the Theory of Heat Transfer is used. The governing differential equation of heat transfer in conduction is:

$$\frac{\partial}{\partial x}\left(\lambda_x \frac{\partial T}{\partial x}\right) + \frac{\partial}{\partial y}\left(\lambda_y \frac{\partial T}{\partial y}\right) + \frac{\partial}{\partial z}\left(\lambda_z \frac{\partial T}{\partial z}\right) = \rho c \frac{\partial T}{\partial t} \tag{10}$$

Where: λx,y,z is a thermal conductivity (temperature dependent); ρ is a density of the material (temperature dependant); c is a specific heat (temperature dependent). The fire boundary conditions can be modeled in terms of both convective and radiative heat transfer mechanisms. The heat flow cosed by convection is:

$$q_c = h_c(T_z - T_f) \tag{11}$$

Where: *hc* is coefficient of convection, *Tz* is the temperature on the boundary of the element, *Tf* is the temperature of the fluid around the element. The heat flow cosed by radiation is:

$$q_r = V\,\varepsilon\,\sigma_c(T_{z,a}^4 - T_{f,a}^4) = h_r\left(T_z - T_f\right) \tag{12}$$

$$h_r = V\,\varepsilon\,\sigma_c\left(T_{z,a}^2 + T_{f,a}^2\right)\left(T_{z,a} + T_{f,a}\right) \tag{13}$$

Where: *hr* is coefficient of radiation (temperature dependant), *V* is a radiation view factor, ε is a resultant coefficient of emission $\varepsilon=\varepsilon f \cdot \varepsilon z$, εf is the coefficient of emission for the fire compartment, εz is the coefficient of emission for the surface of the element, $\sigma c=5.67\cdot10^{-8}$ is Stefan-Boltzmann constant, *Tz,a* is the absolute temperature of the surface, *Tf,a* is the absolute temperature of the fluid, [4].

4. RC BEAM EXPOSED TO DIFFERENT FIRE MODELS

4.1. Numerical example

In this numerical example, simply supported reinforced concrete beam exposed to the standard ISO 834 fire curve and to the parametric fire curve, is analysed. The span of a beam is 5.5 m, with a rectangular cross section of 40/50 cm. The beam is loaded with permanent load of 31 kN/m' and live load of 21 kN/m'. The static system and the adopted reinforcment of the beam are presented in Figure 2.

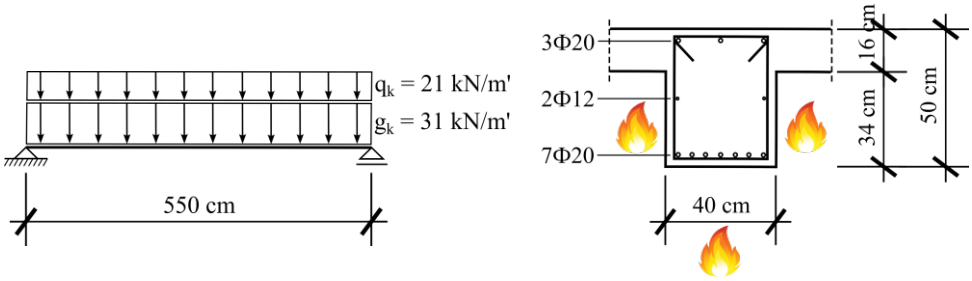

Figure 2 – Simply supported RC beam

The analyzed beam is structural element from 6 storey building for office permises. All storeys are with height of 3 m. Every storey represents separate fire compartment. The floor area of the fire compartment Af is 440.64 m^2 and the total area of enclosure At (walls, ceiling and floor, including openings) is 1124.3 m^2. The weighted average of window heights on all walls hv is 1.6 m and the total area of vertical openings on all walls is 61.44 m^2. Design fire load density $q_{f,d}$ related to the floor area is 900 MJ/m^2. Thermal load in terms of convection and radiation is applied at the three sides of the beam, except at the upper side. The fire is ventilation controlled.

4.2. Results and discussions

Vertical displacement-time curve of the mid-span node is presented in Figure 3.

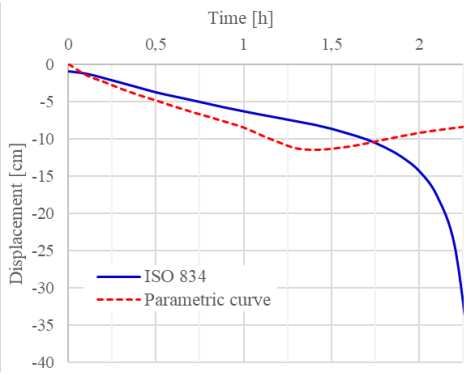

Figure 3 – Vertical displacements of the mid-span node in case of different fire curves

The vertical displacements of the beam exposed to the parametric fire curve decrease during the cooling phase, while in case of ISO 834 fire curve vertical displacemets increase during the whole period of fire action.

The temperature-time histories for the two steel bars of the cross section are presented in Figure 4. Temperature in the bottom corner bar is considerably higher in comparison with the top corner bar. This is due to combined heat transfer from the both fire exposed sides of the bottom part of the cross section. The temperature differences of the top corner bar, in case of standard ISO 834 fire curve and in case of parametric fire curve, are insignificant.

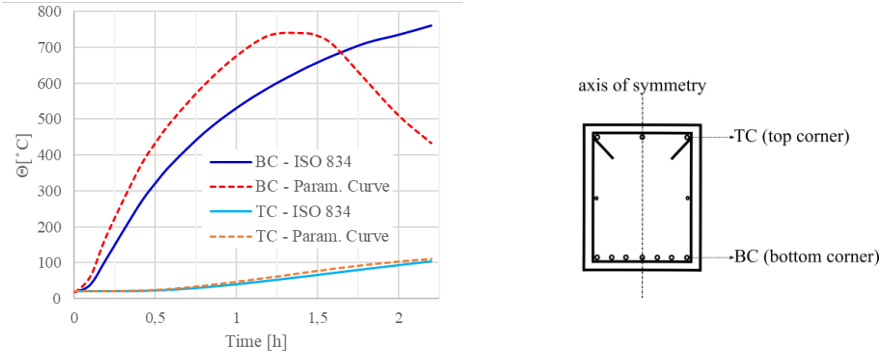

Figure 4 – Temperature - time histories

The stress - strain diagrams are presented in Figure 5. The stresses on the diagram are presented as persentage of the yield strenght of the reinforcement at defined temperature. The bottom corner bar is in tension during the whole fire action. At the beginning of fire action, due to the large temperature diferences between the bottom and the top zone of the cross section, the stresses decrease in the tensioned steel bars, which has favourable impact on the

behaviour of the RC beam at that moment. The top corner bar after aproximately 40 minutes of fire action changes the stresses from compresion to tension.

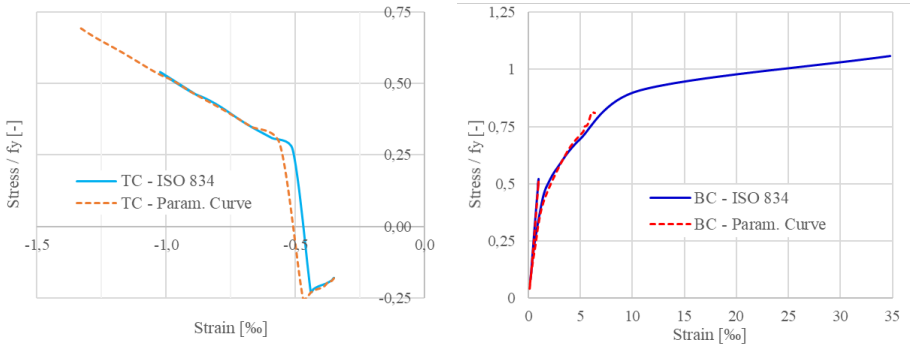

Figure 5 – Stress - strain diagrams a) top bar, b) bottom bar

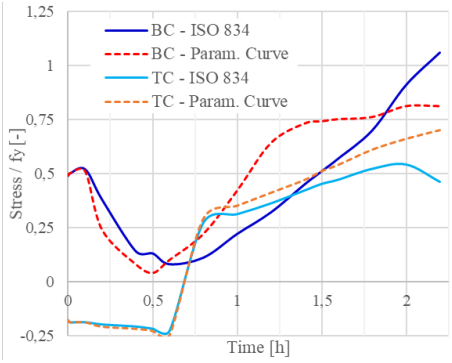

Figure 6 – Stress - time histories

The temperature profiles of the cross section of the analysed RC beam exposed to ISO 834 and Parametric fire curve are presented in Figure 7 and Figure 8, respectively. At the beginning of the fire action the temperature in the cross section of the RC beam is higher in case of parametric fire curve than in case of ISO 834 fire curve.

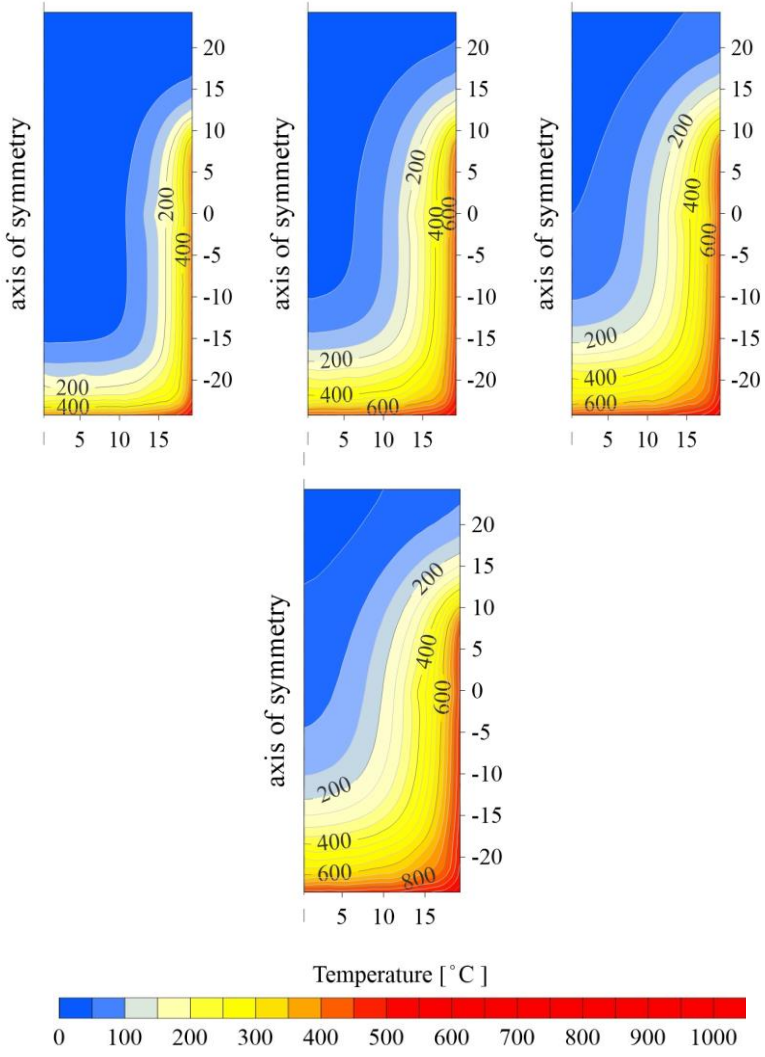

Figure 7 Temperature profiles of RC beam exposed to ISO 834 fire curve after 30,60, 90 and 120 minutes

From Figure 7 and Figure 8 we can find out that after 120 minutes the temperatures of the cross section are higher in case of ISO 834 fire curve. This is due to the permanent temperature rise in case of this fire curve.

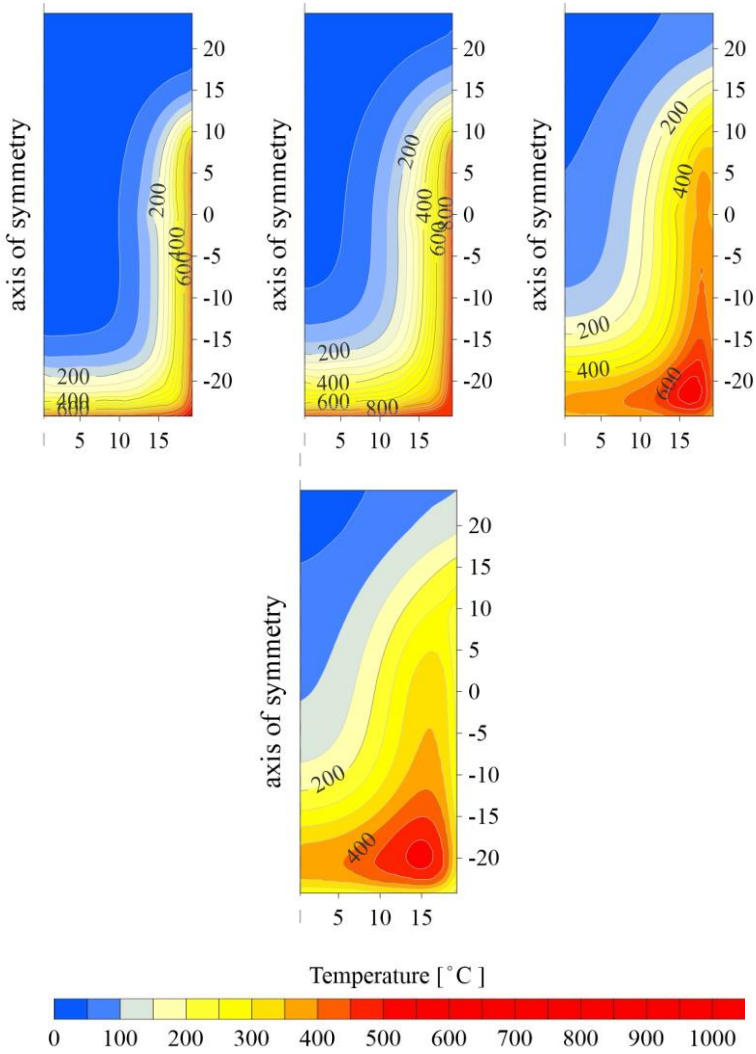

Figure 8 Temperature profiles of RC beam exposed to Parametric fire curve after 30,60, 90 and 120 minutes

5. CONCLUSIONS

Despite the strict fire resistance requirements prescribed by the codes, according to the recommendations given in Eurocodes the fire resistance of structures may be proved either by applying a Standard fire curve, in which case the structure has to survive during the prescribed time, or by applying a parametric fire curve, in which case the structure has to survive during entire period of fire action. The results obtained by usage of the parametric fire curve are more

realistic, as the cooling phase is of a great importance for the behavior of structural elements. As a result of the discending branch the vertical displacements of the mid-span are much lower in comparison with action of nominal curves. During the heating phase the temperatures of the cross section in case of ISO 834 standard curve are lower, but during the cooling phase it is opposite. Due to the fire exposure of the RC beam only from the bottom side of the element, the temperature differences between the bottom and the top part of the cross section are considerably high and result with redistribution of stresses.

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THE USE OF BIOMASS ASH IN THE CONSTRUCTION INDUSTRY AS A WAY TOWARDS A CIRCULAR ECONOMY

Abstract: Unlike a traditional linear economy with high materials consumption, emission, and pollution, a circular economy (CE) system is a closed system in which all elements are circular. Transition to CE requires changes from product design to new business models, from new ways of turning waste into a valuable resource to alternatives of consumer behavior. The increase in demand for construction materials, derived as a consequence of rapid industrialization has called for an alternative way to develop materials from different sources, including biomass ash, generated by combustion oh harvest residues (BA). Researches are already investigating the use of various types of BA (rice husk ash, corn cob ash, wheat straw ash) for the building materials manufacturing as substitutes for sand and/or cement in cement based composites. A description of this application and its environmental contribution, as a way towards a circular economy, is presented in this paper.

Key words: circular economy, waste, biomass ash, resource, business model

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1. INTRODUCTION

A Circular Economy (CE) is a regenerative system that replaces the 'end-of-life' concept with 'cradle to cradle' design concept which involves the safe and potentially infinite use of materials in cycles. This concept shifts towards the use of renewable energy, eliminates use of hazardous chemicals and aims for the elimination of waste through the proper design of materials, products, systems, and, within this, business models. Therefore, in a CE, materials are kept in circulation for a longer period of time than in a linear economy thus aiming to minimise the use of natural sources and generation of waste (Figure 3).

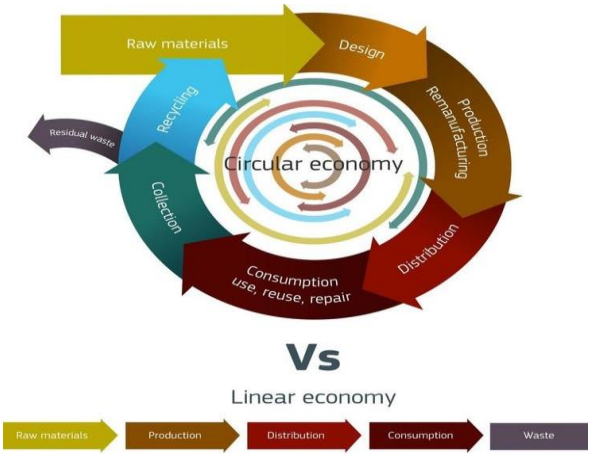

Figure 3 - Circular vs. linear economy

There are some obvious environmental benefits of renewable products compared to fossil-based ones. Firstly, during growth, renewable resources absorb CO_2, hence they act as carbon storage. When they are ultimately managed as waste, e.g. incinerated or combusted, they will not contribute to net emissions of CO_2 into the atmosphere, as opposed to fossil-based products 0. Secondly, the use of renewables instead of fossil products leads to lower rate of resources depletion. Renewable products, taken out of the technical cycle, can be further incorporated into new products, which is typically a low or net positive energy (e.g. biogas) process.

The increase in demand for construction materials, derived as a consequence of urban industrialization has called for an alternative way to develop materials from different sources, including biomass ash, generated by combustion oh harvest residues (BA). A number of investigations have demonstrated the validity of using various waste materials from both technical and environmental reasons and, often, economical. The same principle can be applied to biomass ashes, as presented in this study.

2. CIRCULAR ECONOMY IN CONSTRUCTION PRACTICE

The construction industry has major impacts on the social, environmental and economic aspects of sustainability, hence the importance of sustainable building practices becomes an essential issue. The major negative impacts include:

- generate of waste,
- greenhouse gas emission (particularly CO_2),
- generate of noise,
- generate of dust.

Approximately one third of all waste in Europe comes from construction and demolition (C&D) and only one third of that amount is recycled 0. Recycling concrete from C&D waste reduces country's dependence on primary raw materials (primarly natural aggregate) and reduces the amount of waste landfilled. Over the years, recycled concrete has been successfully used as a aggregate for new concrete.

The researchers worldwide are seeking to increase the use of waste materials for concrete production, both to decrease energy dependence on conventional fossil fuels and to mitigate the adverse environmental impact of clinker production 0. The possibility of the using of different types of solid waste in construction materials are shown in Table 1.

Table 1 - The possibilities of application of different wastes in the production of building materials

No.	Name of waste	Type of waste	Use in construction industry
1	• fly ash • rice husk ash • palm oil fuel ash	agro-industrial	• aggregate • concrete • SCM • bricks, blocks, tiles • wall panels, roof sheets
2	• phosphogypsum • waste glass • slag • rubber tire	industrial	• aggregate • concrete • blended cement • bricks, blocks, tiles • ceramic products
3	• quarry dust	mining/mineral	• aggregate • concrete • bricks, blocks, tiles
4	• C&D waste	industrial	• aggregate • concrete • bricks, blocks

One of the most common wastes and one of the most promising renewable energy sources (RES) is biomass.

3. CO_2 EMISSION AND BIOMASS IN CIRCULAR ECONOMY

Total emission from the cement industry contribute as much as 8% of global CO_2 emissions whereby two aspects of cement production result in emissions: the chemical reaction in the production of clinker (calcination) and the combustion of fossil fuels to generate the significant energy required to heat the raw ingredients - Figure 4 0.

More than 400 billion metric tonnes of CO_2 have been released into the atmosphere from the consumption of fossil fuels and cement production since 1750, half of which was emitted since the 1980s 0. Figure 5 illustrates that the combustion of liquid and solid fossil fuels causes around three fourths of all CO_2 emissions.

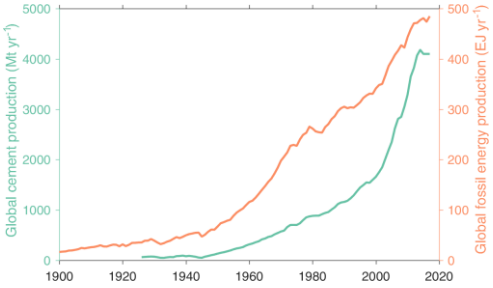

Figure 4 - Global cement and fossil energy production 0

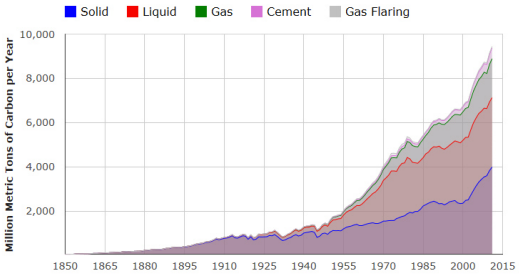

Figure 5 - Worldwide CO_2 emission from fossil fuels consumption and cement production 0

As a renewable source, biomass has the potential to replace non-renewable energy sources, such as fossil fuels, in the process where wastes of biomass activities and disposed products are processed within a supply chain network. Biomass combustion releases CO_2 as well, but the plants, that are the source of biomass, capture a nearly equivalent amount of CO_2 through photosynthesis while growing, which makes biomass CO_2 - neutral energy source.

On a global scale, an average of 140 billion tons of biomass is produced from agriculture annually. In the European Union, in total energy consumption, biomass accounts for 4%. Despite the large consumption of biomass as a energy source, enormous quantities remain in landfills as unused waste/raw materials 0.

Waste biomass is generated in several production sectors: forestry, wood processing industry, crop husbandry, animal husbandry, fruit and vine growing etc. Greatest potential of biomass in Serbia lies in the agricultural residue and wood biomass, a total of about 2.7 million tons. It was estimated that around 9 million tons of waste biomass per year is generated in the agricultural sector of AP Vojvodina 0. All this suggests that there is a good prospect for larger use of biomass as RES, but also for generating larger quantities of ash produced by its combustion.

The Serbian agriculture is in the process of creating a significant switch towards CE, throughout its innovation system. This could be established, by using biomass as energy source at the larger scale (plants, factories), while generated biomass ashes are used as building materials in concrete production, making this system circular and sustainable.

4. BIOMASS ASH AS A SUSTAINABLE BUILDING MATERIAL

Based on the physical, chemical and morphological properties, it is reported that biomass ash, an industrial by-product of thermal power industries, has a substantial potential for use as a pozzolanic mineral admixture and/or as an activator/binder in cement-based materials.

Based on the availability investigation data, annualy generated quantity of biomass ash in Vojvodina, is approximately 5.000t. Within different types of ashes, following are dominant: wheat straw ash, soya straw ash and sunflower husk ash (separate or mixed combustion). Currently, most of the biomass ash produced in thermal power plants is either disposed of in landfill or recycled on agricultural fields or forest.

The reuse of such waste as building material appears to be a visible solution not only from the aspect of pollution, but also from the aspect of land-filling, conservation of natural resources for future generations, and high prices of building materials - Figure 6.

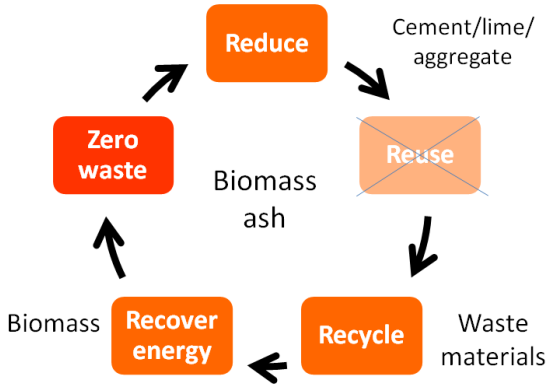

Figure 6 - Using biomass ash as building material in circular economy

In this system, biomass is used as RES (recover energy), while nonreweable sources (such as fossil fuels) are preserved and biomass waste is eliminated. Biomass ash, a byproduct of biomass combustion, is recycled and used as a substitute for cement, aggregate or lime in concrete production, whereby natural sources are preserved (and CO_2 emission significantly reduced). Such eco-friendly product, at the end of life-cycle, can be recycled (crushed, separated) and used as aggregate for new concrete, making this system circular in accordance with the principles of CE.

Worldwide, there are countless initiatives to make the biomass sector, especially agricultural, more circular - Table 2. The scope of initiatives is broad and could aim at, for example, using rice husk ash as a highly reactive SCM, oyster shell ash as a lime substitute in concrete, or groundnut shell ash as sand replacement.

Table 2 - The possibilities of application of different biomass wastes as building materials

No.	Biomass ash	Application	Effects of substitution
1	rice husk ash	SCM (mortar, concrete)	• improved mechanical and durability properties 0
2	oil palm shell	lightweight aggregate	• high strength lightweight concrete 0
3	oyster shell ash	lime	• a lower carbon footprint 0
4	sugarcane bagasse ash	SCM (concrete)	• lower permeability, increased resistance to chloride corrosion 0
5	coconut shell	coarse aggregate	• structural lightweight concrete 0
6	wheat straw ash	SCM (mortar)	• cement substitution of 50% without compromising mechanical properties 0
7	sugarcane biomass ash	mineral additive	• 25% replacement level of cement in producing sustainable concrete - an optimum replacement 0
8	tobacco waste	lightweight aggregate	• low thermal conductivity lightweight concrete 0
9	wood waste ash	mineral additive	• cement replacement up to 10% by total binder weight can produce structural grade concrete or mortar
10	sewage sludge ash	mineral additive	• 20% addition to a mortar and concrete mixture provides 80% of the strength of the control mortar and concrete 0

5. CONCLUSIONS

The raw materials used to produce cement and concrete, primarily clay, limestone and aggregates, are plentifully available worldwide. However, construction industry is making strong efforts to reduce their exploitation, as it creates visible irreversible scars on our planet. This can be accomplished through the use of different types of waste from a variety of other industries, such as biomass ash, used as a cement substitute and recycled concrete aggregate, used as natural aggregate substitute.

Using biomass waste and biomass ash in cement based composites would allow companies, building developers and cities to leverage a local, non-toxic resource in a product that is core to our built environment. This approach offers a viable solution to two pressing problems: concrete's high CO_2 emission and the increasing amount of landfilled biomass waste/ash.

If applied, this solution presents a unique opportunity to create a moral circle of awareness and recognition, resulting in greater economy of scale. This circle leads to reducing carbon emissions and increasing health on the one side, and reducing costs on the other. Diverting biomass ash from landfill to be used as a building material is a great example of cascading a technical material to another valuable use - one of the key principles of value creation in the circular economy.

ACKNOWLEDGEMENTS

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ADAPTION TO CLIMATE CHANGE - COUNTRIES PERSPECTIVE (A COMPARISON BETWEEN SERBIA AND ALBANIA)

Abstract: Since the early 90s the world begun to raise awareness towards a very common risk: climate change. Nowadays, we are witnessing the impact of these adverse effects and moreover undertaking steps to adapt the strategies and mitigate the consequences. All the countries have embraced their own approaches, adapting to their level of exposure to the risk. Some of the most endangered areas are: food, water and health and natural habitat along with their components. The paper will weigh two regional countries, Albania and Serbia, by paralleling their areas of vulnerability and how they choose to confront them. The response of the government politics, society sensibility and economic impacts will be on target as well.

Key words: adaptation index, agriculture, climate change, readiness, vulnerability

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1. INTRODUCTION

From national to local scale, adaptation planning is the most significant tool for all governments in the world, to set adaptation priorities and to define strategy for climate change combat. Assessing countries vulnerability is starting point in adaptation planning and researchers have been developed many vulnerability indices to show vulnerability in different spheres of interest (environment, society, economy).By establishing international methodologies for calculating vulnerability indexes, vulnerability profile of each country can be set and comparable to each other. By comparing countries vulnerability, less prepared countries can learn from countries which readiness to climate change is higher

The Notre Dame-Global Adaptation Index (ND-GAIN) Country Index is a free open-source index that shows a country's current vulnerability to climate disruptions. It brings together over 74 variables to form 45 core indicators to measure vulnerability and readiness of 192 UN countries from 1995 to the present.Vulnerability is composed of 36 indicators. Each component has 12 indicators, crossed with 6 sectors. Readiness is composed of 9 indicators.

For the purpose of this paper two country profile will be analyzed and discussed, Serbian and Albanian profiles. By their position on the ND-GAIN Country Index, Serbia is ranked at 70th place in the world by scoring relatively low vulnerability and high readiness. While on the other hand, Albania occupies the 78th place by being 91st least vulnerable county and 75th most prepared.[1] The level of readiness is in common, while Albania appears to be more vulnerable.Although less vulnerable, both countries still have to face significant adaptation challenges.

By targeting the most critical areas for both countries provided by ND-GAIN indexes, regarding the vulnerability components and the readiness too, this paper will show strategies and level of adaption that these countries have embraced so far.

2. STUDY AREA

Serbia is a landlocked country situated In Southeastern Europe, in the center of Balkan Peninsula, but due to southern region, in terms of geography and climate it is also considered as Mediterranean country.Albania is located in Balkan Peninsula too, bordered by Adriatic and Ionian Sea in the west and crossed by Albanian Alps in the eastern side.

The greatest sector that climate change has already hit in Serbia since 2000. is agriculture, considered to be the backbone of the economy. Agriculture employs 21% of total labor force, and it is accounted to be 12% of GDP and 19.4% of all exports.[2] Upon these figures one can easily spot the tight bond and high sensitivity that conducts the country's welfare and this sector. It is estimated that in period of 2000-2018. the severe impacts of climate changes have brought a decline in the yields of grains, mainly maize, wheat and sugar beet which can be

[1] https://gain.nd.edu/our-work/country-index/rankings/
[2] https://www.export.gov/article?id=Serbia-Agribusiness

converted into 4.6 billion dollars of loss for the country. Major shifts in climate change such as severe droughts and unexpected floods have brought damages in different districts of Serbia from 10% (Bačka) to 90% (Nišava). [2] According to studies, more and more extreme weather conditions are expected and accompanied with decreased frequency of precipitation in summer days, warmer winters and an increase in the number of days with extreme temperature in summer and winter. Under these severe condition'sagriculture is most affected. Projected reduction in cereal yields and agriculture capacity declinecould beexistential problem for poor population too.

As mentioned earlier, Serbia and Albania, as two regional countries, share the same natural climate conditions and characteristics. Global warming has caused an increase in 1.5 °C in the temperature of both countries compared to 0.5 °C that used to be 50 years ago. According to the World Bank study, regarding the countries that represented high vulnerability, precipitation in Albania is expected to decline at a minimum of 30 mm and worst scenario reaches up to 90 mm within 40 years.[3]The coastal area of Albanian territory is dangerously targeted by climate changes too. It is estimated that within five or six generations sea level will rise up to one meter which would completely cover the current coast line and even coastal cities like Durres, partial Vlora, Kavaja would disappear. The greatest thing in common that these countries feature is the high dependency on agriculture sector. The contribution of this sector in the GDP of Albania is 22.5% where 24% of the land is arable.[3] The dominance of the sector becomes more obvious when figures show over 50% of Albanian population is employed in agriculture.

3. RESEARCH RESULTS AND DISSCUSION

a. Adaptation to climate change - Serbia

According to ND-GAIN study, the level of readiness for a country facing these challenges is related to the government, business and social response. Considerable size of arable land of maize, sugar beet, fruits and legumes, which seem to be intolerant toward water deficiency, each year is affectedby extreme drought, thus water supply has been the main focus of Government of Serbia so far. Prevention requires measures like irrigation, drainage system along with the adaption of the technology. Today approximately 70.000 ha of land are under irrigation systems and state government are planning to cover up to 85.000 ha in the next decade, which will result in a total of 5% of the whole arable land.[2]The areas that have had received most of the attention are Šumadija, Vojvodina(where almost 80% of all production of the country is agriculture) and Belgrade Region with the cultures of potatoes, berries and vegetables. These figures show great disadvantage if we compare with other developed countries which are capable of irrigating at least 20% of their arable land. Disadvantages are mainly brought by the lack of: economic stability, expertise, and technology.

As for the drainage, according to Water Master Plan, approximately 2.01 million of hectare is covered by drainage and water management system.[4] In the past years of 2014 and 2015 it is shown that minimum of maintenance cost has significantly exceed the capacity of

[3]https://www.export.gov/article?id=Albania-Agricultural-Sector

government to invest, as only 59% of required investment could be fulfilled by the government. The main water management companies in Serbia (Srbijavode, Vode Vojvodine and Beograd Vode) currently require for regular maintenanceand investment respectively 8.9 million RSD, 3.5 billion RSD and 2 billion RSD.[4]

The biggest priorities technology-related are: changes in plant species, where one specie's feature combines with the other's so that it the new one can perfectly adapt to the future climate change, introduction to the species more tolerant to severe conditions, creation of new adaptive genotypes and so on. All that require investment, progress tracking and training.

During this present decade Serbia has been an active part of numerous EU regulations, projects and frameworks for the purpose of adapting to the climate changes and mitigating their consequences.The agreement with FAO allowed the launch of farmers' training in different municipalities which seemed to have considerable positive feedback. It is worth mentioning the catastrophic floods that invaded Serbia back in 2014 where the natural disaster found the state especially landowners completely uncovered and vulnerable towards very threatening conditions. Under these adverse circumstances one can easily spot the obstacles that hinder the whole society while trying to adapt and overcame such difficulties.

Nowadays it takes a lot of budget for a low-medium society to invest in innovation which according to ND – GAIN study, appears to be the lowest score on chart. This crucial criterion of Readiness appeared briefly a few lines above where was mentioned the inability of the state to invest in the proper technology that the system of irrigation, drainage, the implementation of newest technology and an ameliorated forecasting is to be done. In the end, as we can understand, it takes the whole incorporation of society and businesses in the terms of raising awareness towards gas emission from fabrics and vehicles where seems like the country finds it difficult to quit.

b. Adaptation to climate change -Albania

According to ND - GAIN Albania showed higher rate of vulnerability than Serbia, due to higher exposure of population in this field. Accompanied with the help and guideline of World Bank and other small financing institutions Albania in 2007 establish an irrigating system for about 180.000 hectare of land and another 120.000 hectare of total drainage and storage water stream. These figures cover respectively 50% and 40% of total arable land in Albania which means that still half of it crucially depends on rainfalls.

As for the productivity under climate change conditions wheat remains the most productive and important in Albania. But as it is seen since '90s, wheat continues to grow at a very slow rate, by only 1.6% each year. In the predicted scenario by World Bank if Albania continues to undertake the same level of measures towards unstoppable climate change events, some substantial shortages in the crop production are expected. Starting by fruits and vegetables, especially tomato and grape, production of each is expected to decline respectively 11% and 20% in the next few decades. Maize, alfalfa and pasture tend to have shortages in 10-25% of production. The impact of these figures becomes more and more severe when we add the fact that three-quarters of families placed in rural areas can make averagely 5$ per day.

[4]http://www.fao.org/faostat/en/#data

Certain global institutions such as WB and FAO have supported Albania by investing in irrigation systems, increasing the exposure towards new technologies and leading our institutions into a better management of grants that are given to this sector.

According to UN "Map of Food Security and Climate Changes" Albania is the most endangered country in terms of food security by climate changes. According to the study, by the year of 2050 the estimated risk in the terms of food access will rise in 25%, considerably high in compare with other neighbor countries. While speaking for the food safety, the figures appear even more alarming, where almost 48% of food will certainly be unsafe to consume. Climate extreme events will increase the intensity of natural disasters such as floods, drought and storms. This would lead to the complete destruction of yields, infrastructure and bring more poverty in the affected areas. Another argument in disfavor stands behind the fact that currently there are certain cultures endangered because of adverse climate conditions and the lack of supply for these items increases tremendously the price in certain areas of cultivation. This leads to unequal share of goods where low income families have to give up in consuming certain goods and eventually a decrease in the number of the goods in a consumer' basket.

4. CONCLUSION

If we compare the conditions that both countries are situated we get to realize that amongst everything, the zone with highest vulnerability in Serbia is the high fluctuation on revenues in the exporting of agriculture that climate changes bring, while agriculture capacity remains a problem by the lack of technology, irrigation and drainage system, along with shortages in crop production year after year. This counts as an adverse impact in this crucial sector of economy for the whole Serbian population and the state in general. In Albania, climate changes bring the adverse effect directly to the farmers of the rural area, whose revenues are completely depending on the production, while the conditions get worsened by the high dependency ratio in food import which again falls over poor population.

The level of readiness for both countries remains abstract and far away from figures that show proper level of adaption. Global organizations have helped countries so far by analyzing data, giving funds and then advising countries' institutions towards a better adaption. Many studies and surveys prepared by academics, environmentalists, statisticians show that most of the people regardless of age, education and social status believe that through proper environment politics and policies in gas emission criteria, water management, agricultural policies, waste management, renewable energy and sustainable solutions it is possible to embrace the first steps towards fighting global warming.

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MICROFINANCE PRODUCTS AS TOOL FOR FINANCIAL RESILIENCE TO HAZARDS

Abstract: Microfinance development over the last decades has been significant and increasing. It can be defined as providing financial services such as microinsurance and microcredit for the poor in rural and urban areas, thus enabling increased income levels and improving living standards. The purpose of this paper is to identify the role and impact of different microfinance products and services in economic growth and how to reduce the risk of natural disasters. In the past, disaster risk management approaches had been focused on response and haven't address social vulnerability and exposure in a sufficient extent. Recently, this approach has been replaced by integrated approach in managing disaster risk which includes ex ante risk financing.

Key words: Disaster Risk Management, Financial Resilience, Microfinance, Microinsurance, Microcredits, Index insurance

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1. INTRODUCTION

Resilience to hazards or to disaster is ability (capacity) of society or nature to recover quickly from the adverse effects of disaster event. Community that wants to be resilient to catastrophic event must incorporate disaster risk management in everyday living.

The most widely accepted theory is that risk is probability of harmful consequences or losses resulting from a given hazard over a specified time period.[1] Disaster risk also must be viewed as a function of hazard, vulnerability, exposure, and resilience.[2] Risk exposure and resilience to exposed risk have major role in risk allocation. Disaster risk can be allocated to:

- individuals and businesses;
- local or/and national government, international government and UN;
- insurance and reinsurance market.

Risk allocation depends on selection of disaster risk management techniques that is the most appropriate for certain risk (Figure 1)

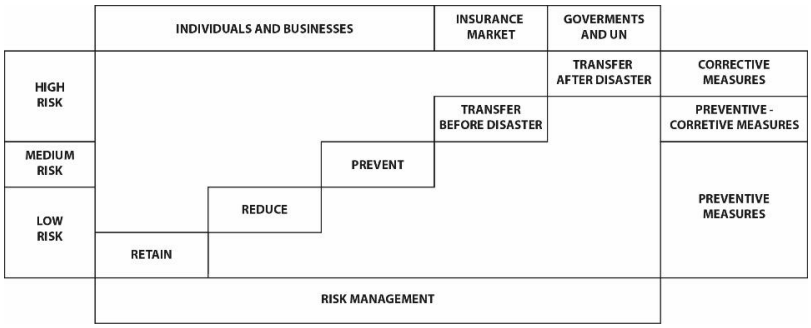

Figure 1 – Risk allocation (Popović, 2011)

In mature insurance markets, insurance has a substantial role in mitigating climate change consequences. Insurance reduces the effects of weather variability and extremes on national economies and provides security against poverty that strikes regions affected by climate change. [3]

Financial resilience to hazards is preventive financial measure that helps individuals or communities to quickly recover from financial shocks that disaster event brings. Wisely chosen financial service cannot prevent disaster to happen, but it can mitigate the financial consequences, which are the most common cause of long-term recovery.

2. DISASTER RISK MANAGEMENT

Disaster Risk Management (DRM) is a dynamic process that requires constant adjustments, making decisions and interaction at different but interdependent levels and between a variety institutions and actors, including individuals, families, communities and non-governmental organizations institutions, market organizations and governments. [4]

There are four phases of the DRM:

- Prevention and mitigation phase refers to generally localized policies, measures and activities before a disaster - reduce the risks and / or the vulnerability to be reduced the likelihood or extent of future disasters and the minimization of human and economic losses. Mitigation involves structural and non-structural activities and measures.
- Preparation phase tries to develop an emergency response and leadership skills before a catastrophe occurs to provide an adequate response. By definition, it will help mitigates the effects of disasters.
- Response phase involves actions performed immediately before, during and after a catastrophe that will save lives, increase the effectiveness of healing and minimize material damage. Purpose of this phase is not only to address the physical impacts of the disaster, but also to mitigate the new risk factors.
- Recovery phase involves short-term activities to restore long-term life support systems activities aimed at restoring life to normality. Depending on the size of a disaster, the community resistance and available resources, recovery phase can take several weeks or even years.

The role of risk transfer in DRM has typically focused on the response and recovery stages. However, more recently attention has focused on possible contributions of risk transfer (insurance and microfinance) to the risk prevention and preparedness stages. (Figure 2) [5]

3. INTEGRATED CLIMATE AND DISASTER RISK MANAGEMENT

In 2009. Munich Climate Insurance Initiative (MCII) offered proposal for climate risk management module that includes prevention and insurance as complementary instruments that will facilitate adaptation to climate change in climate post 2012 agreement. This module:

- follows the principles set out by the UNFCCC for financing and disbursing adaptation funds;
- provides assistance to the most vulnerable, and
- include private market participation. [6]

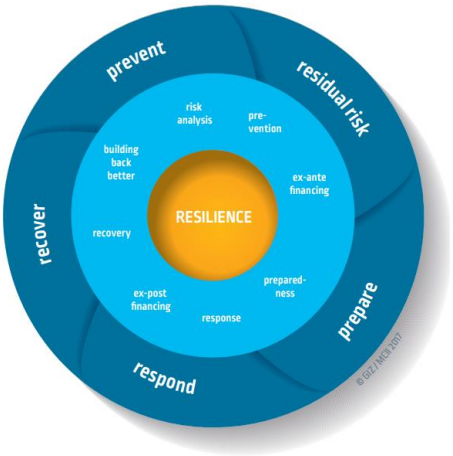

Figure 2 - Integrated climate and disaster risk management (GIZ/MCII 2017)

Climate risk management module has two pillars (Figure 3) [6]:

- Prevention Pillar that emphase risk reduction and
- Insurance Pillar with two tiers:
  - *Climate Insurance Pool* that would absorb a pre-defined proportion of high-level risks of disaster losses, particularly in vulnerable countries, at no cost to the beneficiary countries, and
  - *Climate Insurance Assistance Facility*, that would address middle-level risk and facilitate public safety nets and public-private insurance solutions.

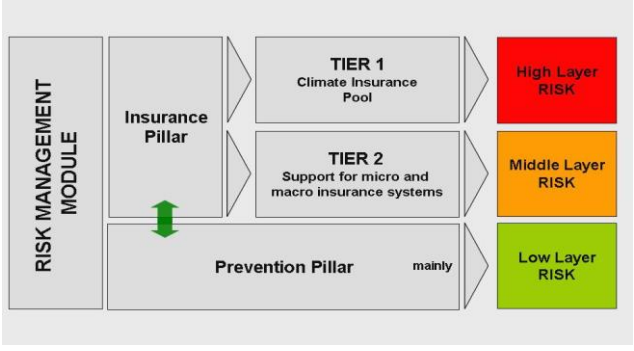

Figure 3 – Climate risk management module (MCII, 2009)

4. MICROFINANCE PRODUCTS

Microfinance is a kind of banking service available to individuals, unemployed or low-income groups who otherwise will not have access to financial services. It is generally seen as

a tool for repairing credit markets and unlocking the productive capacities of the poor communities. Ultimately, the purpose of microfinance is to empower the poor.

Microcredit is a small loan for poor households or micro enterprises. Usually it is characterized by short-term standardized credit products, limited amounts, fixed repayment plans and high interest rates. Most microfinance institutions require potential borrowers to save before applying for a loan in order to demonstrate their intention to develop long-term banking relationships. When the amount of savings reaches a certain level, the borrower will consider allocating a certain amount as the loan. Although compulsory savings can effectively contribute to controlling the risk of moral hazard, they increase the effective interest rate and limit potential debt.

Microinsurance refers to insurance services provided mainly to low-income consumers and limited access to traditional insurance services and other means to manage risk effectively. More specifically, micro insurance is a tool to protect low-income individuals from specific risks in exchange for paying a regular premium, the sum of which is proportional to the probability and cost of risk. Microinsurance works in the same way as conventional insurance, with the difference being low-income families, particularly low-income workers, who have little or no financial reserves and fluctuating incomes strongly. The most important difference between conventional insurance and microinsurance is the size of the premiums and the amount of the guarantees[5]. The premiums and / or coverage limits are generally low and are paid in sporadic installments due to the irregular income flows of the insured. Furthermore, microinsurance policies are generally written in simple language, which facilitates their understanding because this market generally has a limited educational and financial culture.

Index Insurance is an innovative approach to insurance that pays out benefits based on a predetermined index or loss of assets and investments due to weather conditions and disasters without complaining about traditional service compensation claims[6]. Moreover, it allows the process of demand resolution to be faster and more objective. In countries where agricultural insurance and disaster insurance are unavailable or expensive, index insurance can provide an alternative and protect people from collisions without having disadvantaged insurance in terms of information.

5. CONCLUSION

Microfinance is not a standalone solution for adaptation to disaster risks. However, it can be a strong complementary mechanism in a wider adaptation strategy.

If risk has high frequency, but low severity, risk should be prevented and reduced. It is the most cost-effective measure. That also means that risk should be retained. When probability of occurrence of adverse event is medium with medium severity (losses) risk should be at first place prevented and reduced, but also it should be financed. Savings and microfinance in this case is good way of risk financing. In case of low frequency of risk and moderate to high

[5]According to International Association of Insurance Supervisors

[6]Defined by International Finance Corporation, part of World Bank Group

severity of consequences, beside risk prevention that is mandatory, the most cost-effective way of managing risk is risk transfer to insurance/reinsurance market.

If insurance or microfinance are considered to be an appropriate tool for responding to the risk then financial product must be design for the specific needs of community that is exposed to risk. It must consider nature of the hazard and socio economic aspects of population at risk.

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MUNICIPALITIES DEVELOPMENT AS INDICATORS OF SOCIO-ECONOMIC VULNERABILITY

Abstract: In the past few years, significant attention has been given to the development of tools that attempt to measure the vulnerability, risk or resilience of communities to disasters. Today's various socio-economic indices have a great impact on the development of a country. In this paper vulnerability changes were analyzed for southern area of AP Vojvodina, Republic of Serbia. Socio-economic indicators were derived from statistical data for municipalities in South Bačka. The study area contains 11 municipalities, and it has been considered a three year examining period, from 2015 to 2017. The aim of this paper is to explain theoretical basis for understanding some of the factors of socio - economic development (such as employment, investments, average earnings and working age population) and to show how great impact these indicators have. By measuring vulnerability to disasters, decision makers could be timely provided with information for a better monitor progress towards a disaster resilient society.

Key words: disaster, resilience, socio-economic indicators, vulnerability

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1. INTRODUCTION

The frequency of natural disasters and the extent of their consequences at a global level are constantly increasing**.** This trend is partially caused by increased population vulnerability, which implies the degree of population vulnerability due to high magnitude natural processes. [1] Vulnerability can be described as: the degree of loss to a given element at risk or a set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total damage). [2] Vulnerability modified over time and it depended on physical, social, economic and environmental factors. [3] Disaster risk is considered as the combination of the severity and frequency of a hazard, the numbers of people and assets exposed to the hazard, and their vulnerability to damage. [4]

According to INFORM (Index For Risk Management[7]) Serbia ranks at 99 place on the INFORM country risk list of 191 countries, which is also among the highest scores in the region regarding to natural hazards and humanitarian crises and disasters. (Figure 1) The overall INFORM risk index identifies countries at risk from humanitarian crises and disasters that could overwhelm national response capacity. It is made up of three dimensions – hazards and exposure, vulnerability and lack of coping capacity.[5] In the category of Hazard and Exposure, Serbia ranks at 66. place with overall constant trend. In Vulnerability category, Serbia ranks on 117. place with overall decreasing trend in past three years. In the category of Lack of Coping Capacity, Serbia ranks on 119. place with constant trend.

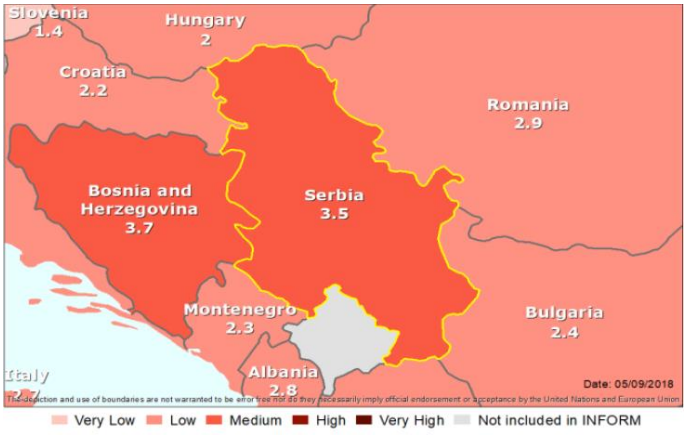


Figure 7- INFORM 2019 Risk Index [8]

Vulnerability to natural disaster represent the susceptibility of people to potential hazards and it is mainly focused on socio-economic vulnerability. In this paper, main attention is given to four socio-economic indices: population growth, working age population,

[7] http://www.inform-index.org/
[8] http://www.inform-index.org/Portals/0/Inform/2019/country_profiles/SRB.pdf

unemployment and average earnings. It is shown how these indicators changed in the last three years in some of the municipalities of South Bačka, North Serbia.

2. METHODOLOGY

The study area that in this paper is South Bačka, Serbia. This area has 12 municipalities and the most important one is Novi Sad City. For analyze it have been used historical data extracted from the Statistical Year Books of Serbia, in three-year period, from 2015. to 2017. Research focus consist on showing trends and values for all data categories of interests (population growth, working age population, unemployment and average earnings) and finding out if there are any correlations between them.

The South Bačka District is one of seven administrative districts of Vojvodina, Serbia. Geographically it lies in the southern part of Bačka and northern part of Syrmia. The administrative center of the district is the city of Novi Sad, which is also the largest city of the Autonomous Province of Vojvodina. Main results are shown for nex four municipalities: Novi Sad, Bačka Palanka, Bač and Žabalj.

3. RESULTS AND DISCUSSION

In 2017, in the Republic of Serbia, the number of unemployed persons totaled 435.155[9], while the unemployment rate was 13,5%, being by 1.8% lower than in 2016.

Observed by regions, there was a general decrease of the unemployment rate, and the greatest decrease was noted in Vojvodina Region (by 3.5%). On the other hand, in South Bačka we have a total unemployment of 41.275. (Graph 1)

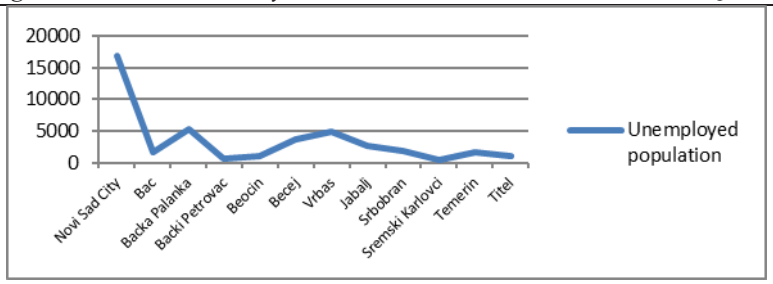
According to the Survey of Labor Force, the number of active persons (labor force, composed of employed and unemployed persons) amounted to 3.229.814[3] in 2017., being an increase of 0.7% relative to 2016. Observed by regions, the largest increase in the labor force was recorded in Beograd region (by 2.8%). In the study area of this paper, the working age population is 416.138.

In 2017. the population of the Republic of Serbia is estimated to 7.020.858[3]. The rate of population growth to the previous year is negative and amounts to -5.3 per 1.000 inhabitants.

South Bačka area total population in 2017. is 867.767 and the population growth has decreased since 2016. with 0.2%. (Graph 2)

The average salary of employees in the Republic of Serbia, in 2017. is 70.464 RSD[3]. For the region of Vojvodina, it is 65.919 RSD. South Backa in 2017. had an average salary of 44.036 RSD.

[9] Statistical Yearbook of Serbia 2018



Graph 1-Unemplyment in South Bačka district in 2017.

3.1. City of Novi Sad

From 2015. to 2016. there is a slightly increase of population with 27%, which decreases in 2017. with nearly the same percentage (26.65%). From this statistical data it is noticed a direct correlation between population growth and working age. When the population growth tends to increase, so does the working age and vice versa. There is a direct correlation between unemployment and rapid population growth. First, unemployment tends to increase population growth. The main factor in this is a tendency for groups with lower education to have higher birth rates. This statement is true for year 2017, but not for 2016, when these indexes are not positively correlated. Lower unemployment rates cause higher average earnings, a true statement in the case of Novi Sad city.

3.2. Bačka Palanka

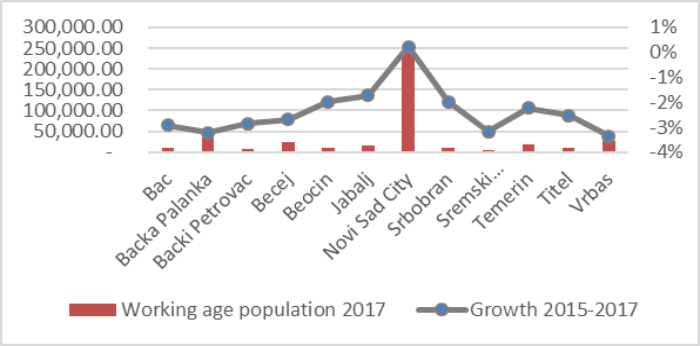
The second biggest municipality (by surface area) in South Bačka, is Bačka Palanka. The population growth rate has risen year by year. From 2015. to 2016. with 17%, while the working age population has also risen by 23%. From 2016. to 2017. the population growth has risen 10.27%, but the working age population has decreased by 21%. Unemployment has a trend to fall from 2015. to 2017., causing higher average earnings in this period of time.

3.3. Bač

Population growth has decreased in 2016. comparing to 2015., and in 2017. we see a small positive change. The working age population has increased with 21% in 2016., fallen again in 2017., same as the previous municipality, showing us again a positive connection between population growth and the working age population. From 2015. to 2016. There is no significant effect on the unemployment rate since there is only a difference by 17 individuals, and a rise by 69 individuals in 2017. which was expected seeing the changes on the population growth. Oddly enough, even though the unemployment rate has slightly risen, so has the average earnings.

3.4. Žabalj

It can be seen a huge gap in the population growth rate in Žabalj, rising from 2015. to 2016. generating a higher working age population, but not on the same scale. The unemployment rate has slightly decreased by 3.8% in 2016., and with 18.1% in 2017. The average earnings have risen as it was expected, considering the lower rates of unemployment year by year.



Graph 2-Working age population from 2015-2017, for all 12 municipalities in South Backa area

4. CONCLUSIONS

District of South Bačka is an important area and has a major impact on the socio-economic factors on the whole territory of Serbia. It has been noticed that in Serbia the municipalities with the highest population density are more exposed to the risk. According to the study results, the changes in the indicators are not significant in the three-year research period. Therefore, it can be concluded that in South Bačka exposure towards risks, in sense of socio-economic vulnerability, have not risen and it is constant. In context of global exposure, that is positive finding.

However, city of Novi Sad, as administrative center of South Bačka, disproportionally leads in district development, which can lead to permanently growing regional disparities in the labor market domain. Consequently, it could bring many economic, social and political risks in future.

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COMPARATIVE ANALYSIS OF EVACUATION CALCULATION AND PATHFINDER SIMULATION MODEL OF MULTISTORY PUBLIC BUILDING

Abstract: Evacuation calculations are becoming progressively key element of performance-based analyzes to evaluate the level of safety in buildings. Estimation of evacuation time is important especially for buildings with large number of people such as public, residential and business buildings. In some cases, engineers use hand calculations to evaluate life safety, while in others computer evacuation models are used. In this paper, a comparison between hand calculation and PathFinder simulation model has been provided for the study of multistory building evacuation. Hand calculation are usually applied to determine the time required for evacuation. However, evacuation simulation models are contributing to better evaluation of flow of evacuation in real time. These models could provide an effective way of testing the safety of a building in the case of fire and showing critical points during evacuation of occupants.

Key words: evacuation, performance-based analysis, simulation model, fire safety engineering, egress model

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1. INTRODUCTION

Evacuation calculations are becoming gradually part of performance-based analyzes to evaluate the level of safety in buildings situations. The engineers use hand calculations to evaluate the safety of life while computational evacuation models are used in some others. In order to calculate the mass flow evacuation from any location within the building, engineers mainly use hand calculation equations given in the handbook of the Society of Fire Protection Engineers. [1] These equations applied by hand calculation treat the occupants as elements that follow known guidelines. Excluding density, individuals decision-making processes and interactions are ignored. In order to obtain a more accurate evacuation calculation or a more effective solution, engineers looked for computer models to help evaluate key aspects of the life safety characteristics of a building. [2]

The purpose of this paper is to bring attention to current software-Pathfinder, where the selected building's 3D model was generated and different velocity values were used during evacuation. Through a comparative assessment of the calculation data received on the basis of technical suggestions and the results generated by a software model with different evacuation speeds, the benefits of the software are highlighted and suggestions are provided for implementing and improving current regulations through software testing and using different evacuation speeds.[3]

2. CASE STUDY

Building selected as a case study is “Tower Building” which is an administrative building located in University Campus in Novi Sad. Building is designed as underground floor, ground floor and nine floors for a total of eleven floors and approximately 28 meters in height which makes this building to be categorized as a multy-store building. All floors also contain sanitary facilities, while kitchens are located on the 2nd and 4th floor. The building’s floor height is 3 meters, the surface of an individual floor is 275m2 and total area of the building is 3025m2.

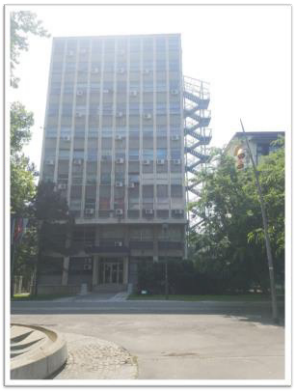

Figure 1 Tower Building

From taken data's the number of occupants per floor in building is provided in table below. There are 316 occupants in total within the building. As you see they are distributed depending on the floor, the most populated floors are from first to fourth floor as there are main offices, some meeting rooms and conference rooms.

Floors	Nr. Of Occupants
Basement Floor	3
Ground Floor	18
1st Floor	25
2nd Floor	30
3rd Floor	70
4th Floor	35
5th Floor	25
6th Floor	30
7th Floor	25
8th Floor	25
9th Floor	30

Table 1. Number of people per floor in building

3. CALCULATION OF EVACUATION TIME USING SRPS TP 21

3.1. Evacuation Speed and some other definitions of SRPS TP 21

The design speed of the undisturbed movement of a man on a flat floor is Vo = 1.5 m/s.The speed of evacuation is reduced due to the grouping of people from the narrowing of the corridor (doors, etc.), the corridor turning, the staircase, stairway, ramps, etc.Design speed of hindered movement (ve) is product of speed in the unhindered movement and deceleration factor.

$$Ve=u*Vo \quad (1)$$

u = 0.8 when moving down the stairs;

u = 0.6-0.05 d when moving upstairs where d is the number of fictitious floors of 3 m

For each turn at an angle greater than 30° and less than 60°, and confronting the stairs or ramp, retention time is 2 s for every 10 persons. For any change in direction at an angle greater than 60°, an additional 5 seconds is added for every 10 people evacuating.

Evacuation Stages:

- Stage 1: Starting Point (SP) ➔ First Exit (FE)
- Stage 2: First Exit (FE) ➔ Evacuation Exit (EE)
- Stage 3: Evacuation Exit (EE) ➔ Final Exit (FiE)
- Stage 4: Final Exit (FiE) ➔ Safe Place (SPI)

Evacuation Time : $tk = tI + tII + tIII + tIV$ (2)

Total Evacuation Time: $te = tp + tk$ (3)

3.2. Results taken from calculations with SRPS TP 21

While using this standart there was taken into consideration 2 cases in total. Case I Evacuating through external staircase which was devided into two Scenarios. First scenario is evacuation of the complete building through the external staircase and the second scenario is evacuation of the 9th floor only through the external staircase.

Case 2 evacuation underground, gorund and first floor through the main stairs or internal stairs. This cas has only one scenario which is Evacuation of the first, ground and underground floor. All the calculations were done with the Serbian standart of fire and results are shown on table below.

Hand Calculations			
		No. of People	Evacuation Time (min)
Case 1	Scenario 1	270	52.2
	Scenario 2	30	14.3
Case2	Scenario 1	52	5.5

Table 2. Evacuation time for two cases obtained from hand calculations

4. SIMULATION IN PATHFINDER

4.1. Introduction to simulation model

Pathfinder is a non-behavioral egress modeling software that offers an evacuation simulation to clearly display the occupants ' place as a function of moment. The software has the ability to track the motions and positions of people throughout the simulation. The model views the population through a worldwide perspective and allows evaluation of the density of certain construction fields.

Pathfinder does not promote the outcomes of the designs that visualize the fire, nor does it consider complicated human behavior. Software separates people's profiles and behaviour. To make it simpler to handle occupant parameters, Pathfinder involves a profile scheme that regulates velocity, delay, size and appearance settings for occupant organizations. Specific exits can also be appointed to the occupants to assist simulate different levels of familiarity with the exit scheme of a building. [4]

4.2. Results taken from Simulation of Software

Case I: Occupants of underground, ground and first floor evacuate through the main stairs and occupants from 2nd to 9th floor evacuate through the outside staircases. It is important that 2nd group of people should evacuate at final exit of outside staircases and the path they chose to arrive there is not important.

Case II: Occupants of underground, ground and first floor evacuate through the main stairs and occupants from 2nd to 9th floor evacuate through the outside staircases. It is important that 2nd group of people should evacuate at final exit of outside staircases and the path that they choose to reach final exit is decided since the beginning

Simulation Results		
Mode	Steering	SFPE
Nr. Of Occupants	316	316
Evacuation Time (s)	317.1	362.8

Simulation Results		
Mode	Steering	SFPE
Nr. Of Occupants	316	316
Evacuation Time (s)	315.7	362.8

Table 3. Case I & Case II Simulation results

5. COMPARATIVE ANALYSIS BETWEEN HAND CALCULATION AND SIMULATION MODEL

While we compare both methods hand calculation and simulation model, we came to conclusion that during a fire event, the time needed to evacuate all occupants in the building depends on a number of factors, some of which are very hard to predict. In order to have a more realistic evacuation process all engineers are trying to use the evacuation models instead of hand calculation, because model gives the opportunity to have more realistic results, create many scenarios and have a great visualization. Based on the scenarios created in model engineers can define adequate evacuation roots, implement fire protection measures and organize sessions with occupants advising them regarding evacuation rules. Total time required to evacuate all occupants from Tower Building, obtained by hand calculation and computer model are shown on table below.

Hand Calculations			
		No. of People	Evacuation Time (min)
Case 1	Scenario 1	270	52.2
	Scenario 2	30	14.3
Case2	Scenario 1	52	5.5

Simulation Results			
	Mode	Steering	SFPE
Case 1	Nr. Of Occupants	316	316
	Evacuation Time (min)	5.3	6.0
Case 2	Nr. Of Occupants	316	316
	Evacuation Time (min)	5.3	6.0

Table 4. Evacuation time for two methods, hand calculation and stimulation model.

6. CONCLUSIONS

The main goal during the evacuation of persons is the fast and safe evacuation from the endangered area of all occupants. There are many critical spots that can not be observed by hand calculation during the movement of the evacuation actors, so the use of modern technologies and software applications is increasingly needed. Software model makes it possible to detect critical points such as places where there is a deadlock, piling of people, speed and density of actor's movement, while technical recommendation provides only total evacuation time, dependent on number of actors, hence the real picture cannot be obtained. Results showed that congestion will not necessarily be created as technical recommendation

predicted. In addition, the software model has ability to detect that speed down the stairs is not constant, but varies depending on the density of movement of persons during the evacuation.

Something that Path Finder and other simulation models cannot do is prediction of human behavior. There is no model that can predict what an occupant can do in case of a fire, model just assume what he gone do but this assumption is not one hundred percent correctly. The scope and precision of the behavioral models are limited. However, most of the current models enable the user to modify the fundamental performance aspects: pre-evacuation times, route usage, route availability, characteristics of physical motion and behavioral routes. [5]

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INFLUENCE OF CONCRETE COVER THICKNESS ON FIRE RESISTANCE OF RC BEAMS

Abstract: Numerical approach using finite element method is used to evaluate the behavior of reinforced concrete beam subjected to fire. This paper presents the course of finite element model development for assessing the thermal response of reinforced concrete member subjected to different types of fire exposure, using commercially available software ANSYS. Previously, the beam is designed according to Eurocode standards and then modeled using ANSYS, to acquire the transient thermal response. To determine the structural behavior under fire conditions, for the complete duration of the fire, it is necessary to determine the temperature field within the elements. Numerical model is verified according to Eurocode standards. The three-dimensional finite element model is used to evaluate the influence of the concrete cover thickness and different types of fire exposure on structural integrity of reinforced concrete beam in case of fire.

Key words: fire resistance, ANSYS software, transient thermal analysis, finite element method, numerical modelling

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1. INTRODUCTION

Fire can indeed be regarded as the most severe condition in the life of a concrete structure. Our exposure to fire hazard is largely filtered through the built environment in which we live our lives: homes, offices, public and commercial buildings. This risk exposure can therefore be mitigated by successful engineering with a minimum standard set by building codes [1]. Yet, while fire has historically been the primary hazard leading to building codes being adopted, fire safety codes have been slow to evolve [2].

Fire attack can occur on any building type irrespective of the place's economic value. It is therefore inevitable for engineers around the world to study the condition of RC beams exposed to high temperatures and to understand the method of fire propagation within the beam in order to take the necessary migration measures [3].

On this paper we are going to do different scenarios of fire in a section of a 3 m reinforced beam with the help of the Ansys software. Ansys is one of the best software on predicting how a structural element will behave in a case of fire.

2. FIRE CURVES

2.1. Standard temperature-time curve (ISO 834)

The standard ISO 834 temperature-time curve, also known as the Cellulosic curve and/or the standard nominal fire curve, is used to test the fire resistance of materials subject to fire hazard category "A", i.e. fire hazard rating based on the burning rate of general fuel building materials and building content.

The standard temperature-time curve is given by [4]:

$$\theta_g = 20 + 345 \cdot \log_{10}(8 \cdot t + 1) \tag{1}$$

where θ_g is the gas temperature [°C] and t is the time [min].

2.2. External fire curve (EXT)

The external fire curve is given by:

$$\theta_g = 660 \cdot \left(1 - 0.687 \cdot e^{-0.32 \cdot t} - 0.313 \cdot e^{-3.8 \cdot t}\right) + 20 \tag{2}$$

where θ_g is the gas temperature [°C] and t is the time [min].

2.3. Hydrocarbon fire curve (HC)

Hydrocarbon fires are growing rapidly, reaching temperatures above 1000°C in 15 minutes. These serious test circumstances are not achieved in conventional flame trials, such as ISO 834, and are therefore an extra necessity for environments in petrochemical and liquid fuel processes. The hydrocarbon fire curve is given by:

$$\theta_g = 1080 \cdot \left(1 - 0.325 \cdot e^{-0.167 \cdot t} - 0.675 \cdot e^{-2.5 \cdot t}\right) + 20 \quad (3)$$

where θ_g is the gas temperature [°C] and t is the time [min].

3. TYPES OF HEAT TRANSFER

Processes for heat transfer are classified into three types. The first is conduction, which is defined as transferring heat that occurs by interfering matter without the matter's bulk movement. Convection, or heat transfer due to a flowing fluid, is the second heat transfer process. The third process is radiation or energy transmission through space without the need for material presence. Radiation is the only space heat transfer method. Equation of heat conduction follows [5]:

$$\begin{aligned} \dot{q}_{x-net} &= \left[\dot{q}''\left(x + \frac{dx}{2}\right) - \dot{q}''\left(x - \frac{dx}{2}\right)\right] dydz \\ &= \left\{\left[\left(k_1 + \frac{\partial k_1}{\partial x}\frac{dx}{2}\right)\left(\frac{\partial T}{\partial x} + \frac{\partial^2 T}{\partial x^2}\frac{dx}{2}\right)\right] - \left[\left(k_1 + \frac{\partial k_1}{\partial x}\frac{dx}{2}\right)\left(\frac{\partial T}{\partial x} - \frac{\partial^2 T}{\partial x^2}\frac{dx}{2}\right)\right]\right\} dydz \end{aligned} \quad (4)$$

Convection is not a basic heat transfer mode from a conceptual point of view. Rather, it occurs through a combined conduction (and/or radiation) effect and the transmitting medium's motion. Convection, however, plays a very important role in fires. It transports to the surrounding environment the enormous amount of chemical energy released during a fire by the movement of hot gasses.

Radiation is now recognized as the dominant heat transfer mode in flames with characteristic lengths exceeding 0.2 m, whereas convection in smaller flames is more significant. Thermal fire radiation involves the exchange of energy between surfaces (i.e. walls, ceilings, floors, furniture, etc.) as well as the emission and absorption of different gasses and soot particles.

3.1. Heat flux calculation from a flame

It is important to predict the radiative heat flux from a flame in determining the hazard of ignition and fire spread and in developing devices for fire detection. Under actual conditions, the shape of flames is arbitrary and time-dependent, making a detailed analysis of radiation very cumbersome and inexpensive. Flames are idealized as simple geometric forms like plane layers or axisymmetric cylinders and cones in most calculations. Assuming κ_λ is independent of path length, integration of the radiative transport yields [6]:

$$I_\lambda = I_{b\lambda}\left[1 - \exp\left(\frac{-2\kappa_\lambda}{\sin\theta}\sqrt{r^2 - L^2\cos^2\phi}\right)\right] \quad (5)$$

4. CASE STUDY

4.1. Design of RC beam according to Eurocode standards

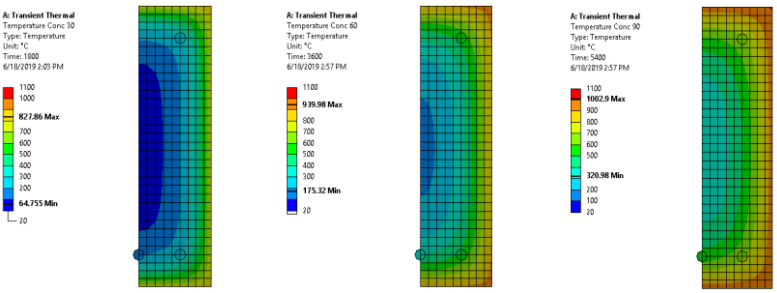
The beam cross-section dimensions are 16/30 cm with a span of 3 m. The beam is designed for a combination of permanent load $g = 8$ kN/m' and imposed load $q = 10$ kN/m'. The adopted reinforcement amounts to 3 reinforcement bars Ø12 in the lower part of the section and 2 bars Ø12 in the upper part, with stirrups Ø6/20/10. For the numerical analysis, it is not needed to model the whole beam but only a section of it, since the heat transfer occurs through the beam cross-section and not along the beam.

4.2. Transient thermal analysis - ANSYS Workbench and model verification

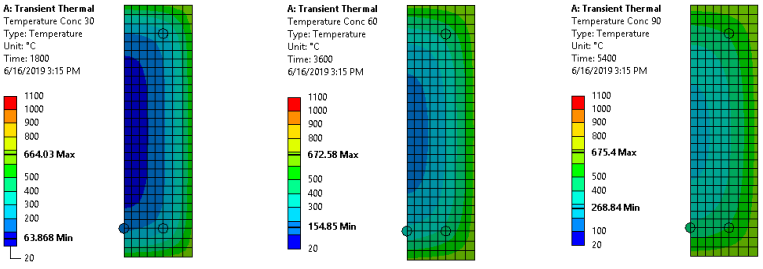
To find the temperature evolution in concrete and reinforcement bars inside the beam, the transient thermal analysis is conducted using ANSYS Workbench. Material thermal properties in form of engineering data are taken according to Eurocode 2 part 1-2 and Eurocode 3 part 1-2.

5. RESULTS

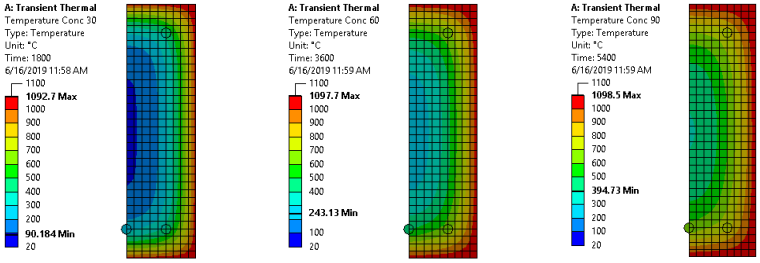
Figure 1 presents temperature profiles after 30, 60 and 90 minutes, for three types of fire exposure and a concrete cover of 2.2 cm. Maximum temperature in reinforcement bars after 90 minutes of fire, in relation to the concrete cover, is presented in Figure 2a-c.



a) Standard fire curve ISO 834

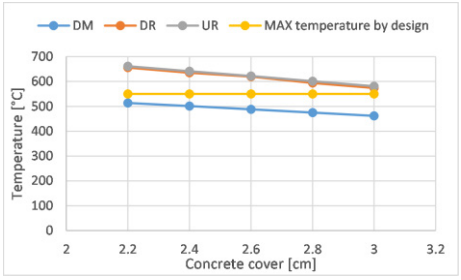


b) External fire curve

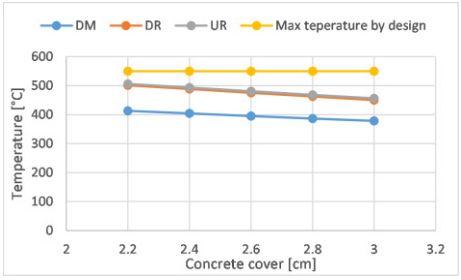


c) Hydrocarbon fire curve

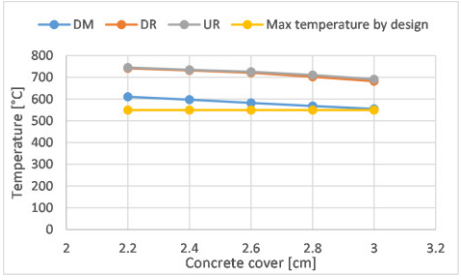
Figure 3 – Temperature in the beam with a concrete cover of 2.2 cm at 30 min (left), 60 min (middle) and at 90 min (right) for various types of fire exposure



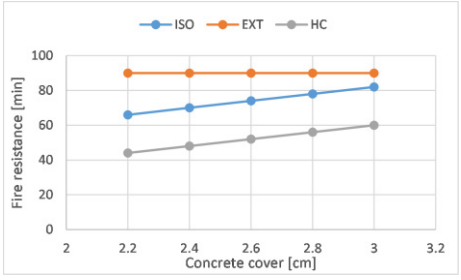
a) Standard fire curve ISO 834



b) External fire curve



c) Hydrocarbon fire curve



d) Fire resistance in relation to concrete cover

Figure 4 – Maximum temperature in the reinforcement bars after 90 min for various types of fire exposure and fire resistance in relation to concrete cover thickness

6. DISCUSSION AND CONCLUSIONS

Since the concrete thermal conductivity is approximately 30 times lower than steel, concrete cover acts as a thermal insulation for the reinforcement bars, protecting them from direct exposure to the fire. With the increase of cover thickness, the temperature in reinforcement bars decreases.

The adopted fire resistance failure criterion is based on the maximum temperature in reinforcement bars. When the temperature reaches 550°C, it is assumed that the reduction of

the load bearing capacity of steel would be significant enough to lead to a structural failure of the beam. By tracking the time at which the temperature in the bars exceeds this threshold, fire resistance (until 90 minutes of the analysis time) can be determined for concrete cover in the range of 2.2 cm to 3.0 cm, which is presented in Figure 2d.

In case of external fire curve, 2.2 cm concrete cover would be sufficient to provide 90 minutes of fire resistance. Since the cover increase would decrease the beam load bearing capacity and the maximum distance between the bars, needed for proper concrete cast, further increase beyond 3.0 cm would not be permitted. For the more severe types of fire exposure, such as ISO 834 and hydrocarbon fire, it can be seen that fire resistance is increasing linearly with concrete cover thickness, at a rate of 2 minutes per additional 1 mm of cover, but in all analyzed cases, the beam fire resistance would be below 90 and 60 minutes for ISO 834 and hydrocarbon fire, respectively.

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COMPARTMENT FIRE MODELLING USING ZONE AND PARAMETRIC FIRE MODELS

Abstract: Fire development in compartments depends on various parameters, resulting in different fire models, which can be used to predict fire curves. Standardized fire curves have been developed over the years, such as nominal fire curves and parametric fire curves, to predict the severity of fire. More recent methods include zone modelling and field modelling, which are based on energy and mass balance equations. Eurocode standards, providing prescribed procedure to calculate parametric temperature-time curves, as well as zone modelling, will be described in this paper to predict fire development in various compartments. OZone, a two-zone model software, is used to calculate temperature-time curves for different case studies. Results obtained from OZone are compared with parametric fire curves gained by following the method defined in Eurocode.

Key words: fire models, temperature-time curves, parametric fires, zone models

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1. INTRODUCTION

Fire is defined as the uncontrolled combustion which puts in danger materials, the environment and especially the health and the lives of people. Its severity si affected by different factors such as: characteristic of the space where the fire initiates, available combustion material and the ventilation conditions.

The starting location and growth of fire depend on so many parameters that is imposible to certainly predict the fire-development. In order to get essential data for structural fire design, different fire models are used, that rely on differnt strategy to predict fire development in defined enclosures.

In this paper two fire models, parametric fire curves and zone model, will be described and used to define the fire develpment in differnt compartments.

2. FIRE MODELS

2.1. Parametric Fire Curves

Parametric fire models take into account differnt environmental conditions, such as the thermal properties at the boudaries of the fire compartment, the total amount of fuel or cumbustibile material and ventilation conditions, which affect the fire development. Parametric fire curves as described in Eurocode Annex A are defined as a set of temeperature-time curves depending on various fire loads and opening factors (0.02-0.2) [1]. These factors are directly related to the occupancy of the building and its configuration. In order to effectivaly use parametric fire curves the following conditions should be fullfilled:

- The enclosure must have a floor area up to 500m^2 and a height of maximum 4m with no openings in the ceiling
- The combustion rate and radiation from the fire load are close to cellulose fires.
- The opening factor should be known throughout all the duration of fire and is defined as below [1]

$$O = A_v \sqrt{h_{eq}} / A_t \quad (1)$$

Where:

O - opening factor [m$^{1/2}$]

A_v - total areal of vertical openings on all walls [m^2]

h_{eq} - weighted average of window heights on all walls [m]

A_t - total area of enclosure (walls, ceiling and floor, including openings) [m^2]

During the ignition and development phase of fire, the temperature-fire curve is defined by the following relationship:

$$\theta_g = 20 + 1325\left(1 - 0.325e^{-0.2t^*} - 0.204e^{-1.7t^*} - 0.472e^{-19t^*}\right) \quad (2)$$

Where:

θ_g - gas temperature in the compartment [^{o}C]

t^* - time multiplied by a factor depending of the opening factor as defined in Eurocode [h]

As suggested in the research of Magnusson & Thelandersson [2], in the cooling phase the temperature is asssumed to decay in a linear way depending on the maximum temperature reached and opening factor

2.2. Zone Model

Advanced models like zone model are based on mass and energy balance equations. In one-zone model it is assumed that in the whole compartment, conditions like gas temperature, gas density, pressure and energy are uniform. One-zone model is valid when the fire is fully-engulfed or post-flashover.In this kind of model it is also neccesary to take into account the mass and energy exchange between internal and external gases thourgh the openings.

On the other hand two-zone models, representthe temperature development in two different zones within the same compartment. The upper and the lower layer, with a horizontal interface. The parameters are calculted in the same way as in the one-zone model for each of the layers. This system is valid only for pre-flashover fires and the two layers are combined into one-zone model once certain criteria are met. (In Ozone when the upper layer exeeds 500^{o}C, the upper layer height is more than 80% of the total height or when the fire area is more than 25% of the floor area [3].

As in the parametric fire curves, parameters such as openings have an important effect, since they guarantee the necessary fresh air for fire developmetn and also ventilation throughout the compartment. However, in contrast to the parametric fire model, where only the opening factor *O* in Eq.1 is responsible for the effect of all openings, in multi-zone models, every opening is defined individually in the compartment. In zone models openings can be defined to follow certain mechanisms as being activated at certaind timeor breaking after a predifined temperature is reached. The different partitions (walls, ceiling and floor) can be defined respectively by the layers that compose them. The composition of the partitions affects the energy absorption at the boundaries.

Beside the fire load, the heat release rate (RHR) and the rate of mass loss are also necessary to describe the fire development in the zone-model. In different cases during the fire develpment the degree of pyrolysis and RHR (that change the fire duration), are necessary when these parameters greated than what the openings are able to provide.

Since for the implementation of this kind of model is required the integration of various differntial equations, software Ozone which was developed by Franssen and Cadorin in the University of Liege [3]. This software succeeds in modelling compartment fires and combining two-zone and one-zone models with transition mechanisms in accordance with EN 1991-1-2.

3. FIRE MODELS FOR RESIFENTIAL BUILDINGS

The fire development in five different compartments in a residential building was analysed under the assumption of both parametric fire curves based on Annex A and E of Eurocodes and zone model by using Ozone software. Every compartment was different in area and opening factor (Table-1). All enclosure were assumed to be rectangular in shape and only the outer walls with layers as specified in Table-2 were taken into account. In Figure 1 is shown the typical layout of a compartment.

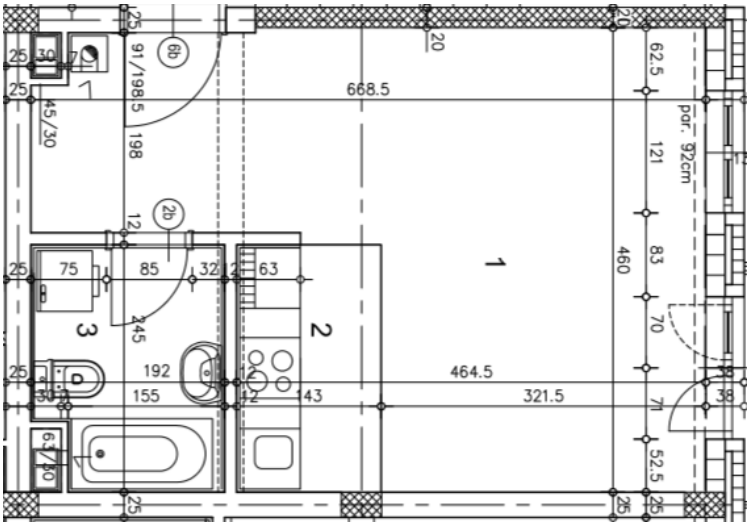

Figure 1- Configuration of compartment 3Ga-2

Table 1- Compartment details

3Ga-2	22.72	0.095
3Gb-2	30.77	0.076
3Da-2	56.66	0.096
3Ti-2	102.31	0.078
3C-2	120.15	0.078

Table 2- Partitions layout

Floor / thickness [cm]		Ceiling / thickness [cm]		Walls / thickness [cm]	
Wood flooring	2.5	Concrete slab	15	Thermal block	25
Concrete slab	15	Wood flooring	2.5	Rock wool	10

Parametric fire curves as described in Annex A and E in EN 1991-1-2 [1] take into account the compartment geometry, openings and boundary enclosure composition. The OZone model gives more attention to the openings by defining the postion of each one of them. Furthermore, the zone model describes the interaction between openings and temperature evolution inside the compartment, starting from two-zone model in the initial phases and transitioning to one-zone model when the the fire is fully ingulfed (flashover occurs).

The design fire in the compartments is ventilation controlled in every case and the maximum temperature reached in every compartment are shown in Figure-2 and Figure-3.

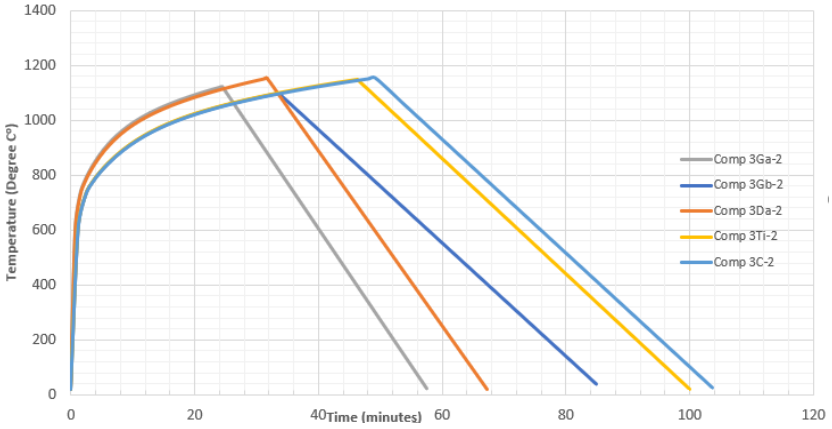

Figure- 2 Temperature-time curves for parametric fire model

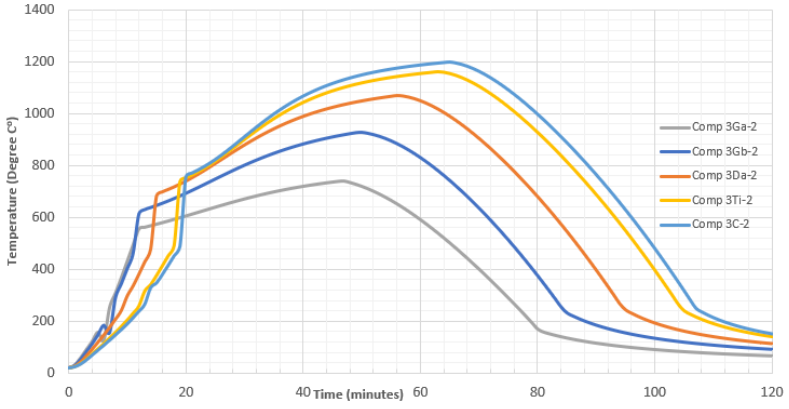

Figure- 3 Temperature-time curves for zone model

4. CONCLUSIONS

The results obtained showed the similarities and differences between the two methods. In both cases the rate at which the fire developed and decayed was similar, as its visible in the

different graphic representation they follow a similar slope. Furthermore, the duration of fire was similar in most of the cases for both procedures. On the other hand, the maximum temperature predicted by the two methods was different. In the parametric fire curves, the compartment fires usually reached a maximum temperature in the range from 1100 to 1200ºC, no matter the size of the enclosure, while in the zone model, the maximum temperature increases constantly from 650 to 1200ºC as the area of the compartment increases. Since the parametric fire curve development is part of the Eurocode methodology, intended for the use by the wider engineering community, the temperature-time predictions, as being more conservative, provide additional safety in the fire design process.

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ASEISMIC MODELING OF THE COLUMN ACCORDING TO EUROPEAN REGULATIONS

Abstract: Considering that Balkan peninsula is in the area of tectonic collision between African and Eurasian plate, in the phase of building design it is of utmost importance to apply the principles of aseismic modeling. The paper gives an analysis and recommendations for the possibility of modeling behavior in the post elastic area, on the example of the basic element of bearing structure. Specifically, an analysis of the reinforced concrete column of the industrial hall in accordance with the Eurocode 8 is shown. According to the principles of Eurocode 8, it has been found that the adequate cross section confining method significantly increases the boundary dilatation on the verge of fracture, and therefore the maximum curvature of deformation.

Key words: Reinforced concrete pillar, European regulation, seismic action, deformation capacity, behavior factor, cross-section confining

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1. INTRODUCTION

In history of Bosnia and Hercegovina, which as a part of Balkan peninsula is in the area of tectonic collision between African and Eurasian plate, multiple devastating earthquakes have occurred with magnitudes over 5.0 and intensities in the epicenter over 7° MCS [7]. According to the European standard EN 1991 - Eurocode 1 [1] seismic actions must be considered as a load case, and detailed procedure for its implementation is given in EN 1998 - Eurocode 8 [2]. In Bosnia and Herzegovina, Eurocodes are gradually adopted into the national system of standardization in the period between 2003. and 2013, and in 2018. five national anexes are issued for selected parts of Eurocode 1, as well as for Part 1 of Eurocode 8 [4].

Unlike dimensioning for everyday loads, in seismic analysis, parts of the bearing structure of a building are alowed to show nonlinear, plastic behavior. Ductile properties of the structure and the dissipation of kinetic energy needs to be used. As a basic bearing element, the collaps of the column is critical, so when defining its plastic behavior in case of an earthquake, local buckling of the longitudinal reinforcement must be taken into the account. Buckling occurs due to the appearance of the insufficient cross section confining, which has to be carried out in the critical area of the column with the correct selection of hoops or cross ties placed with appropriate spacings [4,5,6].

The paper presents the ductility check and cross section confining calculation example for the reinforced-concrete prefabricated column exposed to the effects of earthquake.

2. ASEISMIC DESIGN ACCORDING TO EUROCODE 8

2.1. General requirements

In Eurocode 8 principles for building configuration and design are given, and, according to these, structural regularity criteria are defined which have influence on computation model, calculation method and behavior factor *q*. A reference calculation method for determining seismic actions is *modal analysis* in combination with the *spectrum response method*, where the *linear elastic model* and the *design spectrum* are mainly used [2].

The starting point for the design of the *elastic acceleration spectrum* S_e, whose basic parameters are shown on the Figure 1 - left, is peak ground acceleration a_g, selected according to the seismic zone. The ability of the nonlinear response of the bearing structure and its ductile behavior is simplified in the elastic analysis, where the elastic spectrum is reduced by behavior factor *q,* and the result is *design spectrum*, as shown on Figure 1 - right.

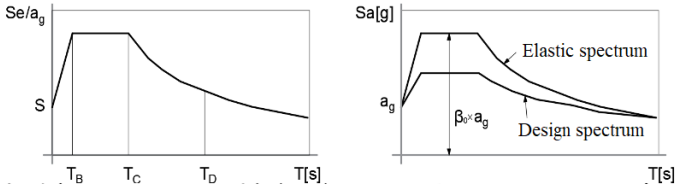

Figure 5 – Elastics spectrum – general form (left) Elastic and design spectrum (right)

Seismic action as a coincidental load case has been treated separately in Eurocode:

$$\sum G_k + A_{Ed} + \sum \Psi_i \cdot Q_{ki} \quad (1)$$

Where, G_k is characteristic permanent action, A_{Ed} - design value of seismic action, Q_{ki} - characteristic variable action and Ψ - the combination coefficient for variable action [1].

2.2. Seismic columns design

Within the part of Eurocode 8 where specific rules for concrete buildings are defined, guidelines for designing monolith and prefabricated concrete structures are provided.

For the achievement of required overall ductility of the structure, the potential regions for plastic hinge formation – chritical regions are defined for each type of building element which needs to possess plastic rotational capacities. For primary seismic columns the design values of shear forces is determined in accordance with the capacity design rule, on the basis of the equilibrium of the column under end moments corresponding to plastic hinge formation [2].

Eurocode 8 prescribes the dimensions of the column cross-section depending on the coefficient of the inter story drift θ, and the conditions for minimum and maximum percentage of reinforcement. In terms of providing the ductile behavior of the columns and prevention of local buckling, there are formulations for calculating the minimum and maximum percentages of transverse reinforcement in the critical and beyond the critical region [2].

The length of critical region l_{cr} may be taken as follows:

$$l_{cr} = \max\{h_c, l_{cl}/6, 0{,}45\} \quad (2)$$

Where, h_c is the largest cross-sectional dimension and l_{cl} is clear length of the column [2].

3. WORKED EXAMPLE

3.1. General data and object disposition

An example is given from the calculation of the prefabricated building with frame system, in Laktaši municipality, Bosnia and Hercegovina. On Figure 2 cross section and basis of building are given.

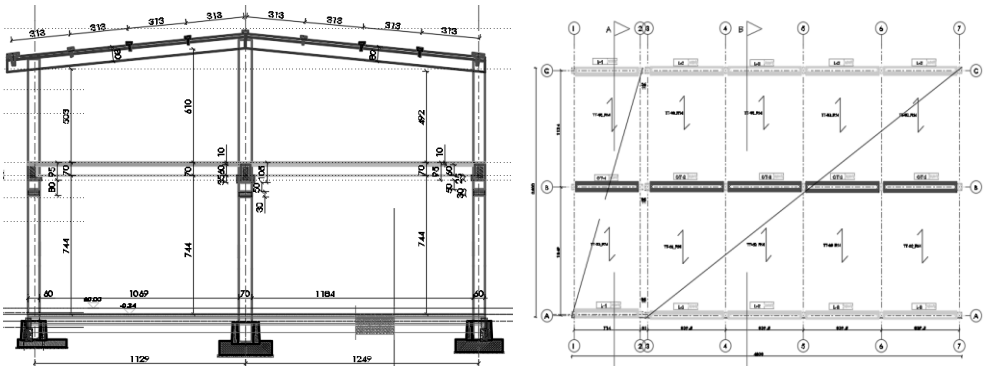

Figure 2 – Cross section and base floor design

3.2. Input data - peak ground acceleration, elastic and design spectrum

According to National Annex to Eurocode [3], reference peak ground acceleration for this location, on type A ground is a_{gR}=0,1g (Figure 3). An importance factor of the building γ=1,0, so peak ground acceleration $a_g = \gamma \cdot a_{gR}$= 0,1 g..

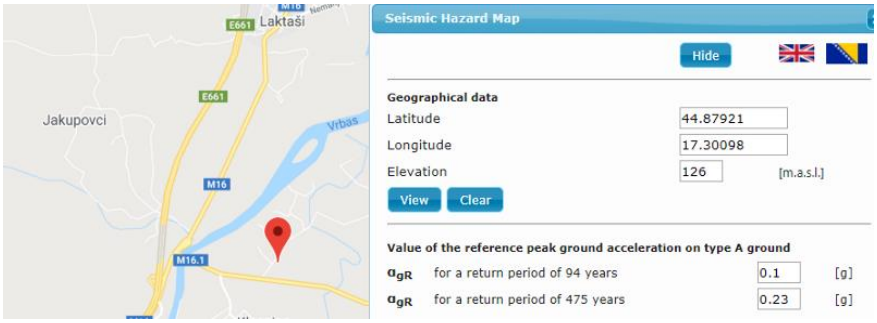

Figure 3 – Seismic hazard map according to NA to EC8 [3]

In geomechanic elaborate ground is categorized as of type E. As detailed geomechanical research is not performed, recommended parameters of elastic spectrum of Type 1 are taken as: S=1,4, T_B=0,15 s, T_C=0,5 s, T_D=2 s.

Design spectrum $S_D(T)$ for horizontal seismic actions is defined according to formulations stated in [2] in which behavior factor q has the largest influence in spectrum plato. Lower limit of *behavior factor* for concrete structures is:

$$q = q_0 \cdot k_w \geq 1,5 \quad (3)$$

Where:

q_0 - basic value of behavior factor, depending on α_0 and α_1 - multiplication factors for horizontal seismic design action is in order to first reach the flexural resistance in any member in the structure and to form plastic hinges for the development of overall structural instability, respectively, while all other design actions remain constant

k_w - factor reflecting the prevailing failure mode in structural systems with walls, which for frame systems is taken as 1,00 [2]

Basic value q_0 for frame system is $3 \cdot \alpha_0/\alpha_1$, where α_0/α_1 for multistory, multi-bay frames can be taken as 1,3, so the behavior factor q in this case is 3,90.

3.3. Calculation method and load combinations

The method of calculation used is an elastic multimodal-spectral analysis. The requirements for the slender elements design according to the limit load condition in reinforced structures depends on the inter story drift. The subject structure is classified as movable system.

For the limit load, combination for seismic load case, according to equation (1) is:

$$1,0 \cdot g + S_{x+/-} + 0,8 \cdot q, \quad 1,0 \cdot g + S_{y+/-} + 0,8 \cdot q \quad (4)$$

3.4. Ductility condition and local buckling prevention of the column

For ductility class medium, *axial force control* condition in vertical element is:

$$v_{d,max} \leq 0{,}65 \text{ or } N_{Ed} \leq 0{,}65 \cdot b_c \cdot h_c \cdot f_{cd} \quad (5)$$

Where:

$v_{d,max} = N_{Ed}/(b_c \cdot h_c \cdot f_{cd})$ – normalized axial force

N_{Ed} – axial force from the analysis for the seismic design situation

b_c, h_c – cross section dimensions of the column

f_{cd} – design value of concrete compressive strength [2]

In this case, for the most critical column (60x60cm, C30/37), ductility condition is fulfilled, as $N_{Ed,max} = 1397{,}89\text{kN} < 0{,}65 \cdot b \cdot h \cdot f_{cd} = 4906{,}20$ kN

For ductility class medium in case of detailing of primary seismic column for local ductility, standard defines *reinforcement for confining* condition as follows:

$$\alpha \cdot \omega_{wd} \geq \mu_{1/r} \cdot v_d \cdot \varepsilon_{sy,d} \cdot b_c / b_0 - 0{,}035, \qquad \omega_{wd} \geq 0{,}08 \quad (6)$$

Where:

α – confinement effectiveness factor, depending on dimensions of the cross section, the distance between consecutive engaged bars and the total number of longitudinal bars laterally engaged by hoops or cross ties

$\omega_{wd} = V_h/V_0 \cdot f_{yd}/f_{cd}$ – mechanical volumetric ratio of confining hoops in critical region

V_h, V_o – volume of confining hoops, volume of concrete core

f_{yd}, f_{cd} – design values of the yield strength of steel and of concrete compressive strength

$\mu_{1/r}$ – required value of curvature ductility factor (9 in case ductility class medium)

$v_d = N_{Ed}/(b \cdot h \cdot f_{cd})$ – normalized design axial force

$\varepsilon_{sy,d}$ – design values of the steel strain strength

b_c, b_0 – the gross cross-sectional width, the width of confined core [2]

General confining solutions is given in Figure 4 - left. For the columns in this example, due to their dimension (60x60 cm) and having in mind the requirement of standard EN 1992-1-1 defining the minimum spacing between the two adjacent longitudinal bars confined with hoops or cross ties, which is 200 mm, a possible armature arrangements are shown in Figure 4 - middle, right. Confining in this example (Figure 4 – middle) is achieved with hoops Ø8/10.

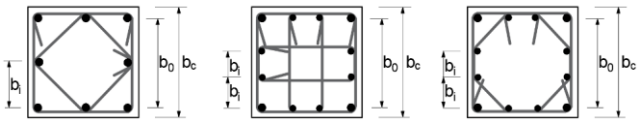

Figure 4 – Section confining, general solution (left) two-arm confining (middle, right)

On critical regions *spacing between the hoops and cross ties* - s, such that a minimum ductility is ensured and local buckling of longitudinal bars is prevented, must not exceed:

$$s = \min\{b_o/2, 175, 8\times Ø\} = \min\{54/2, 175, 8\times 25\} = 175 \text{ mm} \quad (7)$$

Where b_o is minimal dimension of concrete core and Ø minimum diameter od longitudinal reinforcement [2].

4. CONCLUSION

The steps for calculating the seismic resistance of the structure are clearly defined in the Eurocode 8 and in this example some principles for its application are given. As shown, seismic resistance is depending on the location where the building is built, behavioral factor which describes the ductility of the construction and detailed calculation of the ductility capacity at the chosen location of energy dissipation.

In example, the accent is given on proper cross-section confining. By confining, the concrete in column is in tri-axial state due to maximum exploitation load. Vertical armature is held by a transverse armature with proper spacing. This way, during the earthquake, after the concrete protection layer spalling, buckling is prevented and the bearing cross-section of column is confined concrete core. Proper confining significantly increases the boundary dilatation when the fracture of cross-section is reached, and therefore the maximum deformation capacity. The stability of the structure is not compromised, and the damage is such that the construction can be repaired in the most optimal, constructive manner [5,6].

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EFFECTS OF HIGH TEMPERATURES ON CONCRETE MICROSTRUCTURE

Abstract: The paper presents an analysis of the effect of elevated temperatures on concrete, with an emphasis on microstructural changes in the hydrated cement paste. The physical and chemical processes in the cement paste due to the increase of temperature are described. Research has shown that the first changes in the cement matrix occur at a temperature of 300°C, and that the microcracks appear at temperatures of 500°C. Intensive microcrack development occurs at 700°C, while at temperatures of about 900°C some particles of hydration products completely cracked. Reducing the degree of degradation of cement paste is possible by applying certain types of addition.

Key words: concrete, microstructure, hydrated cement paste, high temperature

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1. INTRODUCTION

Many research show that a large number of structures have been damaged under fire conditions [2,3,8,9].

Given that a large number of structures are made entirely or partially of concrete, knowing the behavior of concrete at elevated temperatures is of utmost importance.

Research show that a resistance of concrete to high temperature is dependent on many factors [3,4,9], among which a significant impact have concrete component materials. Since the aggregate occupies the largest percentage of the concrete volume (60 to 70% for conventional concrete), the type of the applied aggregate has a great influence on concrete fire resistance [4]. Therefore, when designing concrete elements, in accordance with EN 1992-1-2:2004, different input values are applied to the design, if a calcareous or siliceous aggregate is used [4,5]. Also, the behavior of concrete at elevated temperatures is influenced by the quality of the cement paste as well as the quality of the interfacial transition zone between the aggregate and the cement paste.

This paper describes the processes that take place in cement paste at elevated temperatures, as well as its microstructural analysis. Regarding this, it is important to note that the tests are mainly performed maximum up to 1200ºC, when concrete starts to melt (Fig. 1).

Figure 1 – Molten decomposed concrete [7]

2. MICROSTRUCTURE OF CEMENT PASTE AFTER EXPOSURE TO ELEVATED TEMPERATURES

Exposure of the cement paste to elevated temperatures leads to its dehydration, which results in a decrease in strength and an increase in pore pressure in the paste. It can result as explosive spalling of concrete [12].

Figures 2 and 3 show descriptions of the physical and chemical processes in the cement paste due to the increase of temperature [1,6,8,9,10].

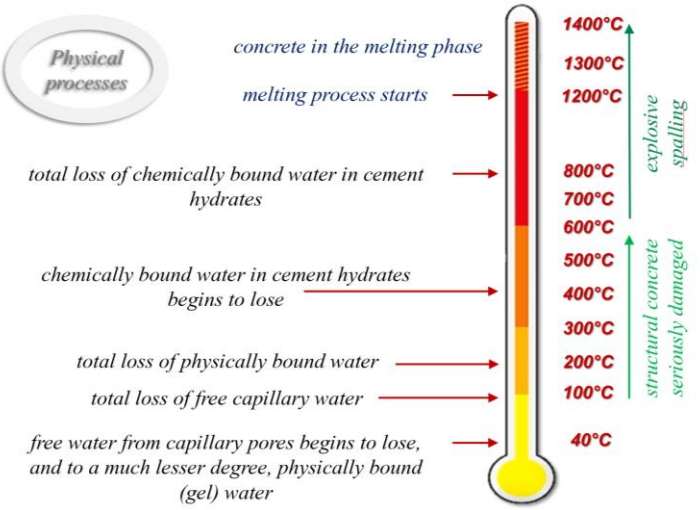

Figure 2 – Physical transformations in cement paste at elevated temperatures

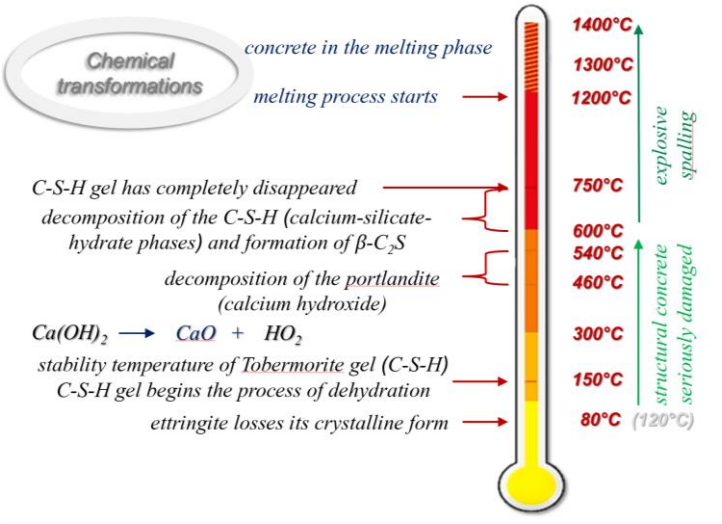

Figure 3 – Chemical transformations in cement paste at elevated temperatures

According to experimental research on cement paste dehydration at high temperatures [12], range of the temperature corresponding to the dehydration of the cement paste varies with the heating rate. In this experimental research it was found that for the samples of the cement paste with different heating rate, the dehydration starts at the same temperature, but ends at different temperature. The reason for this is that the samples of the cement paste with higher heating rate need less time to reach target temperature, and result is that dehydration

time is less. Figure 4 shows the mass loss of cement paste, calcium-silicate-hydrate (CSH) and calcium hydroxide (CH) under different heating rates, according to this experimental study.

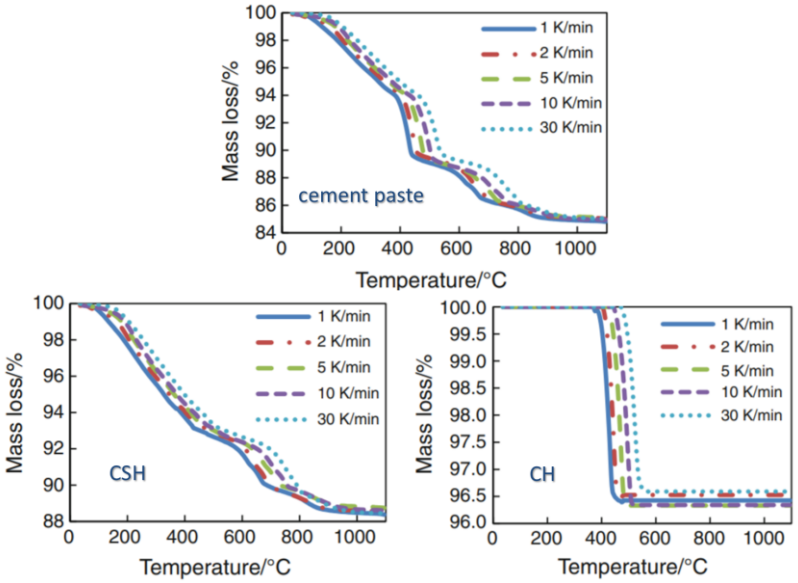

Figure 4 – The mass loss of cement paste, CSH and CH under different heating rates [12]

By microstructural analysis using scanning electron microscopy, on cement pastes with 0,35 w/c ratio [8], it was shown that ,at ambient temperature, the CH and C-S-H crystals remained intact. At 105°C, slight increase in surface toughness was observed, but without any other changes in the microstructure and morphology. At 300ºC the degradation of hydration products started, in addition to the appearance of angular particles, marked as C in Fig. 6, (presumably, non-hydrated cement particles). At 500ºC the microcracks appeared at their interface, with propagation between the anhydrous phases and the paste matrix. Also, there was a decrease in the CH peaks and the emergence of CaO peaks. Microcracks got more intense at 700ºC and 900ºC, increasing the paste porosity. At 900°C, some particles, marked as M, as shown in Fig. 6, are totally cracked. Simillary, according to research [11], it was shown that some particles of hydration products have cracked at 800ºC, whereby the presence of metakaolin in amount of 10% from the amount of powder in the paste, results with better thermal resistance, lower shrinkage and denser microstructure.
SEM images of fractured cement paste surfaces, in 100x and 3000x magnification, are shown in Figures 5 and 6.

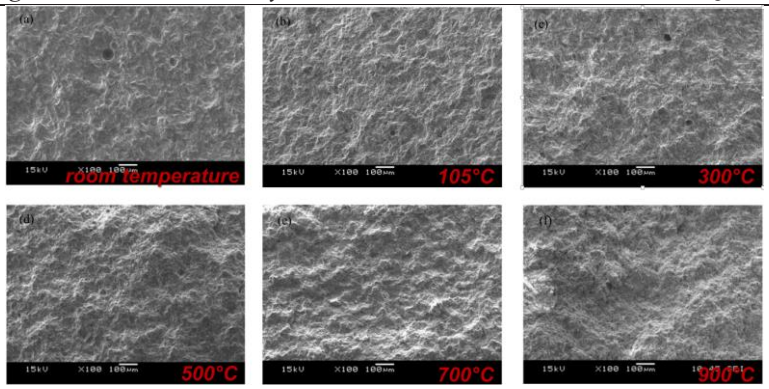

Figure 5 – SEM images of fractured surfaces of cement paste in 100× magnification [8]

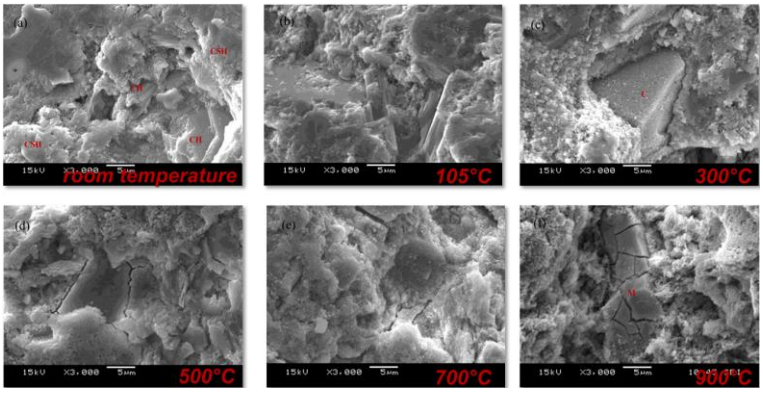

Figure 6 – SEM images of fractured surfaces of cement paste in 3000× magnification [8]

3. CONCLUSION

The frequency of fire occurrence in constructions and the fact that most engineering structures are built of concrete, indicate the importance of analyzing the effects of high temperature on concrete. Since more recent research indicate that microstructural changes in concrete significantly affect the mechanical properties and durability of concrete, of particular importance is research on microstructural changes in the aggregates, the hydrated cement paste and the interfacial transition zone, at elevated temperatures.

The analysis of hydrated cement paste showed that up to 100ºC, there were no significant changes in paste, except for slight increase in surface toughness. At 300ºC the degradation of hydration products started, and at 500ºC the microcracks appeared at their interface. Microcracks got more intense at 700ºC, increasing the paste porosity. At 800°C and 900°C, some particles are totally cracked. Thereby, certain mineral cement additives can reduce the degree of degradation.

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METAMATERIALS IN EARTHQUAKE ENGINEERING

Abstract: The origin of metamaterials is in electromagnetics in the end of 19th century. By using the analogy between electromagnetic and elastic waves, the application of metamaterials starts to grow in the field of optics, acoustics and nowadays there is a lot of research for their use in the seismic design. Large-scale metamaterials can be used as shield against seismic waves in hazardous area. With specific design (shape, height, width, material) and specific periodicity (periodic scheme and periodic constant), these systems can attenuate the waves before they reach the targeting structures in that way minimizing the damaging effect of the earthquake. This approach is efficient for protecting multiple structures at ones. Current and emerging research activities regarding seismic metamaterials will be summarized in this paper.

Key words: seismic metamaterial, seismic waves, resonator, bandgap, dispersion curve

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1. INTRODUCTION

In recent years, seismic metamaterials have received great attention from the scientific community, which has rendered several concepts for their potential engineering use. The trigger for their origin was the analogy between the electromagnetic and elastic waves and the findings in the band theory of solids throughout the concept of photonic crystals followed by the concepts of phononic crystals, sonic crystals and locally resonant metamaterials. Photonic crystals are artificial periodic structures that alter the motion of photons, by analogy, phononic and sonic crystals (fluid medium), affect the motion of acoustic waves. These periodic arrangements obey Bragg's law, which connects the lattice parameter of the system (distance between the centers of the elements) with the wavelength. This means that in order the system to distribute the wave energy inside the grid, the periodicity of the system has to be comparable to the wavelength and this link is unfavorable for application in the low-frequency range domain, that would require unpractical, large structures. With the introduction of locally resonant structures in this kind of periodic systems, in 2000, by Liu and co-workers [1], this limitation was overcome. The resonators couple with the propagating waves and pluck their energy at frequencies near their resonances. In this way the periodic constant can be below the wavelengths of interest. With this findings locally resonant metamaterials were established as artificial periodic structures with unique wave-manipulation performance that arise from the influence of their locally resonant units. The concept of metamaterials (phononic crystals and locally resonant metamaterials) can be applied for filtering and manipulation of the seismic waves that opens new possibilities in earthquake engineering.

2. DISPERSION CURVES

Metamaterials are artificial structures that manifest unique properties that cannot be found in the nature. They have ability to suppress the propagation of free waves in a certain frequency region that is called bandgap. To identify the formation and the width of the bandgap, the dispersion diagrams (band structure) are used. These diagrams show the relation between frequency and wave number and give information about the wave propagation behavior of the metamaterial. There are different techniques for deriving the dispersion curves. Finite element method is the most used. The band structure is obtained by solving the eigenvalue problem that is formed by FEM modelling of the parametric unit cell and by setting Floquet-Bloch periodic boundary conditions. This Floquet-Bloch theorem reduces the study of the infinite periodic system to the analysis of a single unit cell. Although the wavenumber k is unrestricted, it is only necessary to consider the wavenumbers going around the edges of the first Brillouin zone, Figure 1.

In an ideal homogeneous material, a plane propagates non-dispersively with linear relation between frequency and wave number, but for a structured material, bandgaps can occur, Figure 2, where R is the resonance frequency, that form the band-gap.

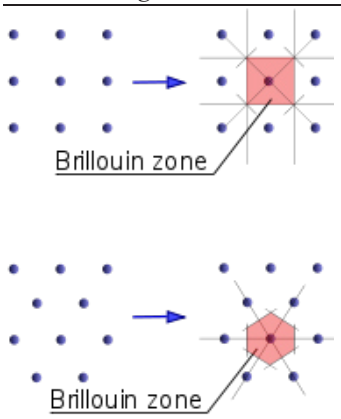

Figure 8 – Brillioun zone

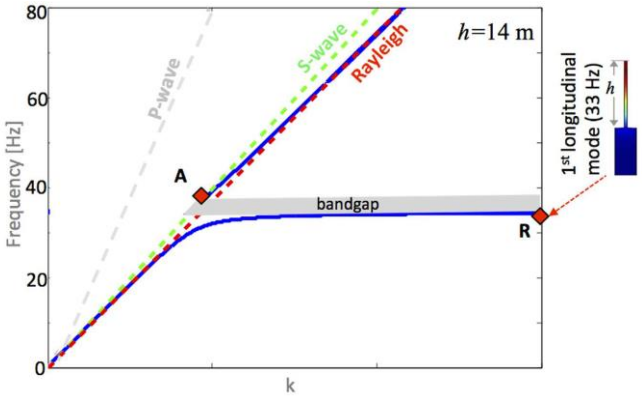

Figure 9 – Dispersion curves, [10]

3. CURRENT DESIGNS OF SEISMIC METAMATERIALS AND EXPERIMENTAL VALIDATION

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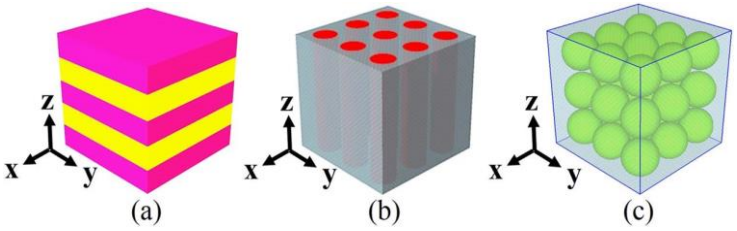

Figure 10 – Types of metamaterials, [4]

Brulé et al. [7] designed and tested large-scale seismic phononic crystal constructed of a mesh of vertical empty inclusions bored in the soil, Figure 4. The source wave (50 Hz) was comparable to the periodicity of the system, not too far off the Bragg's regime and partial stop-band was created. Unfortunately, 50Hz is still above the most damaging excitations in a common earthquake spectrum.

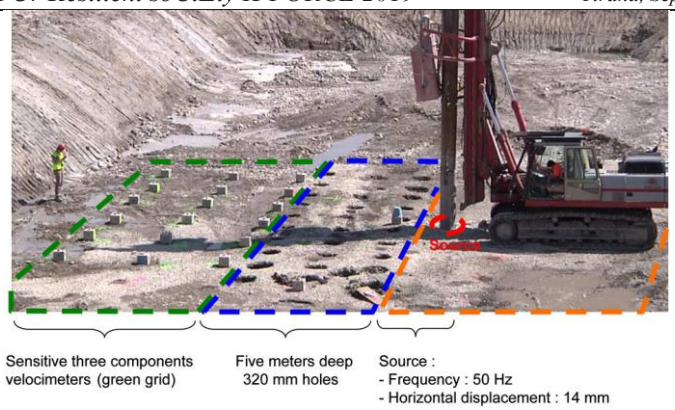

Figure 11 – Large-scale seismic phononic crystal

Kim and Das [17] suggested Helmholtz-like resonators in order to create a seismic shadow zone and possible solutions to transform elastic wave energy into sound and heat. The resonators were designed like empty boxes with a few side-holes, corresponding to the targeting resonance frequencies of seismic waves, envisioned to be buried in the soil around the building, Figure 5.

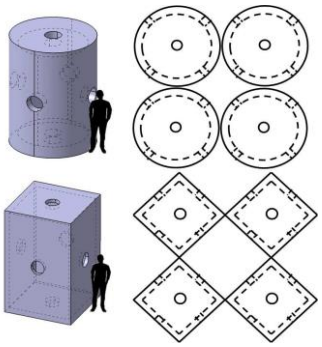

Figure 12 – Configuration of Helmholtz-like resonators buried in the soil

Qiujiao et al. [2] proposed design of periodic array of different shapes of steel piles embedded in the soil, Figure 6. The first three piles are hollow and the last one is filled with soil/concrete. From the numerical analysis it was obtained the formation of bandgaps for these systems is in the range 8-25 Hz. Geometrical parameters such as the filling fraction, thickness and height of the piles affect the results. In addition, material parameters such as the Young's modulus and mass density of the soil have significant impact on the location and width of the bandgaps.

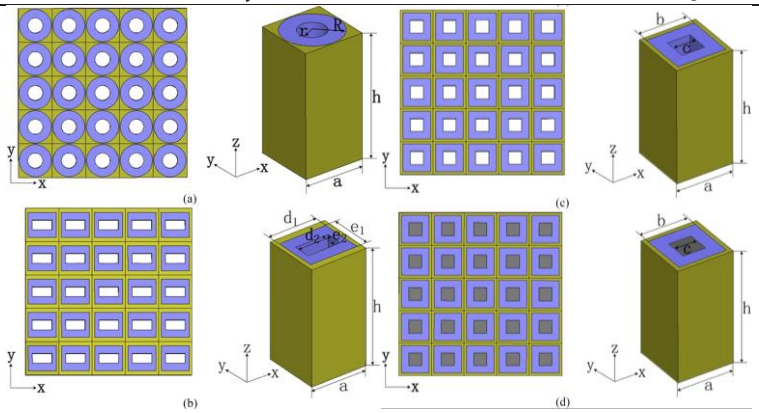

Figure 13 – Periodic array of steel piles embedded in soil

Miniaci et al. [15] considered different type of seismic metamaterials: a cross-like cavity, a hollow cylinder filled with soil and a locally resonant inclusion made of a soft rubber layer around a heavy core cylinder as inclusions in the soil, Figure 7. Furthermore, the authors investigate the influence of some geometric and mechanical parameters like ratio between the Young's modulus of the inclusion and matrix, cylinder thickness, filling fraction. Depending on the type of the element, different parameter has different influence. The bandgaps for the considered metamaterials are registered in the region bellow 10 Hz.

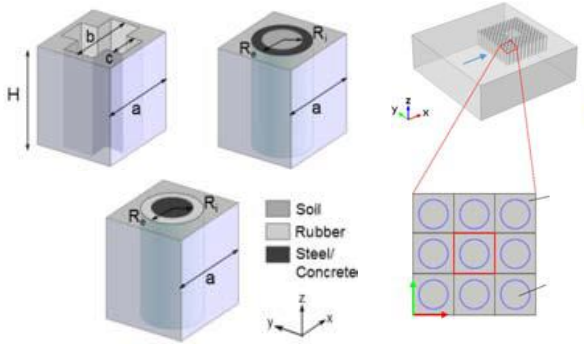

Figure 14 –Metamaterial with different types of inclusions

Achaoui et al. [8] used cubic array of steel spheres connected to a bulk concrete via steel or rubber ligaments, Figure 8. With modification of the parameter of the ligaments the bandgaps can be tailored and achieve multiple-resonance. This infrastructures, creates large stop band between 8 and 49 Hz, depending upon the ligaments used.

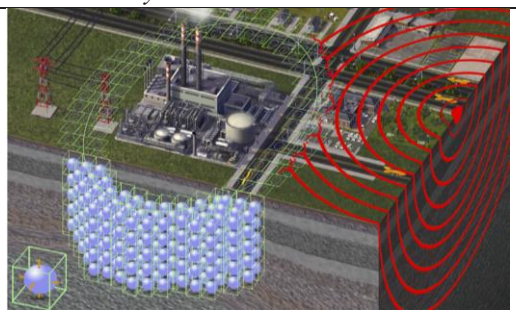

Figure 15 – Array of steel spheres connected to a concrete with ligaments

Krodel et al. [9] designed array of resonating structures buried around sensitive buildings. The periodical elements were constructed as cylindrical tubes containing a resonator suspended by soft bearings, Figure 9. To obtain broadband attenuation characteristics, each resonator in the array was designed to exhibit a different eigenfrequency by changing the stiffness in the connecting soft springs. To verify the design, a 1:30 scaled model was build with array of resonators constructed from aluminum tube, containing a resonant mass made of a cylindrical steel rod and connecting springs of polymeric material, build in a soil, Figure 10. The formed bandgaps are in the region bellow 10 Hz.

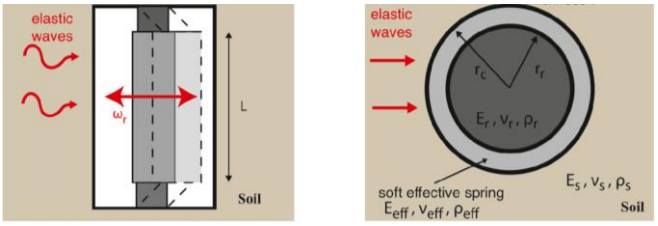

Figure 16 – Cylindrical tubes containing a resonator suspended by soft bearings

Figure 17 – Experimental setup for array of resonators

Achaoui et al. [13] proposed periodic array of steel columns, in a layer of soil, that are clamped to underlying bedrock, Figure 11. With this metamaterial, zero-frequency stop-band stretching all the way to 30 Hz is achieved. Some parameters like the filling fraction, periodicity, diferent boundary condition, different shape of the colums are investigated. The

coupling of each column to its neighbours via steel plates is shown to be essential for obtaining broad ultra-low frequency stop-bands.

Figure 18 – Array of steel columns in a layer of soil clamped to underlying bedrock

Yan et al. [16] designed three dimensional periodic foundations with steel mass, rubber spring, embeded in the concrete matrix, Figure 12. Theoretical frequency band gaps can be as low as 32.9 Hz. When the input wave falls into the attenuation zones the response of the upper structure could be greatly reduced in comparison to the same structure without the periodic foundation.

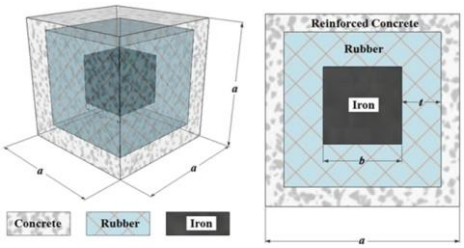

Figure 19 – Unit element of the metamaterial

Figure 20 – Experimental setup for 1D metamaterial foundation

Witarto et al. [4] designed and fabricated one-dimensional periodic foundation for small modular reactor using reinforced concrete and synthetic rubber (polyurethane) materials. The experimental test could not be performed at a full-scale size so a scaled model was designed for the study. Different excitations were used: white noise, frequency sweeping, seismic, and harmonic signals. Band gaps between 10-50 Hz were registered with 90% efficiancy of reduction of the acceleration response.

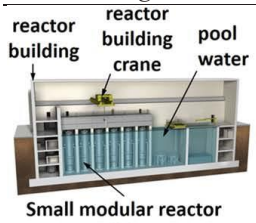

Figure 21 – The original structure

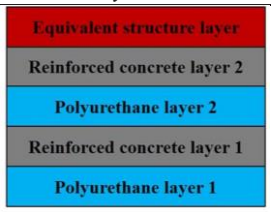

Figure 22 – One-dimensional periodic foundation

Figure 23 – The test for the scaled model of superstructure and periodic foundations

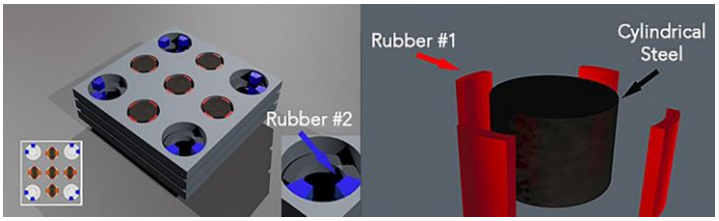

Figure 24 – Composite metamaterial foundation

Casablanca et al. [3] create composite foundations based on metamaterials - local resonance and a dual-stiffness structure, Figure 17. The foundations are made from reinforced concrete plates that are disconnected with an ultra-low damping surface of layers of steel and Teflon. Each plate has a matrix of nine cylindrical inclusions divided from the host with rubbers. The proposed design was experimentally validated, Figure 18. This system forms a bandgap above the frequency of 4.5 Hz and in the bandgap region it can filter more than 50% of the wave energy.

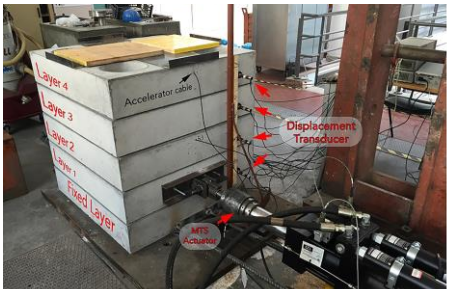

Figure 25 – The experimental set-up for the composite metamaterial foundation

Colombi et al. [10] designed array of rods placed on an elastic substrate that act like resonators - metawedge, Figure 19. These structures are capable of creating effective band-gaps for surface waves or filters that transform surface waves into bulk waves. The coupling between Rayleigh waves and the first longitudinal mode of the vertical resonators, creates

large bandgaps bounded below by frequencies inversely proportional to the resonator height h. Nice results for frequencies around 50 Hz are obtained, but unfortunately higher than the relevant from earthquakes.

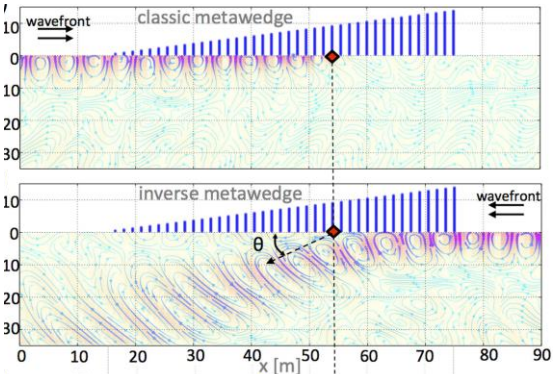

Figure 26 – Array of rods placed on an elastic substrate

Colombi et al. [12] explore the thesis that the trees from the forests can act like locally resonant metamaterials for Rayleigh surface waves. A geophysical experiment (seismometers-ambient noise) demonstrates that a Rayleigh wave, propagating in soft sedimentary soil at frequencies lower than 150 Hz, experiences strong attenuation, when interacting with a forest, over two separate large frequency bands, but still, at frequencies higher than those primarily present in earthquakes.

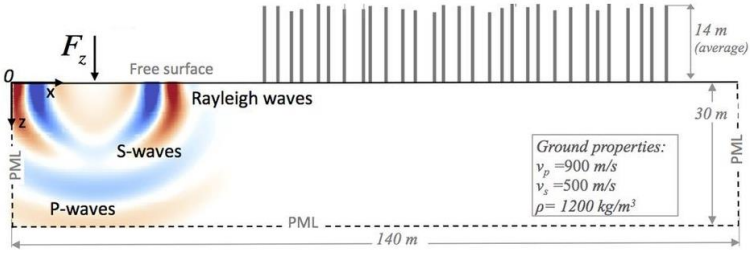

Figure 27 – Trees from forests as resonators

Brulé et al. [5] explore the idea that a district of buildings could be considered as a set of above-ground resonators. This comes from a fact that the urban patterns reminisce of the geometry of the metamaterials, Figure 21.

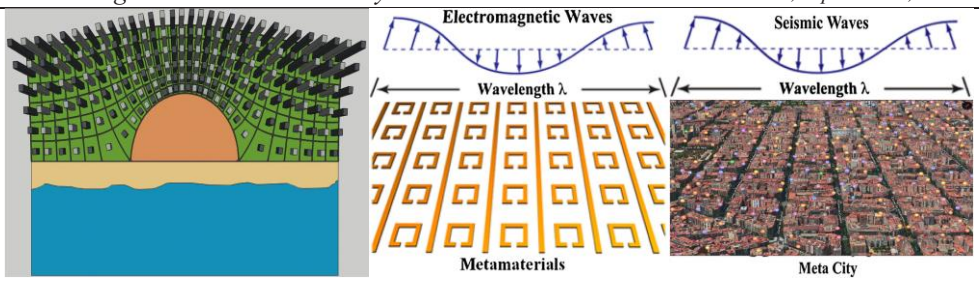

Figure 28 – Urban districts as metamaterials

4. CONCLUSIONS

Metamaterials has unique properties not found in nature. They can be used for controlling the propagation of seismic waves overcoming the disadvantages and limitations of classical system for seismic protection. Classical SI devices introduces a shift in the natural oscillation periods of the building, have significant fatigue, can produce large horizontal displacements, they ignore the soil-foundation interactions, they are incapable of isolating vertical earthquakes and can act only on one individual structure etc.

With specific design and specific periodicity, seismic metamaterials can attenuate waves before they reach the targeting structures. This approach is efficient for protecting multiple structures at ones. Resonant seismic metamaterials are better than the ones that relly on Bragg's law, but they have narrow bandgap. The width of the bandgap can be broaden [8], [9], but this kind of metamaterials are hard to build. The current designs are promising but still there is needs for further investigation.

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TCC FLOOR IN FIRE

Abstract: Nowadays, timber-concrete composite floors are gaining attention in the research community, but still they aren`t commonly used in practice. There is a great diversity in terms of connections of TCC systems so, it is impossible to develop a universal numerical model that can accurately describe the behavior of all TCC floor systems in fire. Due to the high costs, fire tests on TCC structures aren`t often conducted and therefore the validation and verification of new numerical models for analysis of TCC floors in fire can be done only on few available experimental data.

This paper presents a 2D numerical model for analysis of TCC floors in fire, validated through comparison of the results with experimental data from a fire test of TCC floor with plug concrete reinforced with a steel pipe as connector, tested at CSTB Marne la Vallée. The results from the thermal analyses are in good correlation to the thermocouples measurements and the model in the structural analysis simulated very well the behaviour of the structure in fire.

Key words: thermal analysis, structural analysis, fire resistance, timber-concrete composite (TCC) floor

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1. INTRODUCTION

Extraction of raw materials, enormous energy consumption for manufacturing, transportation and building, waste generation, carbon emission, polution and so on, are some of the main problems of the construction sector. With raised awearness for negative environmental impact of the construction industry, the use of bio-based materials is slowly but certainly increasing.

Timber is a renewable and sustainable material which has been used in construction for centuries. Nowdays, not only solid timber, but a variety of engineering timber products: glued-laminated timber, cross-laminated timber, laminated veneer lumber, sawn timber etc. are widely used for load-bearing structures.

Timber-concrete composite structures use the advantages of both materials: timber and concrete. Timber is mostly intended to act in tension, while the concrete is intendet to act in compression. The crucial component of these composite systems is the connection. There are various types of connnections and each brings different degree of rigidity/flexibility to the TCC system.

The disadvantage of timber to burn when exposed to fire remains also in TCC structures. However, the fire resistance of TCC strctures is higher in comparison to solely timber structures. Estimation of the fire resistance and the behaviour of TCC structures in fire is ussualy done eighter with simplyfied analytical methods or with advanced methods based on finite elements, since large-scale fire tests are highly expencive. However, the accuracy of numerical models needs to be firstly verified with real fire tests, so that they can be used for other parametric analyses afterwards. Up to date, there are quite few fire tests of TCC structures (mainly floors), and even fewer developed numerical models analyzing the structure`s both thermal and structural behaviour in fire.

This paper presents a 2D numerical model developed for analysis of TCC floors in fire. The aim of the conducted analyses was to validate and verify the model for futther use in this field. The verification process was done by comparing the results of the analyses to the results of the TCC floor with plug concrete reinforced with a steel pipe as connector, experimentaly tested at the CSTB Marne la Vallée fire labaratories [1]. Verification of this model was also done on another experimentaly tested TCC floor in fire, but with screwed connection in fire [2]. The presented 2D model in this paper is used for determining the thermal and structural behaviour of the TCC floor in fire from [1], while the 3D model of a part of the floor structure presented in [1] can be used only for determining the thermal and not the structural behaviour of the TCC floor. The results of the analyses are graphicaly presented and discussed in the sections below.

2. NUMERICAL MODELLING

2.1. Description of the TCC floor

The TCC floor in fire from [1], tetsed at CSTB France under standard ISO fire is presnet in Figure 1.

The connector is a dimple/plug concrete reinforced with a steel pipe with tickness of 2 mm and outer diameter of 70 mm, placed at each 356 mm through the length of the timber beam. The strength and stiffness properties of this conector are determined with tests presented in Deam, Fragiacomo & Buchanan [3].

. For concrete and timber, the only given material characteristics in [1] are:

- For concrete: f_c=30 Mpa
- For timber GL 24: ρ=450 kg/m^3, w=12%.

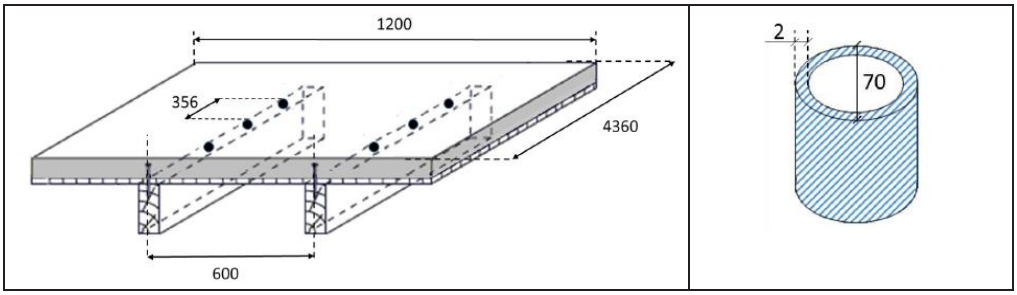

Figure 6 – TCC floor with interlayer from [1](left) and connector (right)

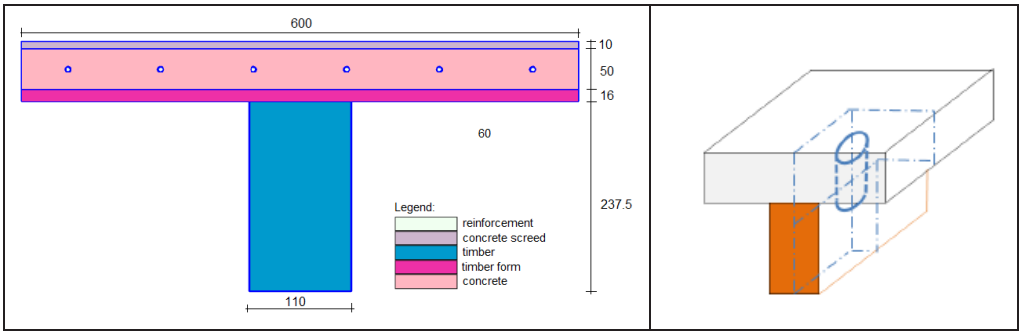

Figure 2 – Cross-section of the TCC floor from the 2D numerical models presented in this paper (left) and the 3D model from [1]

In [1] only thermal modelling was done in the computer program SAFIR, using a 3D model of a quarter of the floor around the connector.

This paper presents a 2D model for analysis of the TCC floor in fire, also in SAFIR, but this model can be used for both thermal and structural analysis. The cross-section of the TCC floor in this paper is modelled with SOLID elements as presented in Figure 2-left, while the part of the floor modeled in [1] (marked with blue doth-dash line) is presented in Figure 2–right. For determining the structural behaviour, the TCC floor was modelled as a Virendel truss (using BEAM elements) where the top chord represents the concrete slab, the bottom chord represents the timber beam and the verticals represent the connectors. The verticals in

the Virendel truss are placed at the exact position of the connectors in the real floor and have steel circular cross-section. The height of the steel verticals coresponds to the distance from the bottom fiber of the concrete slab and the lowest point of the connector in the timber.

The loads applied in the structural analysis are as shown in Figure 3.

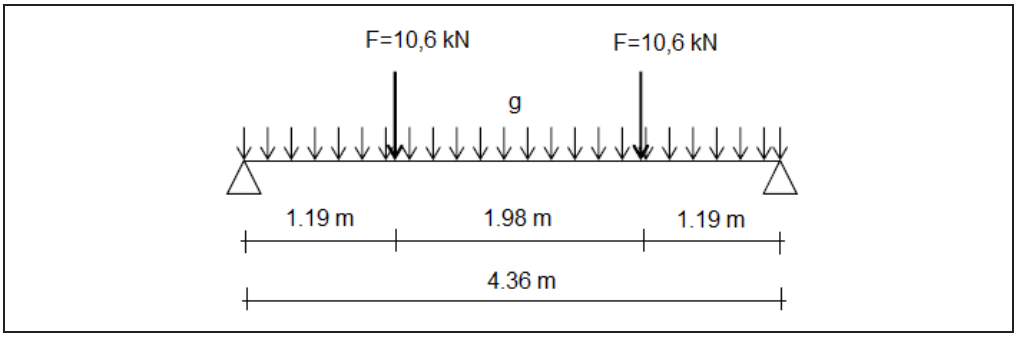

Figure 3 – Structural system of the tested TCC floor and applied loads

For the 2D numerical models presented in this paper, the following material models were used:

- for concrete - SILCON ETC [4]
- for timber - the uniaxial material model of Annex B of EN 1995-1-2 [5]
- for reinforcing steel - the material model is based on EN 1992-1-2 [6]
- for structural carbon steel - the material model is based on EN 1993-1-2 [7]

Two different models were developed: one with ρ_{timber}=450 kg/m^3 and one with ρ_{timber}=500 kg/m^3. The second model gave results which are in better agreemet with the experimental results both from the thermal and structural point of view.

In the 3D model from [1] the reinforcement is not modelled. For timber the material model from EN 1995-1-2 is used, while for concrete and steel the material models from EN 1995-1-2 [5] and EN 1994-1-2 [8] are used.

2.2. Results from the thermal analysis

During the fire tests in CSTB, the temperatures: in the timber, around the connector (at timber-concrete interface) and on the concrete surface were measured with thermocouples. Figures 4, 5, 6 and 7 show the measured temperatures in the timber beam, at the x centroidal axis and at different distances from the side edge: d=20, d=30, d=40 and d=50 mm. The above mentioned figures also show the calculated temperatures from the thermal analysis from [1] and from the 2D models presented in this paper.

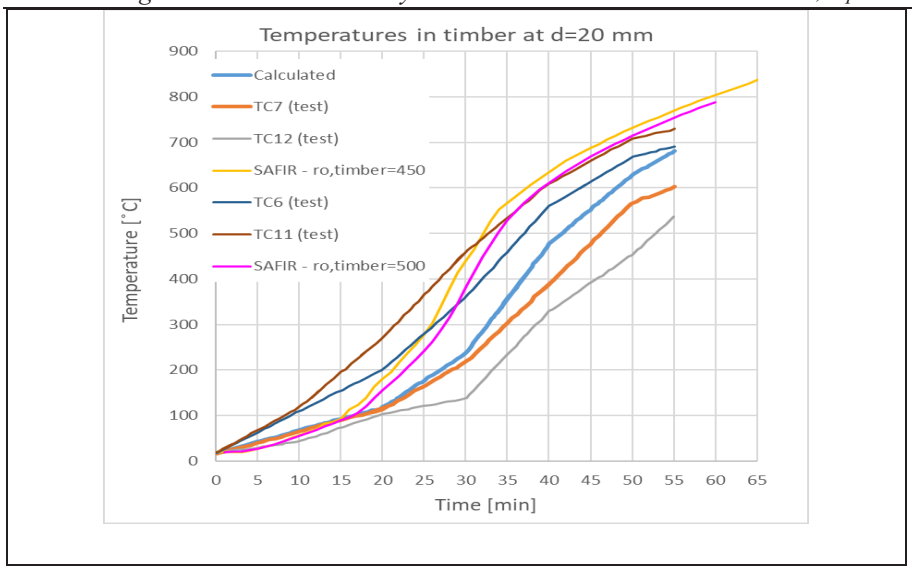

Figure 4 – Temperatures in the timber beam at distance d=20 mm from the side edge from: the test, the 3D numerical model from [1] and the 2D numerical models in Safir

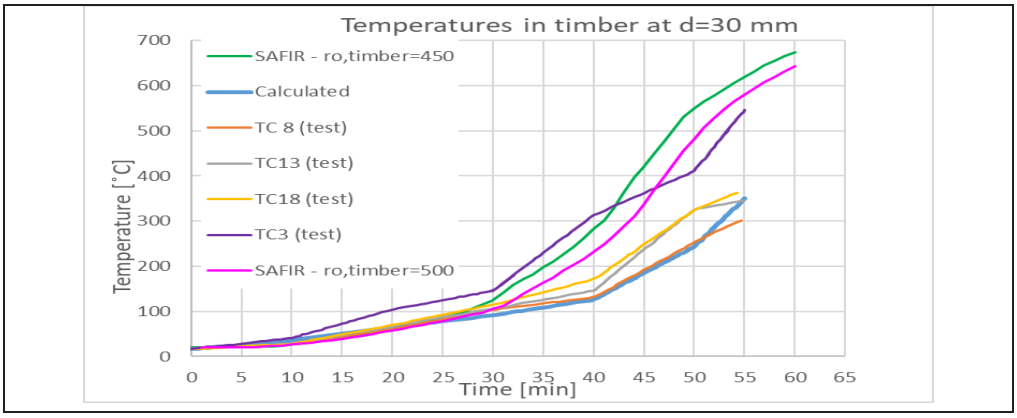

Figure 5 – Temperatures in the timber beam at distance d=30 mm from the side edge from: the test, the 3D numerical model from [1] and the 2D numerical models in Safir

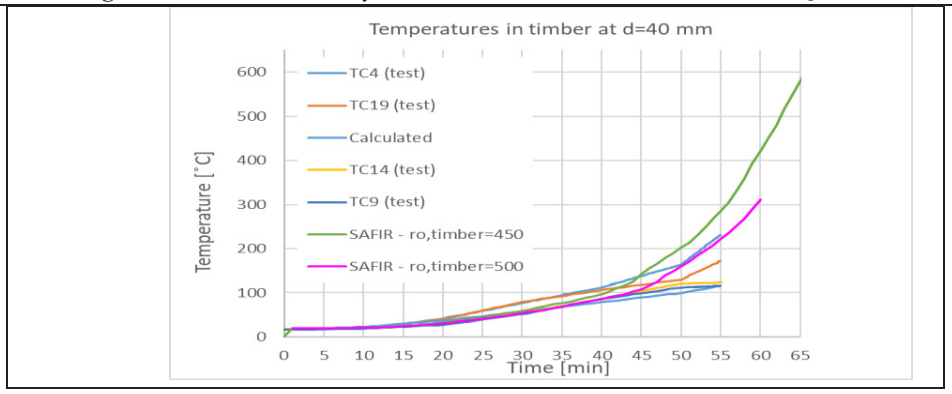

Figure 6 – Temperatures in the timber beam at distance d=40 mm from the side edge from: the test, the 3D numerical model from [1] and the 2D numerical models in Safir

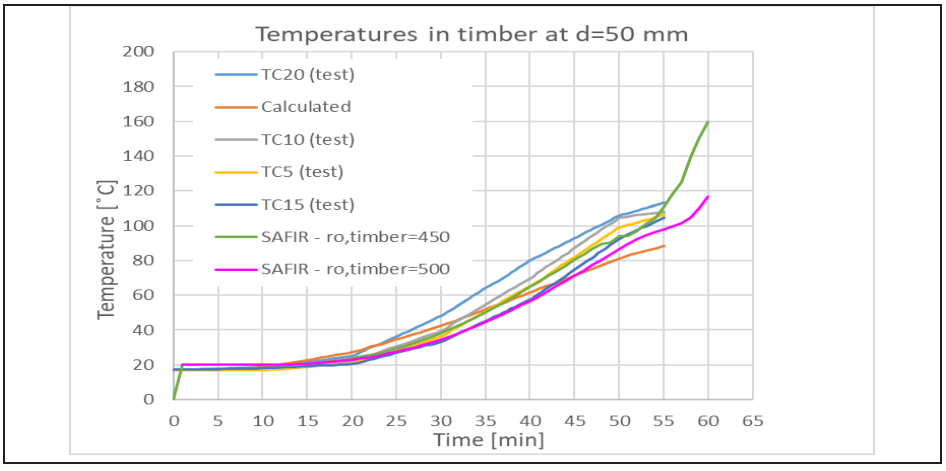

Figure 7 – Temperatures in the timber beam at distance d=50 mm from the side edge from: the test, the 3D numerical model from [1] and the 2D numerical models in Safir

At each distance from the fire exposed side edge of the timber beam, the temperatures calculated with both models (with ρ_{timber}=450 kg/m^3 and ρ_{timber}=500 kg/m^3) are close to the measured temperatures, except in the case for d=30 mm where higher temperatures are calculated with the 2D numerical models. The temperatures calculated with both 2D models start to differ from each other after the first 15 to 30 minutes of the fire exposure, depending of the distance d, always resulting in slightly higher values for the 2D model with lower ρ_{timber}. Also, at each distance from the fire exposed edge of the timber beam, the temperatures calculated with both 2D models are a bit higher than those calculated with the 3D model from [1].

In order to describe the temperature evolution around the connector, the results from the 2D model with ρ_{timber}=500 kg/m^3 are presented. Figure 8 compares the temperatures at the lowes point of the connector in the timber, at the interface timber-timber board and at the interface timber board-concrete from the 2D model to the measured temperatures from the fire test and to those from the 3D model from [1]. As expected, around the lowest point of the connector in the timber, the temperatures are higher than at other higher positions along the connector`s length. The temperatures around the connector at the interface timber board-concrete from the 2D model agree very well with the temperatures registered with the thermocouples.

The 2D models presented in this paper slightly underestimate the temperatures on the concrete`s surface (Figure 9).

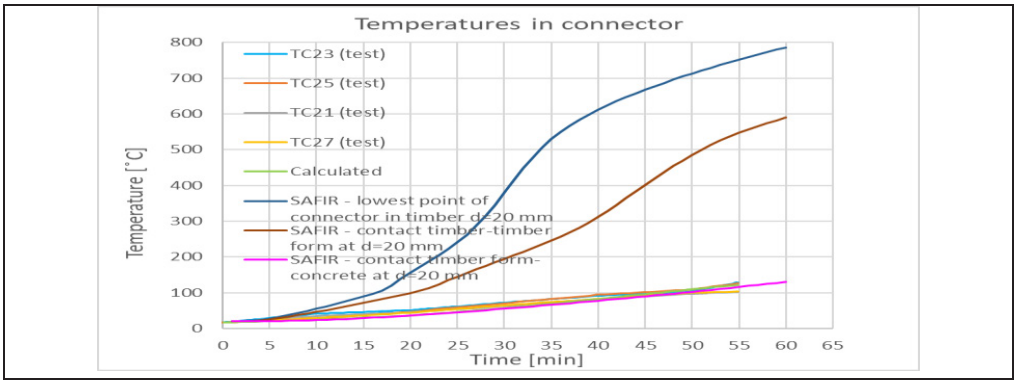

Figure 8 – Temperatures in the connector from: the test, the 3D numerical model from [1] and the 2D numerical model in Safir (for ρ_{timber}=500 kg/m^3)

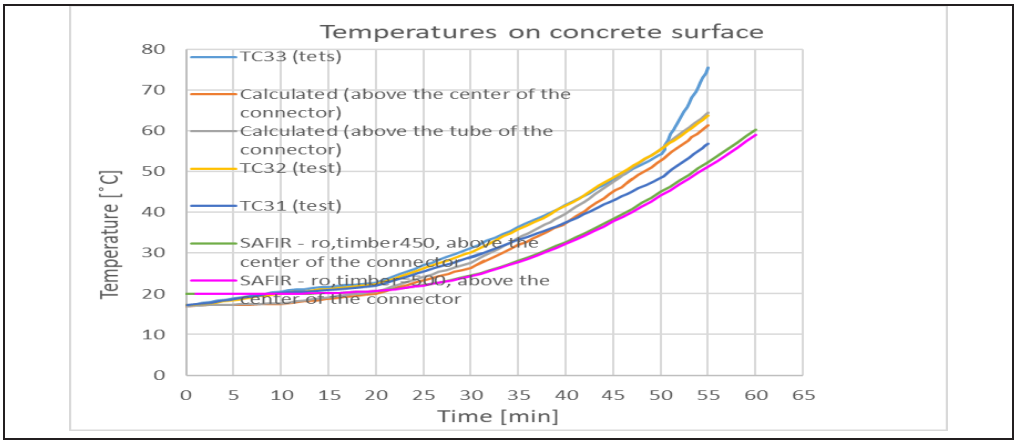

Figure 9 – Temperatures on the concrete surface from: the test, the 3D numerical model from [1] and the 2D numerical models in Safir

2.3. Results from the structural analysis

The fire resistance of the tested TCC floor is t_{fi}=55 minutes. The maximum measured deflection is Δy=34 mm.

No structural modelling was done in [1], but the deflection was calculated using the theoretical Formula 1, which generates lower values for the deflection in comparison to the measured in the fire test.

$$\Delta y = 2Pa(3\cdot 2a+b^2-4a^2)/(48EI_{eff}) + 5q(2a+b)^4/(384EI_{eff}) \quad (1)$$

Figure 10 shows the measured deflection of the floor from the fire test, the deflection calculated in [1] using the theoretical formula and the deflection calculated with the 2D numerical models in Safir presented in this paper.

In [1], there are no data for slip measurements, so the slip calculated with the 2D numerical models won`t be commented.

In the case of the 2D numerical model with ρ_{timber}=450 kg/m^3, the anlysis terminates earlier i.e the calculated fire resistance is t_{fi}=43 minutes and the deflection has a bit higher values in comparison to those measured in the fire test.

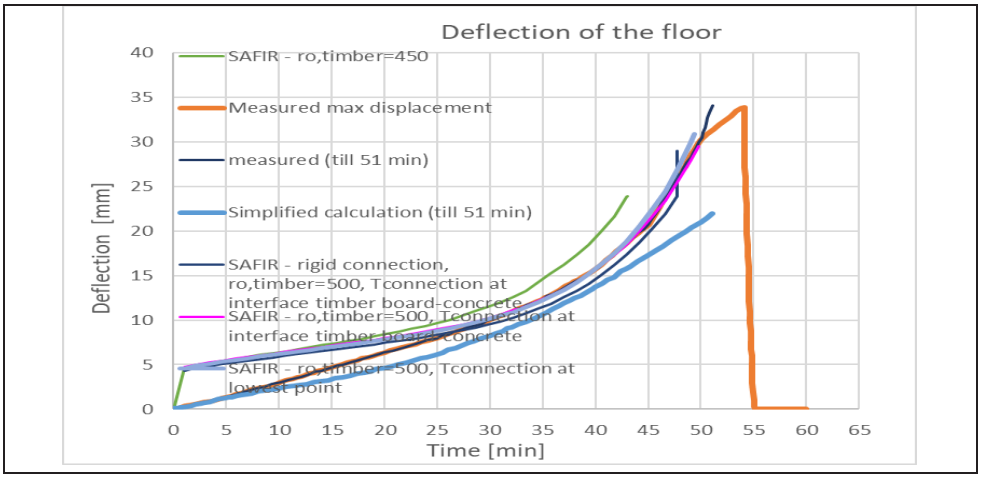

Figure 10 – Deflection of the TCC floor from: the tests, the analytical calculation and the numerical modelling in Safir

In the case of the 2D numerical model with ρ_{timber}=500 kg/m^3, the calculated fire resistance is t_{fi} =49.4 minutes and the deflection before the moment of failure is Δy=34 mm. This model has high accuracy concerning the fire resistance and the deflection of the TCC floor.

Additionally, another much simpler numerical model was developed for the purpose of comparison of results. This additional model assumes a fully rigid connection between the concrete and the timber, and the influence of the connection on the system`s behaviour is not taken in consideration. Figure 10 shows that this model, which is simpler and less time consuming, also delivers quite accurate results in terms of fire resistance and deflection. This is due to the fact that the connection in this particular TCC floor is quite stiff and the behavior

of this composite system is more similar to a rigid composite system than to a flexible composite system.

3. CONCLUSION

2D thermal and structural modelling of TCC floors in fire can be successfully done in the computer program Safir. The accuracy of the results is highly influenced by the accuracy or the input data concerning the thermal and mechanical characteristics of the materials. The developed 2D model was twice verified: with experimental results of TCC floor with screwed connection, presented in [2], and with TCC floor with plug concrete reinforced with a steel pipe as connector, presented in this paper.

The use of this 2D numerical model for analysis of TCC floors with other types of connections in fire is yet to be done.

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CODE APPROACHES FOR SEISMIC DESIGN OF PLAN IRREGULAR STRUCTURES

Abstract: The buildings that are built in seismic active region should resist the seismic forces induced by earthquake ground motion without significant damage or structural collapse. The building structural system can be characterized as regular or irregular. A great number of the registered structural damages occurred during the earthquake action are due to the irregularities of the structural system. The regularity of the structural system depends on numerous structural characteristics and parameters that make it difficult to classify the structural system as regular or irregular. This work discuss how the modern seismic codes control the irregularity in plan and the methodologies by which the plan irregularity is determined for structures.

Key words: Seismic codes, plan irregularities

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1. INTRODUCTION

The buildings that are built in seismic active region should resist the seismic forces induced by earthquake ground motion without significant damage or structural collapse. Moment resisting frames, shear walls and frame-shear wall dual systems are the most common used structural systems to withstand the seismic action. The damage of the structural system initiates in weak spot location that trigger further structural deterioration which leads to the structural collapse. These weaknesses often occur due to presence of structural irregularities in mass, strength and stiffness in a building structural system. The structural irregularity can be generally classified as plan (horizontal) and vertical irregularities, Fig.1.

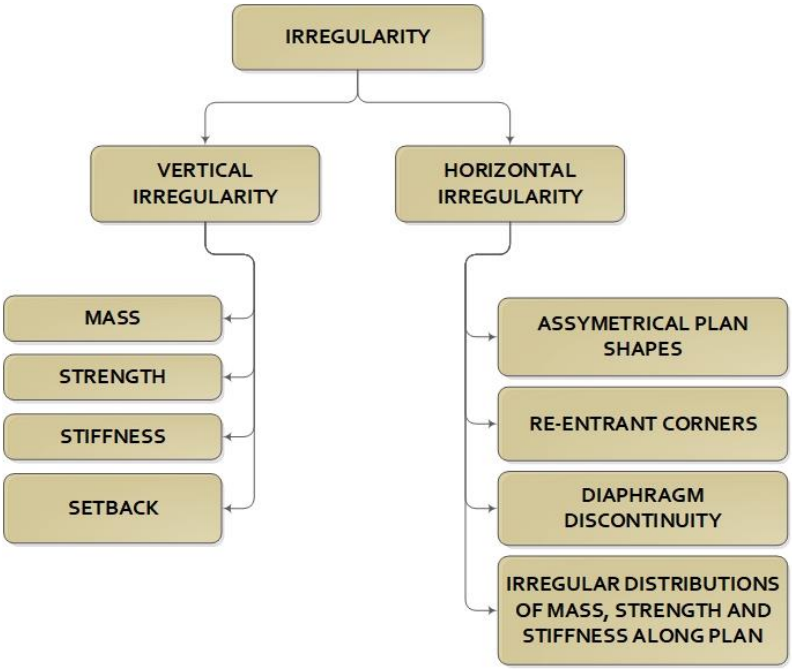

Figure 29 - Classification of different types of structural irregularities

The building structural system can be characterized as regular or irregular. A great number of the registered structural damages occurred during the earthquake action are due to the irregularities of the structural system. The regularity of the structural system depends on numerous structural characteristics and parameters that make it difficult to classify the structural system as regular or irregular.

Irregularity in plan may have negative implication on the design process and on the behaviour of the structures exposed to earthquake loading. Buildings with eccentricity between the center of the mass and center of stiffness or with lack of minimal torsional rigidity can undergo coupled lateral and torsional motions during earthquakes, which can significantly increase the seismic demand, especially at perimeter frames. For these reasons most of the seismic design codes contain

provisions for control of structural irregularities. If the prescript criteria for regularity are not satisfied, certain restrictions related to the selected method or numerical model for seismic analysis have to be done. Moreover, due to potentially uncontrollable torsion oscillation and reduced ductile response, design seismic forces have to be obtained for a lower reduction factor.

High seismic vulnerability of plan irregular structures was a motivation for many researches in the past. An extensive review of different structural irregularities and systematization of conducted researches can be found in Rutenberg (2002), [11], De Stefano and Pintucchi (2008), [5], Varadharajan at al. (2013), [14]. Many of these researches, Cosenza at al. (2000), [4], Humar, J. and Kumar, P. (2000), [7], Zheng at al. (2004), [15], Özhendekci and Polat (2008), [9], Ilerisoy (2019), [8], Alecci at al. (2019), [1] are related to the analysis of codes provisions for plan irregularity.

2. DAMAGES OF PLAN IRREGULAR STRUCTURES

Over the years it have been observed that structures have suffered severe damages during earthquakes, as result of the plan irregularities. The eccentricy between the center of mass and the center of stiffness lead to irregularity in plan which cause torsional behaviour, which results with major damages to the structural elements in the lateral, more flexible zones, of the structure.

Figure 2, shows the collapse of three storey building in Miyagi-Ken-Oki (Japan) during the earthquake in 1978, due to plan irregularity. Due to presence of a stiff wall, the center of stiffness has shifted towards the wall. The occurrence of eccentricity between the center of mass and center of stiffness resulted with twisting of the structure in respect of the center of stiffness. This torsion resulted in severe damages in the periphery columns on the away side of the wall.

Figure 30 - Damage of three storey building during 1978 Mijagi-Ken-Oki earthquake, [14]

Figure 3, shows the damage to the Ministry of Culture building in Haiti during the earthquake in 2010. The stiff core on one side of the building resulted in damage in the lateral load-resisting members away from the center of stiffness and downward pull of the whole storey, which led to the total collapse of the building. Similar type of collapse, due to torsional response about a stiff shaft at the corner, was observed at Athens earthquake in 1999, fig.4, [6].

Figure 31- Damage to Ministry of Culture building during 2010 Haiti earthquake, [14]

Figure 32- Collapse of a building due to torsional response, Athens (1999) earthquake

Severe damage to six storey reinforced concrete hotel in Guatemala City, Fig. 5, during the Guatemala earthquake in 1976, occurred as result of the torsional irregularity due to eccentric location of a rigid service core. The failure of the columns located on the flexible side of the building occurred due to their incapability to resist the torsion from increased shear force. This resulted in second storey collapse in the building (indicated by blue arrows in the figure).

Figure 33 - Damage due to irregularity during Guatemala earthquake 1976, [14]

3. CRITERIA FOR PLAN IRREGULARITY GIVEN IN DIFFERENT EARTHQUAKE CODES

As noted earlier, the reason why different earthquake codes give provisions for the regularity of the structure is that the response of the regular structure in plan during the earthquake action is generally along the main direction and does not combine the horizontal components of the seismic action. For a structure to be categorized as regular in plan, several geometrical and dynamic conditions have to be satisfied, [16].

The Macedonian seismic code do not include regulations for the design of structures irregular in plan. The regulation provide a series of recommendations for the construction of seismic resistant structures such as: the structural disposition of buildings is achieved by a correct and uniform solution in plan, with a uniform mass distribution and in the case of larger structural load, the center of mass should be as low as possible.

According to EN 1998-1 [3], a building can be characterized as regular in plan, if six different conditions are satisfied, at all storey levels. Some of these conditions are qualitative, and can be checked in the preliminary design stage, but some of them that are based on the eccentricity between the center of mass and the center of stiffness or torsional radius, Eq. 1, are quantities that have to be calculated additionally. In-depth discussion of the conditions for plan regularity according to EN1998-1, can be found in Penelis and Penelis (2014), Fardis at al. (2015).

The first condition according to EN1998-1 [3] states that distribution in plan of the lateral stiffness and mass of the structure shall be approximately symmetrical with respect to two orthogonal horizontal axes.

It follows that plan configuration shall be compact. Each floor shall be delimited by a polygonal convex line. There is some tolerance with regard to this requirement: if there are in-plan setbacks (edge recesses or re-entrant corners), the structure is considered as regular under the following conditions, fig. 6.:

- The setbacks do not affect the floor in-plane stiffness.
- For each setback, the area between the outline of the floor and a convex polygonal line enveloping the floor does not exceed 5% of the floor area.

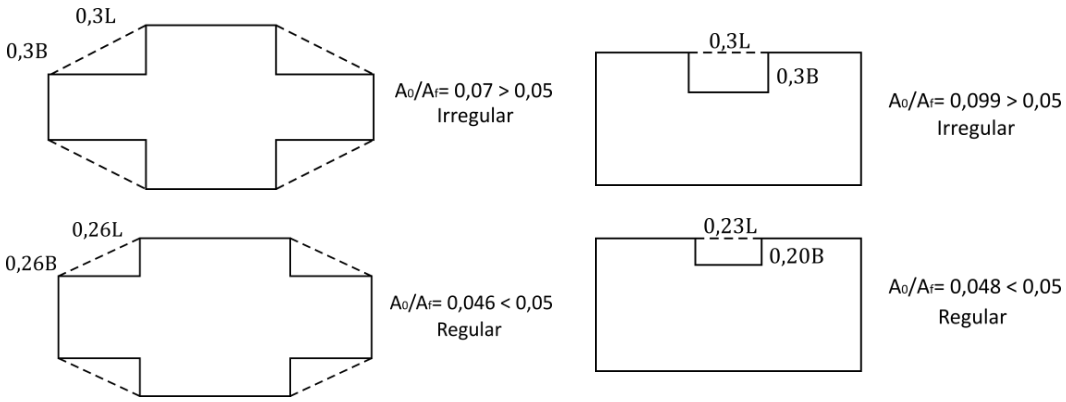

Figure 34 - Regular and irregular plan configurations

The floors should be considered as rigid diaphragms, with sufficiently large in-plane stiffness, so that the deformation of the floor, due to seismic action, is negligible compared to the inter-storey drifts and have a small effect on the distribution of the forces among the vertical structural elements. In respect to that, the L, H, C, I and X shapes should be carefully examined, fig. 7.

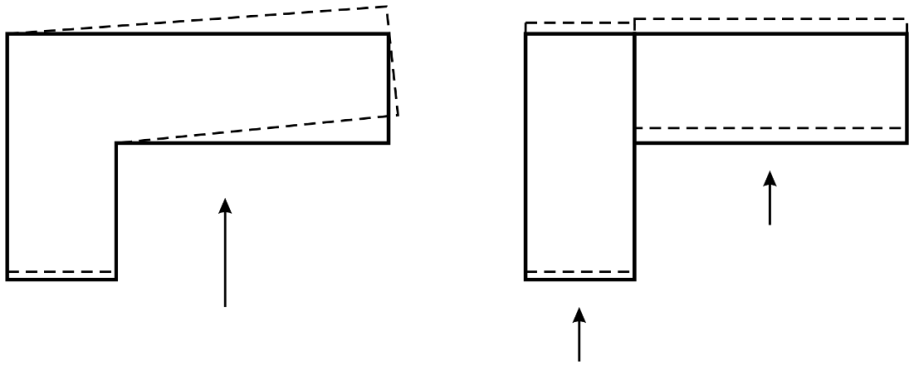

Figure 35 - Provisions for designing building structures with complex shape

The slenderness or the aspect ratio $\lambda=L_{max}/L_{min}$ of the building should be no more than 4, where L_{max} and L_{min} are respectively, the larger and smaller in plan dimension of the building, measured in two orthogonal directions.

At each level and for each direction of analysis x and y, the structural eccentricity e_0, between the floor center of mass and the storey center of stiffness, do not exceed 30% of the corresponding storey torsional radius r, Eq. 1.

$$e_{0x} \leq 0{,}30 \cdot r_x \tag{1}$$

The torsional radius of the storey in each of the two orthogonal horizontal directions, x and y, is not less than the radius of gyration l_s of the floor mass, Eq. 2.

$$r_x \geq l_s \tag{2}$$

For single storey buildings these characteristics are uniquely defined and EN1998-1, [3]. allows to be calculated through the moments of inertia of the cross section of vertical elements. In general, some additional parameters, like beams stiffness or shear deflections can affect the position of center of stiffness or torsional radius. In multi storey buildings, Eurocode 8 allows simplified definition for classification of structural regularity in plan and for the approximate analysis of torsional effects only for buildings in which all lateral load resisting systems are running from the foundation to the top and have similar deformation patterns under lateral loads. Moreover, Eurocode 8 accepts that in frames and in systems of slender walls with prevailing flexural deformations, the position of the center of stiffness and the torsional radius of all stories may be calculated as those of the moments of inertia of the cross-section of the vertical elements.

Similarly, ASCE Standard 7-10, [2], provides a list of conditions to detect horizontal irregularity in buildings, as follows.

Torsional irregularity, depending on differences between the maximum story drift, δ_{max}, computed including accidental torsion with 5% accidental eccentricity, and the average story drift, δ_{avg}. Torsional irregularity is defined to exist where the maximum story drift, at one end of the structure transverse to an axis is more than 1.2 times the average story drift at the two ends of the structure, Eq. 3.

$$\delta_{\max} \geq 1{,}2 \cdot \delta_{avg} \tag{3}$$

Extreme torsional irregularity exist, if this ratio exceeds 1.4 times the average story drifts, Eq. 4.

$$\delta_{\max} \geq 1{,}4 \cdot \delta_{avg} \tag{4}$$

where $\delta_{avg} = (\delta_A + \delta_B)/2$ is the average deflection determined by an elastic analysis, Fig. 8, [1].

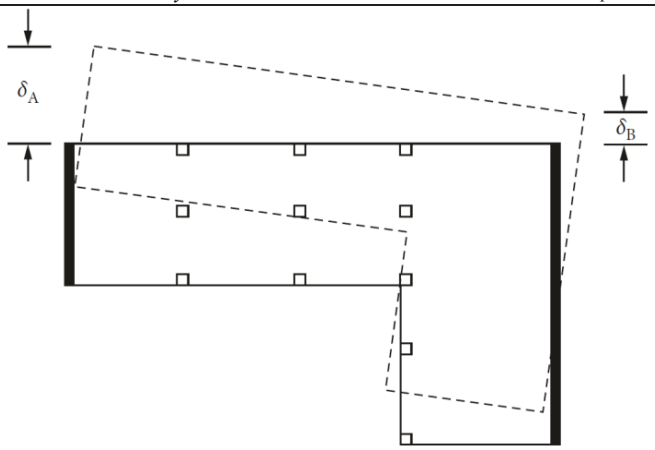

Figure 36 - Determination of the average deflection

Reentrant corner irregularity exists where both plan projections of the structure beyond a reentrant corner exceed 15% of the plan dimension of the structure in the given direction.

Diaphragm discontinuity irregularity exists when a diaphragm with an abrupt discontinuity or variation in stiffness, including one having a cut-out or open area greater than 50% of the gross enclosed diaphragm area or a change in effective diaphragm stiffness of more than 50% from one story to the next.

Out of plane offset irregularity exist where there is a discontinuity in a lateral force resistance path, such as an out-of-plane offset of at least one of the vertical elements.

Nonparallel system irregularity exists where vertical lateral force resisting elements are not parallel to the major orthogonal axes of the seismic force resisting system.

The Turkish code, TEC 2007, [13], have similar provisions as ASCE 7-10, only with different requirements for certain values. The New Zealand code, NZS 1170.5-2004, [12], have three provisions regarding the irregularity in plan and it is the only code that takes in to account the horizontal offset of the columns in the moment frames structural systems and systems with structural walls.

Similar to ASCE 7-10, NZS 1170.5-2004 defines that torsional sensitivity shall be considered to exist when the largest ratio between maximum storey displacement at the extreme points of the structure, at each level, in the direction of earthquake induced by equivalent static actions acting with accidental eccentricity of 10% and average of the displacement at the extreme points at same level in both orthogonal direction exceeds 1.4. This requirement, with the exception of assumed torsional eccentricity, is identical with the condition for extreme torsional irregularity given in ASCE 7-10.

4. COMPARISON OF THE CRITERIA FOR PLAN IRREGULARITY OF DIFFERENT CODES

As noted earlier, the modern codes for seismic resistant structures, have different provisions, by which they categorize the regularity of the structure.

The comparison between the codes and their provisions, is presented in Table 1. When considering the re-entrant corners (setbacks) requirement, proscribed by the codes it can be noted

that EN1998-1 has the most rigorous criteria, i.e. the Turkish code allows 4 times greater setback, and 3 times greater than the ASCE 7-10. The New Zealand code has no defined criteria for re-entrant corners (setbacks).

When it comes to torsional irregularity the definition in the Eurocode differs from the other three codes, because it the irregulariy is defined by geometrical characteristics and the position of the structural elements. The torsional irregularity in the other three codes is defined by the displacements obtained by seismic analysis. Most flexible regarding this provision is the NZS. The TEC2007 for the ratio $\delta_{\max} \geq 1{,}2 \cdot \delta_{avg}$, treats the stucture as torsionaly irregular, same as the ASCE 7-10, the only difference is that the ASCE 7-10 for the ratio $\delta_{\max} \geq 1{,}4 \cdot \delta_{avg}$ defines the structures as extreme torsionaly irregular. It can be noted that a structure can be characterized as torsionaly irregular in New Zealand and as extreme torsionaly irregular in the United States. Similarly the structure may be characterized as torsionaly regular in New Zealand and torsionaly irregular in Turkey.

With regard to the discontinuity of the diaphragms, the Eurocode 8 does not specify what percentage of openings are permitted as required by the US and Turkish regulations. The US regulation also takes the diaphragms stiffness into account and is more flexible than the Turkish regarding this provision. This criteria is not taken into account by the New Zealand code.

Only the New Zealand code, NZS 1170.5-2004, [12], takes into account the horizontal offset of the columns in the moment frames structural systems and systems with structural walls. The first is for all the columns at one storey level and the second is for one column.

Table 3 - Irregularity limits prescribed by EN1998, ASCE7-10,NZS1170.5 and TEC2007

Type of irregulariy	EC8 2004	ASCE-7.10	NZS 1170.5-2004	TEC 2007
Re-entrant corners	$R_i \leq 5\%$	$R_i \leq 15\%$	-	$R_i \leq 20\%$
Torsional irregularity	$r_x > 3.33\ e_{ox}$ $r_y > 3.33\ e_{oy}$ $r_x\ u\ r_y > l_s$	$d_{max} \leq 1.2\ d_{avg}$ $d_{max} \leq 1.4\ d_{avg}$	$d_{max} \leq 1.4\ d_{avg}$	$d_{max} \leq 1.2\ d_{avg}$
Diaphragm discontinuity	-	$O_a < 50\%$ $S_{dst} < 50\%$	-	$O_a < 33\%$
Horizontal offset of the columns in moment frame structural systems and in systems with structural walls	-	-	$\Sigma\lvert a_j/b_j \rvert > 0.1\ N_c$ $a_j/bj > 0.4$	-

Where:

R_i – re-entrant corners, d_{max} – maximum drift at praticular storey level, d_{avg} – average drift at particular storety level, O_a – open area in diaphragm, S_{dst} – diaphragm stiffness, aj – horizontal drift of the column j, bj – vertical distance between the base of the upper column and the top of the lower column, N_c – sum of the columns at particular storey level

5. CONCLUSION

The criteria for irragularity of the structure in plan, has important role in the design of seismic resistant structures, because it shows us whether the structure has potential to enter torsional oscillations, which can be hazardous in relation to the desired behaviour of the structure.

The registered damages, from previous earthquakes, it has been noted that the structures with irregularity in plan are significantly more vulnerable than the regular structures. This justify the need of provisions that shall regulate the irregularity in plan. This has prompted more in-depth research, and thus the development of methodologies and analyzes that can define a larger number of parameters that influence the evaluation of the structure's response.

Although the Eurocode 8 has established criteria for plan irregularity, based on geometric parameters, center of stiffness and torsional radius, it has no defined methodology for their determination. This can lead to some difficulties in its practical implementation. Unlike the Eurocode, the other codes (ASCE 7-10, NZS 1170.5-2007 and TEC 2007) can determine the plan irregularity during the analysis of the structure.

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RISK ASSESSMENT OF REMAINING UNEXPLODED ORDNANCE AND DEVICES NEAR THE SETTLEMENTS

Abstract: According to above mentioned, it has been found that the problem of unexploded ordnance and devices will be present as a real risk for many years to come. Communities bordering suspected mine-threatened areas are the most exposed to this risk. This work, through GIS tools and an adequate methodology, has been analyzed and assessed risks in the study area and offered a methodology that could be applied to similar areas in Bosnia and Herzegovina and the world.

Key words: Unexploded ordnance and devices, GIS tools, hazardous areas, mine incidents.

Summary:

After the wartime in Bosnia and Herzegovina, a large number of unexploded ordnance and devices of different categories remain. According to BH MAC data, the current size of the suspected mine area in Bosnia and Herzegovina is 1,061.32 km^2 or 2.1% of the total area of Bosnia and Herzegovina. 8525 suspected micro-locations have been identified, with an estimated 79,000 mines / ESZR remain, which directly affect the safety of 545,603 inhabitants or 15% of the total population of Bosnia and Herzegovina. In the post-war period, 1758 people were suffered, of whom 614 were fatal (killed). In 2018, three mine incidents were registered in Bosnia and Herzegovina in which one person was fatally injured (killed), one was severely injured and two were slightly injured.

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1. INTRODUCTION

Bosnia and Herzegovina is the most affected country by mine problems in Europe. The current size of the suspected hazardous area in Bosnia and Herzegovina is much larger than the mapped area, which is 1,061.32 km^2, and tends to increase as weather factors affecting the movement of terrain, floods and landslides have moved mining-explosive items. Demining of terrain is in the function of time and financial resources needed to deal with this issue on the quality way.. The Bosnia and Herzegovina Mine Action Center (BH MAC) has appealed to the population not to enter marked mine suspected areas. Otherwise, the media do not pay sufficient attention to this issues as well as every other social institution including cantonal and local authorities, such as civil protection. The problem is present in over 139 municipalities / cities or 1398 vulnerable places. One of the most endangered municipalities in Bosnia and Herzegovina is Lukavac, on whose territory is situated local community Orahovica Gornja. This area is very interesting for the development of recreational tourism, and it is a precondition to eliminate any doubt that there are mined parts that are not adequately marked or there is no information available to citizens about the same. The aim of this research was to see how much is a permanent resident of the area familiar with the presence of mine-fields and unexploded ordnance and device, and whether they are adequately marked so that residents and tourists (recreationalists), are familiar with. [1] By mapping contaminated area maps and placing them in public places, it will be ensured the overall safety of groups and individuals.

2. METHODS

Research and testing methods included analysis of previous research (in situ research) as well as textual and graphical processing of results. On the field, a survey was conducted on 10% of the total population from the test site. Infrastructure, watercourses, suspected areas, risk areas, cleared areas as well as approximate locations of mine incidents (accidents) were monitored, based on which a map was made in QGIS where all mentioned areas were mapped.[2]

3. RESEARCH RESULTS

The local community of Orahovica Gornja is located in the municipality of Lukavac.

3.1 Poll

The topic of the survey concerned the awareness of the local citizens about the mine-fields near their houses, as well as the issues of their adequate marking, and finally their opinion on the risk and impact that life brings besides mine-fields. The survey was conducted on a sample of 30 people of different ages.

The questionnaire consisted of five questions and each of the questions was offered five answers where the first answer corresponds to the worst case scenario and the fifth answer to the best case scenario. The following results were obtained:

Question No.1: Are you familiar with minefields in your area?

Answers:

Table 1. Results of the answers to question no.1

1

N.	Answers	N
1.	I am not familiar	3
2.	Somewhat familiar	9
3.	.I am familiar	6
4.	Something more familiar	4
5.	Very familiar	8
		Total sum: 30

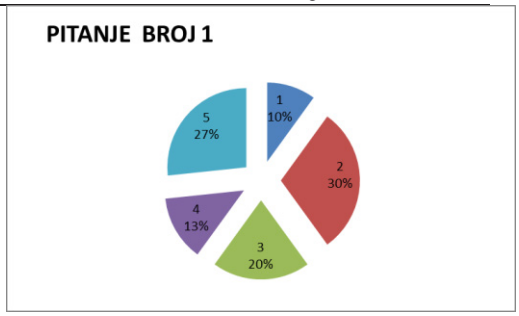

Figure 1 – Based on the answer to question

Based on the answer to question 1 (Table 1, Figure 1), it can be concluded that the indigenous population is relatively well acquainted with the presence of mine-fields in their vicinity. However, here we have the problem of people coming as hikers and recreationalists who are unfamiliar with existing minefields.

Question No.2: Do you think that suspicious or potentially hazardous areas with unexploded ordnance and device have been adequately characterized?

Answers

Table 2- Results of answer to question no. 2

N	Answers	N
1.	There are no marked at all	1
2.	They are badly marked	11
3.	They are good marked	12
4.	They are very good marked	3
5.	They are well marked	3
		Total sum: 30

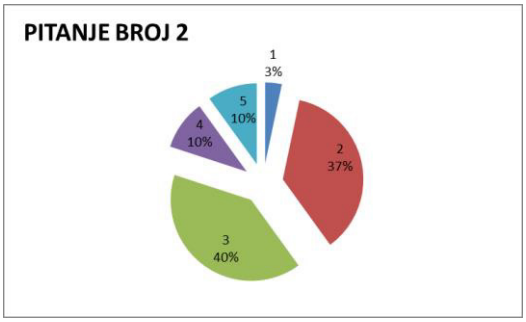

Figure 2 – An analysis of the results

An analysis of the results on this question (Table 2, Figure 2) revealed that mine-fields were not adequately marked or that unconscionable persons removed marks. As such, they present a danger both to the local population and to persons who do not reside in the field of study but come to them as recreational or hikers.

Question No. 3: How risky is it for you to live near a minefield?

Answers

Table 3- Results of answer to question no. .3

N.	Answers	N
1.	Very risky	12
2.	Somewhat risky	7
3.	Risky	8
4.	It is not somewhat risky	3
5.	It is not risky at all	0
		Total sum: 30

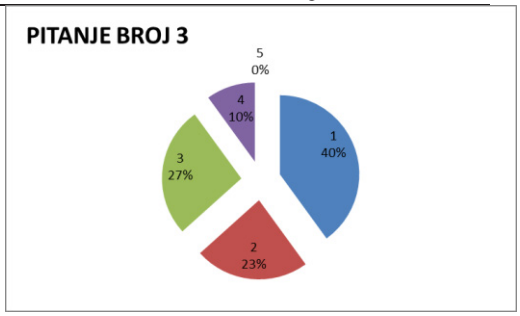

Figure 3 – The results of the answer

The results of the answer to this question tell us that locals find it risky to live near mine-fields. Local citizens know the boundaries of safe areas relatively well, but there is always a risk.

Question No. 4: How much does the presence of a minefield near you have on your life?

Answers:

Table 4- Results of the answer to question no.4

N.	Answers	N
1.	No influence	3
2.	It has some influence	9
3.	It has influence	9
4.	It has significant influence	6
5.	It has very significant influence	3
		Total sum: 30

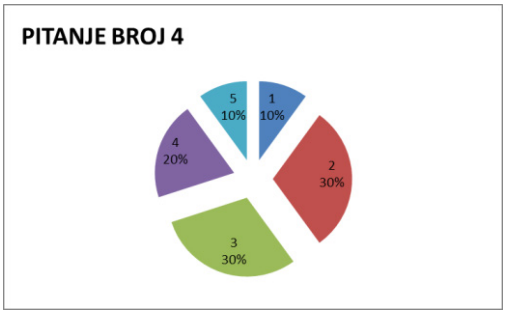

Figure 4 – The results of answering

The results of answering this question revealed that the presence of minefields has a significant impact on the life of the native population.

The population of the area is mostly making for living from agriculture and animal husbandry.

Almost all agricultural land is located near mine-fields, which greatly limits their use, making life even more difficult.

Question No 5.: In your opinion, how effective is the work of de-mining teams in your environment?

Answers:

Table 5- Results of the answer to question no.5

N	Answers	N
1.	No effective	1
2.	Somewhat no effective	1
3.	Neither efficient nor inefficient	7
4.	Somewhat effective	7
5.	Effective	14
		Total sum: 30

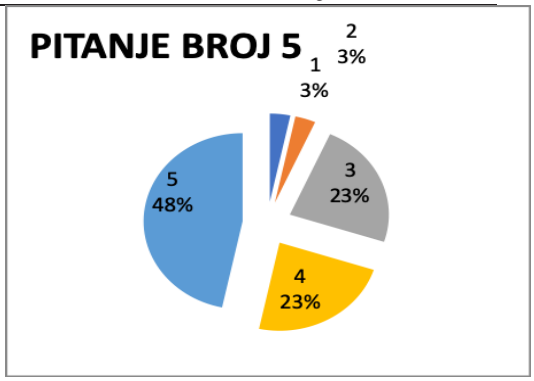

Figure 5 – The results of the answer

The results of the answer to this question have led to the fact that demining services are efficient in their work. Given that the demining process is a lengthy and expensive process, it is expected that this process of mine clearance and unexploded ordnance and devices will continue for many years.

3.2 Map of unexploded ordnance and devices in QGIS

The map was made in the scale of 1: 25,000. It was done at QGIS with marked infrastructure, watercourses, suspected, risky and cleared areas of mine explosives as well as approximate locations of mine incidents. A map from the BH MAC archives from the Turija-Milino Selo site was used as the basis for this map. The mapping of the map with the mentioned marked areas has enabled the population of this locality to become well acquainted with the contaminated surfaces. [4] Placing the same maps in public places, public institutions and billboards with roads would allow not only the local population to be acquainted with contaminated areas, but also persons from outside the area, such as recreationist and picnickers. The aim is to ensure the overall security of groups and individuals.

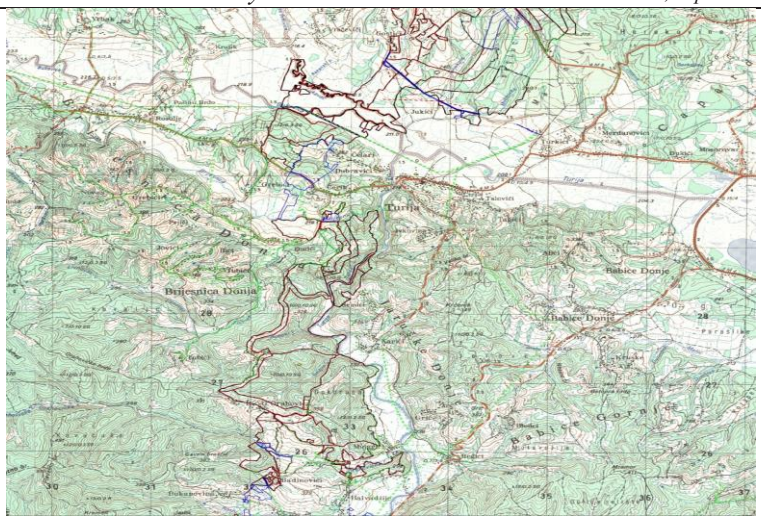

Figure 6 – Map from BH MAC archives Turija-Milino Selo site [5]

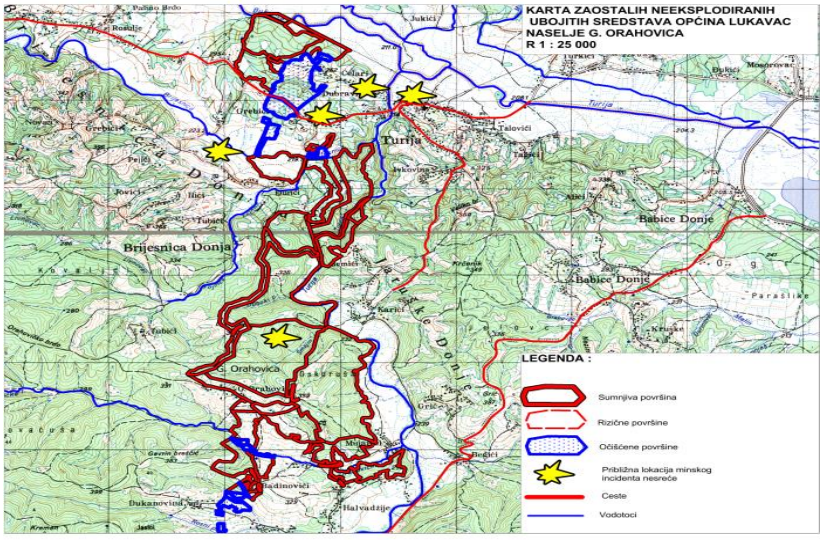

Figure 7 – *Map of unexploded ordnance mapped in QGIS*

3.3 Discussion

Based on the results of the research, it can be estimated that the contamination of mines and unexploded ordnance and devices in this area is very high and poses a great risk to human life. Knowing that suspected and potentially risky areas with unexploded ordnance and devices are inadequately or by no means marked and a large number of inhabitants are not informed where they are, as well as the inaccessibility of information on the same sites by institutions

dealing with this issue, all this becomes even more important . For this reason, a quick and systematic solution to this problem must be addressed.

4. CONCLUSIONS

Based on the conducted research, a number of conclusions can be drawn:
Bosnia and Herzegovina is the most affected country in Europe with problem of unexploded ordnance and devices. There are a number of sites under mines. Awareness of the population about the existence of mine-fields is very low. The mine-fields are very poor or non-existent and there is no control over them. Access to mine-field information does not exist for the population (no unique database of relevant institutions). The number of incident situations is not declining. The media do not give importance to this issue.

All these above mentioned deficiently were also noticed in the local community of Orahovica Gornja in the Lukavac Municipality. Because of all mentioned , a systematic solution to these problems should be approached. First of all, it is necessary to start with the re-education of both children and adults on the presence of unexploded ordnance and devices, to analyze the mine action taken so far, to characterize the vulnerable groups and individuals. Re-marking of suspected, risky, cleared and mine-affected locations should be undertaken and ongoing field surveillance should be ensured. What is most important is the development of maps with mapped areas that will mark all the contaminated areas as well as infrastructure and watercourses.[3] The same maps should be placed in public places, public establishments, in the vicinity of settlements in order to be accessible to the inhabitants of these areas themselves and to people coming from other places, cities and states. Involve the media in all this and work with them as intensely as possible. Provide access to information on the official website of institutions dealing with this issue, which has not been the case so far. We have good examples of these activities in the neighborhood. The Republic of Croatia has given its citizens access to all information regarding this issue. In our case, it would be good to involve the Government of BiH in all activities and apply together for some of the new projects with this topic.

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THE ROLE OF SOCIAL NETWORKS IN PREPAREDNESS AND RESPONSE TO DISASTERS

Abstract: This paper reviews the role of social networks in effective communication during an emergency. Due to a huge number of smart devices and an increase in the number of Internet users millions of people use social networks to share information during disasters and emergencies. The purpose of this research is to explore citizens' information experiences in social media during times of emergency/disaster and to determine level of trust in social networks in Serbia. This research examines different social media tools in order to find out how can they be utilized to provide better communication with the public in emergencies and how to enhance preparedness and response to disaster, reduce casualties and damages.

Key words: social networks, emergency situations, disaster risk management, disaster preparedness, disaster response, crisis communication.

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1. INTRODUCTION

The occurrence of any crisis causes the exchange of a large amounts of information in the whole environment. Efficient crisis management requires cooperation at all levels, quick decision-making and a harmonized communication interaction of all stakeholders. Information management before, during and after the catastrophic event can have a direct impact on crisis management.

Social networks are one of the most common terms in the world of the Internet. According to one of the most accepted definitions of the social network, it can be defined as „a set of Internet applications that are built on the ideological and technological foundations of Web 2.0 technology that allow the creation and exchange of user-generated content“ [5].

Over the past decades, social networks are increasingly recognized as an important tool in the society readiness for disasters and emergency management. As preparation and response to crisis requires timely access to relevant information and the coordination of activities of all stakeholders - from those responsible for responding to each individual in the community, the use of social networks in emergencies allows the dissemination of important information among individuals and communities, as well as the reception of updated data by the first responders [6]. Increasing number of social network users was not the only factor contributing to it, but also the recognition of the various benefits of their use in such situations. For example, in disaster risk management, social networks (*Facebook, Instagram, Twitter* ...) can be used in a different ways: alerts, spreading news about casualties and damage, publishing multimedia information such as videos and photos, tracking public debates, crisis management and dissemination of information on its response to the actual event, the creation of social cohesion and encouraging donations [2].

2. THE POWER OF SOCIAL MEDIA DURING DISASTERS

During disasters social networks provide access to relevant and timely information that are required by the relevant emergency services in such situations. Among other things, this information includes data on the affected areas, the extent of the damage suffered, the number and location of the affected population. It is noticeable that there is an increased use of social networks in emergencies worldwide.

During the Haiti earthquake in 2010. catastrophic material damage and the death of hundreds of thousands of people have been caused. Shortly after the earthquake, a large number of residents remained trapped in ruins, and already vulnerable infrastructure in the country was completely destroyed. While teams of foreign rescue units were trying to reach out to victims, aid agencies struggled to satisfy the basic needs, such as food, water, shelter and medical care for those affected [3]. *Twitter* had a particularly important role in disseminating information as it quickly spread the word about the earthquake and ways to help. Haiti became one of the main topics, information of potential locations of vulnerable people were increasingly transmitted through social media (eg. relatives of victims who sent information directly to the agencies responsible for rescuing) or via SMS [1], and a large number of tweets called for donations in cash or commodity stocks for the affected country.

After the earthquake in Japan in 2011, despite the prediction of a large tsunami, the local government could not issue a tsunami warning on the homepage of local governments because computer servers were shut down due to a power outage after an earthquake. Instead, they managed to create an account on *Twitter* and *Facebook* using their private cell phones and send information through these social networks [4]. The first tweet was published within ten minutes after the disaster [4]. Online blogs and social networks played an important role in facilitating the exchange and understanding of information after damage to the nuclear power plant in Fukushima caused by the earthquake and the impact of tsunami. Citizens actively participated in blogs on *Facebook*, *Twitter* and *YouTube*, exchanging information and referring others to important news articles or videos, especially to the level of nuclear radiation.

During the Hurricane Sandy which hit the Caribbean and North America region in October 2012, the public, government agencies and others turned to social networks more than ever before, as a key channel of communication. For example, the New York Office of Emergency Management provided hourly updates and evacuation orders via *Twitter*[10]. The US Federal Emergency Management Agency (FEMA) also used social media to share information and created special website pages about Hurricane Sandy on *Twitter* and *Facebook* accounts.

During the floods and flash floods that hit Serbia, Croatia and Bosnia and Herzegovina in May 2014, social networks served as a channel for fast information sharing and had a very important role in facilitating the evacuation and rescue[11]. The trending hashtags during this floods were: #floods, #SerbiaFloods and #Serbia.

Considering that one of the key characteristics of social networks is the possibility of two-way communication between a large number of people, the significant role of social networks in crisis is evident. Social networks in such circumstances make it possible to quickly and efficiently distribute large amounts of information to large groups of people in real time [6].

3. RESEARCH METHODOLOGY

The subject of this quantitative research is to examine the attitudes of respondents about the role of social networks in prepardness and response of the community to disasters and to determine the level of trust in the use of social networks during such events.

The research was carried out via an online questionnaire (Figure 1) distributed via email and *Facebook*. In the first phase, the research was conducted among the students of the universities involved in the K-FORCE project, Faculty of Technical Sciences in Novi Sad, Faculty of Mining, Geology and Civil Engineering in Tuzla and Faculty of Architecture, Civil Engineering and Geodesy in Banja Luka. In the first two weeks of the survey, the responses of 93 respondents were collected, with more than half of respondents' answers being received from students of listed faculties.

[10] https://www.govtech.com/em/disaster/Sandy-Social-Media-Use-in-Disasters.html
[11] https://edri.org/social-media-in-key-role-in-the-balkans-floods-incited-censorship/

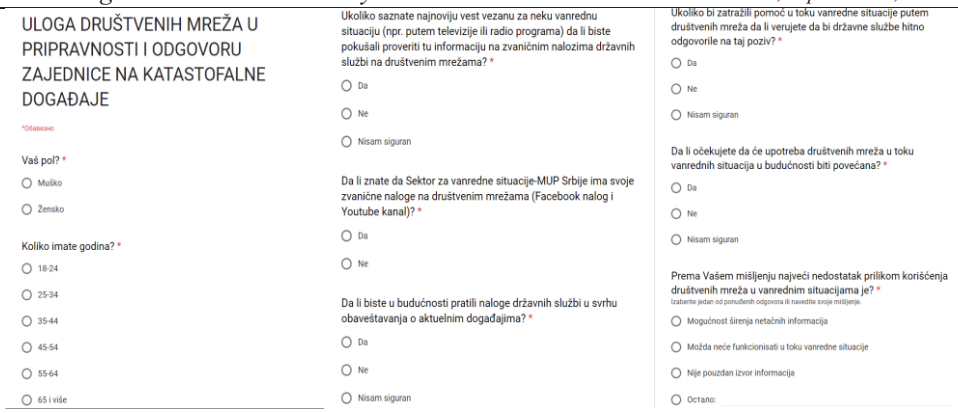

Figure 1 – Questionnaire screenshots

Comparing the characteristics of the sample itself, it can be concluded that female respondents showed greater willingness to participate in the research (65.6%) than men (34.4%). When it comes to the age of the respondents, the sample mainly includes respondents aged 25-34 (49.5%) and 18-24 years (31.2%), which is quite expected due to the participation of the student population. Accordingly, the greatest number of respondents is highly educated, of which 63 (67.7%) has a bachelor's degree, while 12 (12.9%) has a master's degree.

4. FINDINGS

After the survey was conducted, descriptive statistical analysis was used in order to describe the collected answers. All respondents (100%) stated that they have an account on one of the social networks, while most respondents indicated that they have *Facebook* (95.7%), *Instagram* (62%) and *YouTube* channel account (26.1%) (Figure 2). Even 91.4% of the respondents said they access social networks via a mobile phone most often, while for this purpose desktop or laptop computer uses 8.6% of the respondents.

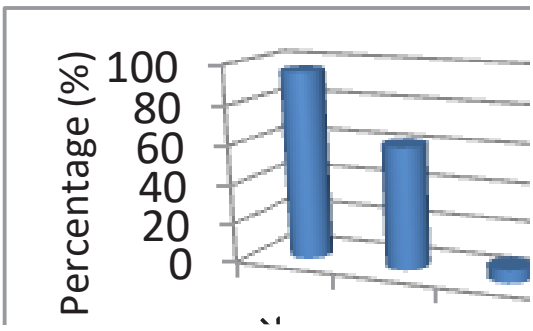

Figure 2 – Social media usage

To the question "How often do You access social networks?", 81.7% respondents answered that they do that several times a day, 12.9% once a day, 1.1% several times a week, while 4.3% of respondents do so several times during the month.

About half of all respondents (49.5%) responded that they used social networks for the purpose of informing about disasters and emergencies (eg. storms, heavy rains, earthquakes), 34.4% of respondents did not use, and 16.1% were not sure if they ever used social networks for this purpose. 58.1% of respondents said they would try to check the news related to an emergency (eg. published on TV or radio) on official accounts of public services, 18.3% of respondents are not sure, and 23.7% would not do so.

When asked if they know that the Sector for Emergency Management – Ministry of Interior of Serbia has its official accounts on social networks (*Facebook* account and *YouTube* channel), 26.9% of respondents answered yes, and 73.1% no (Figure 3). However, 71% of respondents replied that they would track the accounts of public services in the future for the purpose of informing about actual events, while 20.4% are not sure, and 8.6% of respondents said they would not follow these accounts. Most respondents (71%) said they would seek help through social networks (Figure 3) during an emergency if they were able to do so, but only 11.8% of them believe that public services would urgently respond to that call, 46.2% of respondents are not sure about it, and 41.9% do not expect an urgent response from the relevant public services.

Regarding the use of social networks during emergencies in the future, 77.4% of respondents expect it to be increased, 18.3% are not sure, and 4.3% of respondents do not expect increase in the usage of social networks.

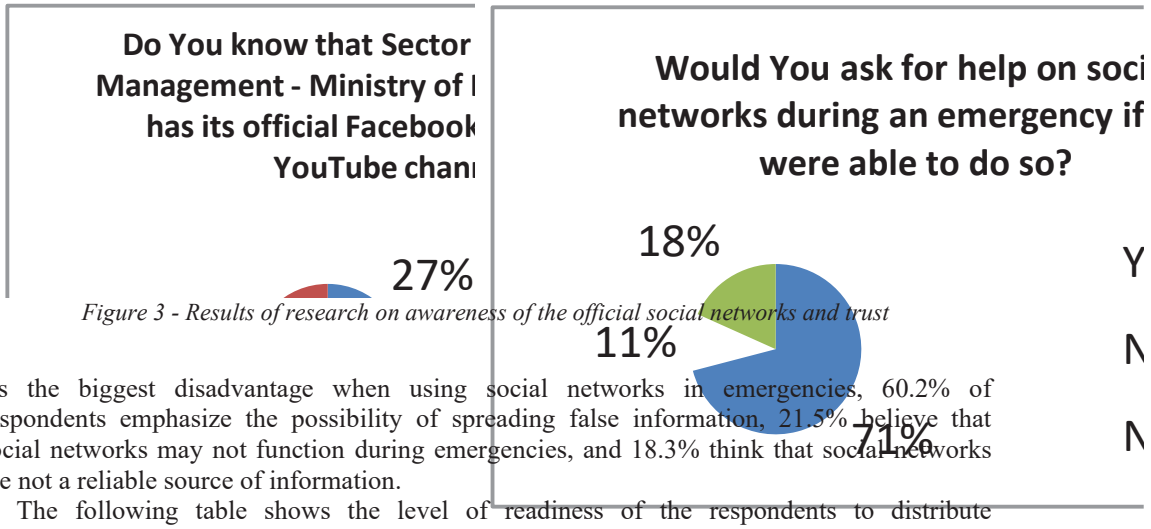

Figure 3 - Results of research on awareness of the official social networks and trust

As the biggest disadvantage when using social networks in emergencies, 60.2% of respondents emphasize the possibility of spreading false information, 21.5% believe that social networks may not function during emergencies, and 18.3% think that social networks are not a reliable source of information.

The following table shows the level of readiness of the respondents to distribute information via social networks in emergencies, depending on certain preconditions, perceptions, previous experiences or expected benefits (Table 1).

Table 1 – Statistic regarding questions from the survey

Questions	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
	Percentage (%)				
I would forward the information because I have experienced disasters before.	20,4	6,5	35,5	22,6	15,1
I would forward the information because I want to warn others.	2,2	0	10,8	31,2	55,9
I would forward the information because I want to attract the attention of others for collecting „likes“.	96,8	2,2	1,1	0	0
I would forward the information because I believe that can help others.	3,2	1,1	9,7	39,8	46,2
I would forward the information because I want to allow exchange of opinion and discussion of a particular event.	20,4	22,6	26,9	21,5	8,6
I would forward the information because I can check whether the information is true or false	17,2	22,6	30,1	19,4	10,8
I would forward the information because I want to inform citizens who do not follow the official accounts of emergency response services.	6,5	8,6	25,8	30,1	29
I would forward the information because I trust the source from which the information came from.	11,8	12,9	30,1	31,2	14
I would forward the information because I believe that information from social networks spreads faster than information via TV and radio.	4,3	1,1	11,8	41,9	40,9
I would forward the information because I can get detailed information from the local population.	8,6	10,8	32,3	28	20,4
I would forward the information because I want to get advice on disaster preparation.	6,5	12,9	39,8	25,8	15,1

5. CONCLUSION

The role of social networks in community preparedness and response to disasters in recent years became extremely important. In particular, the increase in the use of smartphones with installed applications such as *Facebook, Twitter, Instagram* and others that enable their users to share information in the form of text, photos and videos. Social networks have the potential to influence the way individuals think, behave and respond to information and situations during disasters.

Based on the results of the research, it has been confirmed that social networks are used daily and on a large scale, therefore they can be used to raise citizens' awareness of the dangers surrounding them, as well as education on preventive measures in order to enhance preparedness and response to a particular event. It was noted, however, that a large percentage of respondents were not aware of the fact that public services for crisis response have their own accounts on social networks and that there is a lack of trust in the use of social networks

because of the possibility of their abuse and technical shortcomings. However, it is evident that there is awareness that social networks are a tool that enables rapid dissemination of information and alerts.

In order to make social networks more effective in raising preparedness and response of society to disasters, it is essential that all relevant stakeholders are informed about the possibilities of their use before, during and after such events. Only in this way will be possible to take advantage of all the benefits of using social networks.

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GRAIN CROP STUBBLE FIRES IN THE SOUTH BAČKA DISTRICT IN THE PERIOD 2014-2018

Abstract: The paper presents the participation of grain crop stubble fires in the South Bačka District, compared to total fires in the observed period, the average of which is about 2%. The characteristics of such fires, normative arrangement of special protective measures in this area, as well as the procedure in the event of fire are given. The paper is a result of the work of students in the professional master study programme Protection Engineering in the VTŠNS, within the course Investigation of causes, phases and consequences of fire, during the school year 2018/2019.

Key words: grain crop stubble fires, South Bačka District

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1. INTRODUCTION

The aim of this paper is to analyze the grain crop stubble fires in the territory of the South Bačka Administrative District, to analyze preventive measures for fire protection when harvesting grain crop stubble, as well as the fire fighting tactics. According to the data of the Territorial Fire Rescue Unit Novi Sad, which is part of the Ministry of Internal Affairs, the Sector for Emergency Situations, Emergency Situations Office in Novi Sad, in the territory of the South Bačka District, in the period from 2014 to 2018, a significant number of grain crop stubble fires occurred, which caused great material damage and pollution of the environment [1].

Grain crop stubbles are wheat, rye, oats, and barley. Grain is classified according to its purpose, according to which wheat and rye belong to bread grain, or grain for the production of bread and other bakery products, and other grains are grains for livestock use. The greatest number of grain crop stubble fires occurs during the harvest of grain crop stubble, since the harvest is done in the summer period when the daytime temperatures are very high and the grain crop stubble in the final period of vegetation is highly flammable. Grain harvest is a serious and responsible job that requires the engagement of a large number of people and agricultural machinery in a relatively short time period, which is conditioned by weather conditions. Preventive measures for the protection of grain crop stubble fires are determined by the Fire Protection Act [2], as well as the Ordinance on Special Measures of Fire Protection in Agriculture [3], internal legal acts of legal entities, and other participants in the harvest, and include all measures that are carried out in order to protect human life and material goods during wax and full maturity, the harvest of grain crop stubble, threshing, transport, and storage of grain crop stubble.

2. GRAIN CROP STUBBLE FIRES

Grain crop stubble fires are fires in the open space, where flame covers grain crop stubble, that is, uncontrolled combustion of wheat, barley, rye. Grain crop stubble fires occur during the period of full and wax maturity of the grain crop stubble, i.e. from 15 June to 15 July, when it is the grain ripening period, that is, when the daytime temperatures are around 30°C, and the night temperatures are around 15°C. Grain crop stubble fires cause great damage to agricultural producers, endangering the lives and health of people who find themselves in the immediate vicinity and cause great damage to the environment.

According to the data of the Fire fighting Association of Vojvodina, the largest number of grain crop stubble fires was due to a faulty mechanization participating in the harvest, then due to negligence, as a result of natural disasters and as a result of the operation of vehicles, if the plots are close to public roads and railroads. Harvesting machinery consists of: combines, tractors with trailers for transport, trucks for transport, tractors with multiple ploughing ploughs (for the production of cuts or for grain harvesting) in the case of fire and straw bales.

3. NORMATIVE REGULATION FOR SPECIAL FIRE PROTECTION MEASURES DURING THE GRAIN CROP STUBBLE HARVEST

Special fire protection measures for harvesting the grain crop stubble are defined by the Fire Protection Act [2] and the Ordinance on Special Measures of Fire Protection in Agriculture [3]. Internally, at the level of legal entities, the implementation of special fire protection measures is regulated by the appropriate regulations on preventive fire protection measures during the harvest of grain crop stubble, which according to the regulations should be adopted by legal entities where harvesting works are carried out. The Law on Fire Protection [2], Article 49, specifies the obligations regarding the implementation of special measures for the protection of grain crop stubble against fires that must be carried out by companies, agricultural cooperatives, institutions or other legal entities, entrepreneurs and farmers who perform harvesting works. These obligations include: organizing permanent on-calls; organization of observation service; arranging a connection and notification service; equipping machinery with appropriate fire fighting equipment; control of fire fighting equipment; control of the correctness of mechanization; control of crop storage.

Municipal assemblies, companies, agricultural cooperatives, institutions and other legal entities are obliged to make a written decision and to establish the Municipal Staff, i.e. the Staff for the implementation of special measures for the protection from grain crop stubble fires during harvest. The Staff for the implementation of special measures for protection from grain crop stubble fires during harvest consists of: the commander of the staff, the deputy commander of the staff, members of the staff.

3.1. Staff for the implementation of grain crop stubble fires protection measures

The Staff for the implementation of special protection measures for grain crop stubble fires (grain crop stubble) has the following tasks: it adopts a plan for the protection of grain crop stubble against fire; submits the data collected from the field to the competent Staff of municipal assembly or general director; gives instructions and takes measures in the event of difficulties in the organization of harvest; takes certain measures to ensure that the responsible persons comply with certain harvest organizations as well as the implementation of special fire protection measures; ensures proper storage of grain; analyzes the course of the harvest and informs the president of the municipal assembly or general director about all important issues.

3.2. Fire protection plan for grain crop stubble fires during harvest

Pursuant to Article 20, paragraph 19 of the Law on Local Self-Government [4], Article 19 of the Fire Protection Act [2] and the Ordinance on Special Fire Protection Measures [3], Municipal Staff, or Staff for implementation of protection measures against grain crop stubble fires during harvest, must adopt the Fire Protection Plan for grain crop stubble fires during harvest. The plan for the protection against grain crop stubble fires during harvest consists of: inspection of planted areas and scope of work; inspection of mechanization; specific Harvest Plan; measures for carrying out technical inspection of harvesting machines; organization of on-calls, control and observation, activation and fire alarm system; other fire protection measures.

The specific Harvest Plan must define:

- Commencement of harvest, and this is mainly the last decade of June, or the period when the grain moisture does not exceed 15%, or when the crop is ready for storing.
- Estimated duration of harvest (number of days of duration of harvest).
- Priority plots that are most vulnerable from the aspect of fire protection and where harvesting should be done first.

3.2.1. Measures for carrying out technical inspection of harvesting machinery

Inspection of the machinery involved in the harvest is carried out by an authorized municipal committee for protection against grain crop stubble fires. Members of the committee are members of a competent volunteer fire fighting association, fire protection engineers, traffic technicians and car mechanics - agricultural mechanics. The Committee carries out the inspection of the technical safety of the machines from the aspect of fire protection:

- The condition of the exhaust pipe and the seal on the cylinder head.
- Existence of a catcher - a contact breaker of the sparks at the end of the exhaust pipe.
- Thermal insulation for protection against fire of exhaust pipe that are placed under the body of the machine. The pipes must be well insulated and attached to the car body.
- Electrical insulation of electrical installations.
- Current fuse protection. The fuses must be of adequate amperage, it is forbidden to put inadequate electrical fuses.
- The output status on the battery poles must be adequately attached, as well as all other connections on the electrical wiring.
- Battery status (adequate position, cover protection in order to avoid bridging the poles).
- The condition of the fuel tank and the fuel supply system of the engine. They must be impermeable and adequately attached.
- The method of safe drainage of static electricity (the existence of a grounding device that is attached to the car body and achieves contact with the ground).
- Signal status (the existence of a light rotation on the vehicle).
- Existence of a no smoking sign.
- Condition of cleanliness - dusting and degreasing of agricultural machinery.
- Possession of an adequate fire extinguisher.
- Equipped with shovel and broom.
- Possession of adequate first aid equipment.
- The vehicle must be registered.

The Committee is obliged to draw up a report on the inspection of the correctness of the agricultural machinery, the copy of which will be handed over to the owner of the agricultural machinery. The Committee is obliged to issue to the owner of a valid agricultural machine a label “PARTICIPANT IN HARVEST IN 2019” certified by the Municipal staff for harvesting and protection against grain crop stubble fires for the current year.

3.2.2. Organization of on-call, control and monitoring, activation and fire alarm system

The Municipal Fire Brigade is obliged to organize regular on-call services in each voluntary fire fighting association of the populated places of the municipality. Before the commencement of the harvest, the Municipal Fire Brigade will deliver the on-call schedule to the Municipal Staff for harvesting and protection against grain crop stubble fires. Observation, by visiting the agricultural land during harvest, is performed by field service and members of voluntary fire brigades, that is, legal entities and employees in agricultural holdings. Observation, by observing the agricultural land which is planted with grain crop stubble, is done from dominating peaks, from where there is a good overview of the area. The liaison service is carried out by mutual informing among the observation services, regional fire brigade rescue units and voluntary fire brigades in the implementation of the measures of continuous on-call duty and observation. In the event of a fire, a regional fire brigade and competent voluntary fire department are activated.

3.3. Other fire protection measures

During the harvest period, the following activities are strictly prohibited: combustion of residues of grain crop stubble, incineration of waste in open space, incineration of plant residues, smoking at the place where the harvest is done.

If the grain crop stubble are planted on a complex of land larger than 50 ha and smaller than 100 ha, the harvest begins with mowing in the middle, at least in width of 15 m. On a complex of land larger than 100 ha, the mowing is carried out so that it is separated approximately every 50 ha in width of 15 m at least. Upon completion of mowing, the mowed part must immediately be ploughed. Harvesting of grain crop stubble on the land next to the railway starts with harvesting crops next to the railway in width of 60 m at least. Mowed crops or straw immediately after harvest have to be removed, and land has to be ploughed the same day.

In places where harvesting is carried out, put visible no smoking signs. In all places of public gathering (health centre, market place, larger shops, post office, local community centre, etc.), put notices that burning of harvest residues is forbidden. Through means of public information, inform the citizens about the free inspection of agricultural machinery.

3.4. Training participants in harvesting in the field of fire protection

All persons handling agricultural machinery in carrying out harvest and transport, and support staff must undergo training in the field of fire protection, and must be able to handle the appliances and fire extinguishing equipment properly.

4. PROCEDURE IN CASES OF FIRE AND FIRE FIGHTING TACTICS

In the event of a fire, it will be announced with a loud exclamation: "FIRE – THE GRAIN IS BURNING" or "FIRE – COMBINE IS BURNING". At the given alarm all machines and all operations are stopped, and fire extinguishing process begins. In the event of a fire on the agricultural machine, it should be turned off, checked for correctness, and determined whether the machine is capable of continuing its operation. A defective machine must not perform work in areas threatened by fire.

Fire fighting tactics of grain crop stubble. Extinguishing grain crop stubble fires can be carried out in many ways, depending on the available fire extinguishers and equipment, depending on the causes that led to the fire. If the cause of the grain crop stubble fire is the fire that broke out on the harvesting machinery, it is necessary to try to extinguish the fire on the machinery itself first, while at the same time try to prevent the spread of fire on the grain crop stubble plot. To extinguish the fire on the machinery, use the devices for extinguishing the initial fires with dust, type S-2, S-3, S-9, which agricultural machinery must be equipped with. In the event that fires on agricultural machinery cannot be extinguished with initial fire extinguishers, fires are extinguished using fire trucks, water and foam combination. Grain crop stubble fire is extinguished with water from a tank or fire vehicles, or by fire brooms in case of initial fire.

5. FIRES IN THE SOUTH BAČKA DISTRICT IN THE PERIOD FROM 2014 TO 2018

The results are shown in Table 1.

Table 1 – Review of fires in the period from 2014 to 2018

Year	Total number of fires	Total number of fires in the open space	Share of fires in the open space in total number of fires [%]	Total number of grain crop stubble fires	Share of grain crop stubble fires in total number of fires [%]	Average annual number/percentage, [%] of grain crop stubble fires for the observed period
2014	1536	1116	72.65	48	3.13	34/1.76
2015	1806	1216	67.33	55	3.05	
2016	1609	1009	62.71	13	0.81	
2017	2500	1795	71.80	36	1.44	
2018	2190	1586	72.42	16	0.73	

In the area of the South Bačka District, outdoor fires represent the dominant type of fire, with a percentage share of 63-73%. The share of grain crop stubble fires in the total number of fires for the observed period ranges between 1-3%, or an average of about 2%. The largest number of grain crop stubble fires (55) was recorded in 2015, with extreme heat and average rain [5], while the largest number of fires in open space (1795) and the total number of fires (2500) was recorded in 2017, which was warm and dry [5]. In the territory of the Republic of Serbia, 2018 was the hottest year in the period from 1951 to the present day, while in most parts of Serbia in 2018 there was average rainfall [6], which to some extent correlates with the number of fires in open space (1586) and with the total number of fires (2190), but not with the number of grain crop stubble fires (16). Namely, in addition to weather conditions, other factors also affect the number of grain crop stubble fires: the area under these crops, the

application of fire protection measures, the use of modern agricultural machinery (with built-in fire protection measures).

6. CONCLUSION

The analysis of the grain crop stubble fires on the territory of the South Bačka Administrative District was performed. Precautionary measures for fire protection during grain crop stubble harvest, as well as fire fighting tactics are listed. The causes of the grain crop stubble fires are presented.

The overall number of fires is mostly influenced by the level of implementation of preventive fire protection measures established by legal acts and by-laws in the field of fire protection. The most common cause of grain crop stubble fires is the failure of agricultural machinery involved in harvesting.

In the period from 1985 until now, the number of grain crop stubble fires that have occurred has been relatively small, with a tendency of continuous decline. Reduction in the number of grain crop stubble fires has been contributed by the reduced area planted with grain crop stubble (wheat is no longer a strategic agricultural product), as well as the purchase of new agricultural machinery of foreign production, which mainly has built-in fire protection measures, starting with spark arrester in the exhaust lines to necessarily built-in - installed fire extinguishers.

The immeasurable importance in reducing the number of fires and the damage caused by grain crop stubble fires has the work of expert committees for inspection of agricultural machinery that through direct field inspection draw attention to the users to irregularities in equipment from the aspect of fire protection. In addition to pointing out irregularities, the committee provides instructions for removing them. An important aspect of the work of the committee is the training of participants in the harvest, which is carried out during the inspection of mechanization.

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NUMBER OF TOTAL FIRES AND SILO FIRES IN THE SOUTH BAČKA DISTRICT IN THE PERIOD 2014-2018

Abstract: The paper presents total number of fires, caused deliberately, and by negligence, child negligence, natural phenomenon and unknown cause; as well as silo fires in the South Bačka District, compared to total fires. The causes of fire in grain silos and measures to protect the silo from fire are given. The percentage of silo fires in the total number of fires is small, less than 1%; however, a high proportion of fires of unspecified cause have been observed in relation to the total number of fires, which is a worrisome finding. The paper is a result of the work of students in the professional master study programme Protection Engineering in the VTŠNS, within the course Investigation of causes, phases and consequences of fire, during the school year 2018/2019.

Key words: total fires, silo fires, South Bačka District

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1. INTRODUCTION

The first data on organized forms of extinguishing fire come from the ancient Romans. The main fire extinguishing agent was water that was brought to the fireplace by fire trucks. Chemical fire extinguishers have been used for a long time. In the 18th century fire extinguishing agents appeared in the form of powder, which were very similar to the ones we use today. Modern fire extinguishing powder appeared in 1912. It was suggested in 1877 that flammable liquids can be extinguished by applying a foam layer to the surface of combustible materials. Halogenated hydrocarbons have been used since 1839 as fire extinguishers, and in the last quarter of the 19th century, carbon dioxide was introduced as an extinguishing agent. In the first half of the 19th century, fire fighting agents and equipments (water pumps, transport vehicles, fire extinguishers, ladders for interventions at altitudes) were found and developed more intensively, and fire fighting units were formed in larger cities. By analogy with the war tactics, which is the science of planning, preparing and conducting combat, the fire extinguishing theory and practice is called a fire fighting tactics. Fire fighting tactics elaborate methods of saving endangered people, animals and property. It examines the methods and principles of proper management of a fire department and fire extinguishing [1]. In modern conditions, fire fighting tactics continue to be developed, but there is an increasing emphasis on the development and application of preventive fire protection measures, bearing in mind the principle that it is easier to prevent than to treat.

2. FIRE, COMBUSTIBLE MATERIAL, FUEL

Fire is a complex physical-chemical phenomenon, the basis of which is the non-stationary combustion process, which takes place in time and space and for whose occurring the presence of the following is required: combustible material, oxidizer, and ignition source [2]. The stopping of the combustion process, for these reasons, should be sought in the elimination of combustible materials or oxidants, then in the cooling of combustible materials below the ignition temperature or in some other way, for example, binding of active particles (anti-catalytic process). Each fire is followed by the release of the appropriate combustion products. By combustion products, it is usually meant gaseous and solid matter, whereby no exempted heat energy should be ignored [2].

Combustible materials are considered to be those substances which, when subjected to the combustion process, provide chemical combustion products and a certain amount of heat and light. Fuels are considered to be those combustible substances that, in the process of combustion, in addition to chemical combustion products, provide such a quantity of heat that can be economically used for heating or be converted into mechanical and electrical energy [2,3].

Combustible material consists of: organic compounds, inorganic compounds and chemical elements. Inorganic compounds are usually non-flammable. Combustible chemical elements are carbon, hydrogen, sulphur, phosphorus and many metals. Some metals react with water at atmospheric temperatures, resulting in hydrogen and high amount of heat, due to which they ignite, e.g. sodium. Some others like zinc, react with water only at elevated temperatures (300°C), also releasing hydrogen [4].

3. SILO PLANTS AND PROCESSING TECHNOLOGY

Silo is a word of Greek origin which means “pit for storing grain”. It is a building for storage of bulk materials. Silos are commonly used for the storage of grain, coal, sawdust, wood pellets, cement and similar bulk materials. In agriculture, silos are used to store grain [5].

Silo plant is the name of plants used in agriculture for receiving, purifying, drying and storing agricultural products, in this case grain. The main purpose of the silo plants is that the grain, which is picked up wet and uncleaned, is made into a quality raw material. For this raw material to become a standard food product, it is necessary to respect the prescribed criteria in processing. The silo plant must contain certain facilities, i.e. devices, which in the technological process are in order [6]: a device for receiving grain from a vehicle; pre-cleaner for the removal of arable admixtures; a tank for moist grain before going into the dryer; drying equipment with filling and discharging equipment; a fine cleaner that is mandatory for larger plants; storage area for dry grains with appropriate instruments and equipment for filling and discharging, content control and supplementary blowing. Parts of the silo are detailed in the reference [7].

4. CAUSES OF FIRES OF SILOS FOR GRAIN

Each grain in its composition, with the exception of the basic grain, contains parts or grains of other plants or weeds, soil, stones, etc. After the removal of rough impurities from the initial grain mass, there remains a mass whose composition is [2,6]: grains of basic cultures; different fractions of a mixture of mineral and organic origin; microorganisms; air in the gap between the grains; infected or damaged grains from various pests.

4.1. Grain breathing

Grain breathing process is a biological process of oxidative decomposition of glucose, which means that oxygen is needed for the breathing of grains, and in addition to oxygen, a certain proportion of water in the grain is also needed. Since the breathing reaction takes place under normal pressure and temperature, many enzymes are involved in it. By breathing, i.e. by decomposition of glucose, heat and humidity are released. It is an enzymatic process that has its own temperature maximum - at a certain temperature the process is fastest. At higher temperatures, breathing intake decreases because the higher temperatures inactivate the enzymes present. Breathing intensity with moisture content below 16% is very weak, while with increasing moisture it increases. If the grain moisture content is 22% and the ambient temperature is 25°C, the temperature of the grain mass will increase by 7°C every 24 hours, the water content will increase by 0.058% and the dry matter loss will be 0.1% [2,8,9].

4.2. Self-heating

Self-heating is a process of gradual heat accumulation due to exothermic chemical reactions. The primary cause of self-heating is grain breathing. On one hand, it increases the temperature of the grain, and on the other hand it increases the moisture. The increase in moisture benefits the development of microorganisms that, along with the existing ones, contribute to self-heating. The temperature range of microorganism activities is very wide, from -8°C to +80°C. The development of microorganisms is influenced by the physical state

of the grain. Peeled, cracked and mechanically damaged grains are more susceptible to the development of microorganisms [2,9].

4.3. Self-combustion

Self-combustion is a phenomenon in which a substance (in this case, grain) is ignited without the presence of a spark or open flame. The temperature of the self-combustion of grain is the lowest temperature required to start self-sustaining combustion of grain. Self-combustion occurs due to self-heating. The grain will be ignited by the process of self-combustion so that due to self-heating its temperature increases, and there is no heat drain in the environment. In this case, the heat is retained and accumulated around the hotspot. Tinting spreads through tight spaces between the grains, thereby increasing the hotspot. If the hotspot is extended to the surface of the stored mass, a flame appears [2,9].

4.4. Inflammation and explosion of dust

Another major risk of fire of silos for grain is the inflammation of grain dust. In the case of grain manipulation and through the technological processes of the silo, a large amount of dust appears, especially in basement warehouses. This dust can accumulate on the construction of the silo, and in some part of the technological process (filling, discharging, transport) it can be swirling in the air in the form of a cloud. Swirling dust (cloud) will ignite and explode considerably sooner than precipitated dust. Since the dust is made up of very fine particles, the cloud has a very small mass and a large reaction surface. Dust that has been precipitated must first be lit up in order for the part to swirl by combustion. It is possible that the swirling will occur due to atmospheric changes (wind) or air flow due to technological processes. Possible sources of dust ignition energy are: self-heating and self-combustion; overheated bearings; lighting fixtures; overheated shields of electric motors or other electrical devices; static electricity; spark; open flame [2,9].

5. MEASURES FOR THE PROTECTION FROM SILOS FIRE

Fires of silos occur due to insufficient attention during: the reception of grain and oilseeds, storage or discharge. Working with organic material itself poses a certain danger and constant fire protection measures must be implemented.

During repairs, various hazardous works, such as welding, cutting and other work activities that can produce fine glowing particles are carried out. Then, strict preventive measures must be taken. The basis is to provide a place where the works will be carried out, which means removing all combustible substances in a zone of minimum 10 meters, stop part of the working line, cover adjacent devices with fireproof liners, sprinkle the surface, bring the fire extinguishers for initial fires [8,10].

Technical-technological measures for the prevention of the occurrence of a fire of a silo are:

- silos motor drives must have thermal protection;
- chain conveyors must have full load protection and disconnection protection in case of chain failure;

- elevators must have protection for disconnection in the event of overload or bursting of the tape;
- all chambers must have temperature sensors;
- the seeds must be dried prior to storage; the moisture content should be between 15.5% and 17.5%;
- it is necessary to prevent grain moistening due to defective construction of silos or poor thermal insulation and hydro-isolation;
- do not store the seed of unequal moisture in the same silo chamber;
- do not store warm seed in cold silo chambers;
- do not ventilate the seeds with high humidity air [10].

6. TOTAL NUMBER OF FIRES AND FIRES OF SILOS IN THE SOUTH-BAČKA DISTRICT FOR THE PERIOD 2014 - 2018

For more successful fire fighting it is necessary to eliminate their causes. Eliminating the cause of the fire implies knowledge of its emergence, i.e. how and where it appears. Answers to these questions are provided by fire analysis, and on the basis of statistical data on the causes of fire, expert processing is carried out in order to take the necessary preventive measures.

On the basis of the records on fire fighting interventions in the period 2014-2018, in the territory of the South Bačka Administrative District, data for total fires and fires of silos were shown, Table 1. The total number of fires for the observed five years amounted to 9,641, while there were only 10 fires of silos, indicating that the fires of silos are not as present as others. There were most fires in 2017, as many as 2,500 fires [11]. Summer of 2017 was warm and extremely hot, with five heat waves, so it is not surprising that in 2017 there were most fires, although high atmospheric temperatures do not always have to be responsible for the occurrence of fire [12].

When it comes to fires of silos, there is an impression of their insignificant representation in the total number of fires. The facts presented this way could indicate that the preventive measures were implemented to the maximum and that this is the reason for such favourable numbers. However, if the data on the total number of silos in the territory of the South Bačka District were available, so that the participation of those which were burning would be calculated, the numbers would probably not be negligible. It would also be interesting to see the financial outcomes of these fires. Bearing in mind the importance of moisture to microbiological processes in silos, it should be said that 2016, with 6 fires of silos, was rainy in comparison with the reference period 1981-2010, and 2014, with 3 fires of silos, was extremely rainy in relation on the reference period 1961-1990. While the raining amount in a year positively correlates with the fires of silos, it is obvious that it correlates negatively with the total number of fires that were least in the mentioned two years [13].

Table 1 – Fires of silos and total number of fires for the period 2014-2018

Year	Total number of fires	Fires of silos	Fires of silos a year/period [%]
2014	1536	3	0.20
2015	1806	1	0.06
2016	1609	6	0.37
2017	2500	0	0
2018	2190	0	0
Total	9641	10	0.10

When looking at the data on the representation of the method of causing total number of fires, Table 2, it can be noticed that the cause of most numbers of fires was undetermined (even 8,912), then fire caused by negligence (490), deliberately (250), child negligence (13) and natural phenomenon (6). The finding that there is such a large number/percentage of fires of an unknown cause is worrisome. This clearly points to the fact that not enough attention is given to fire problematic, especially fire prevention. The maximum application of currently available knowledge of fire prevention, accompanied by adequate and effective legislation, as well as constant analysis of statistical data from the field, is the only way to improve the current bad situation in this field.

Table 2 - Distribution of fire according to the cause for the period 2014-2018

Year	Fire caused by									
	Deliberately	Deliberately [%]	Negligence	Negligence [%]	Child negligence	Child negligence [%]	Natural phenomenon	Natural phenomenon [%]	Undetermined	Undetermined [%]
2014	45	2.82	85	5.53	4	0.26	2	0.13	1404	91.40
2015	62	3.43	127	7.03	2	0.11	2	0.11	1616	89.48
2016	46	2.86	102	6.34	2	0.12	1	0.06	1464	90.99
2017	46	1.84	98	3.92	3	0.12	0	0	2362	94.48
2018	51	2.33	78	3.56	2	0.09	1	0.05	2066	94.34
Total	250	2.59	490	5.08	13	0.13	6	0.06	8912	92.44

7. CONCLUSION

The paper presents fires of silos and total number of fires in the South Bačka Administrative District for the period 2014-2018. The reasons for the occurrence of fires of silos have been described and detailed previously. The number of fires of silos in the observed period is negligible in relation to the total number of fires, which would give the impression that the maximum level of prevention and protection has been achieved. However, due to the lack of data on the total number of silos and the resulting material damage, the displayed data should be interpreted responsibly.

A surprisingly large number of fires of undetermined cause commits to greater engagement in the area of preventive, curative, legislative, and primarily permanent education, both of the general population and personnel involved in these jobs. The Higher Education Technical School of Professional Studies in Novi Sad, with 50 years of tradition in this field, and 60 years of existence, sees its place and role here. Especially having in mind their graduates from the master programme in Protection Engineering, from whom not only is it expected to perform their tasks professionally, but also to have a proactive attitude and leadership role in all aspects of protection in the Republic of Serbia and beyond.

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THE USE OF MATHEMATICAL MODELING FOR DETERIMG THE BUDGET OF A FOREST FIRE PREVENTION CAMPAIGN

Abstract: Every year in the region of Balkans, forest fires causelarge damages of the environment of countries and big financial losses of their economies. In order to act preventively, it is necessary that local governments conduct campaigns to educate the population about the risk factors for occurrence of forest fires, as well as the education of new members of voluntary fire brigades. In addition, it is also necessary to invest in firefighting equipment. The height of the budget of such campaigns depends on many factors such as: the percentage of area under forest, the percentage of rural population (living near the forests) and their habits, climatic conditions, terrain configuration, etc. This paper presents a mathematical model for the calculation of the funds that would be preferable to invest in a campaign to reduce the frequency of forest fireoccurrence. The mathematical model is created on the basis of the aforementioned factors using Fuzzy logics.

Keywords: mathematical modeling, fuzzy mathematics, forest fire prevention campaign, campaign budget, forest fire factors

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1. INTRODUCTION

Forest fires are very common in the period of May 1-st to September 15-th in the region of Western Balcanes. Almost every country has significant finacial losses caused by forest fires every year. According to 0, during the period 2007-2016, in Serbia were 992 forest fires. Serbia lost 20 399 ha of forest in those wildfires. In total 119 046 $m^3$of wood was burnt in those fires. If we consider the finantial loss, then we deal with a price of 35 €/m^3 for firewood (cheapest option) to 50 mm wide oak (1000 €/m^3) or beech (400 €/m^3) boards multiplied by the number of m^3 of burnt wood. Besides, there are additional firefighting costs, ground rehabilitation and afforestation costs, too. So it is clear that it is worth for the goverment to undertake forest fire prevention campains to decrease the number of forest fires and environmental and finantial losses. Such a campain could include:informing and education of people about the risk factors for forest fire occurence, eduaction of people about forest fire prevention, increasing the number of voluntary fire department members and their education, and the investment in fire exitinguishing equippment, etc.

This paper is devoted to the use of Fuzzy Logics in creating a mathematical model for determing the budget of a forest fire prevention campaign. The main goal is to calculate the ammount of money which a government of a region should invest in a forest fire prevention campaign in order to decrease the financial losses caused by wildfires. Section 2. explains the essentials of Fuzzy Logics. Section 3 provides an example of the model for calculating the budget of a forest fire preventing campaign using Fuzzy Logics and its brief description.

1. FUZZY LOGICS

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Table 2- Fuzzy set opeartors

Intersection $\mu_{A\cap B}(x)$	Union $\mu_{A\cup B}(x)$	Complement $\mu_{\bar{A}}(x)$
$min(\mu_A(x),\mu_B(x))$	$max(\mu_A(x),\mu_B(x))$	$1-\mu_A(x)$

Phase 2: **Fuzzy inference** consists in defining Fuzzy rules according to the knowledge in the observed area. Such rules are in the *If-Then* form.Based on this rules, we define Fuzzy output values of variables.

Phase 3: **Deffuzification** consists in obtaining numerical output data from the system.

2. THE USE OF FUZZY LOGICS IN CALCULATING A FOREST FIREPREVENTION CAMPAIGN BUDGET

There are several factors which should be considered in a forest fire prevention campaignbudget model. A very important factor is the percentage of village households, since villages are near forests and human factor is the most common cause of forest fires. According to 0, the percentage of village households in Serbia is 41.Besides, the percentage of area under forestis also very important. In our case, the Republic of Serbia has 27% of area under forest, 0.According to 0,0,0,0,0, there are several other important factors listed below to be considered when calculating a budget for a forest fire prevention campaign.

1. Frequently high temperatures
2. Frequently strong wind
3. Dry zone
4. Frequently lightning strikes
5. Inaccessible terrain
6. Flammable trees (conifers)
7. The area is often visited by campers
8. People often burn garbage in their jards
9. A low number of firestrikers
10. Poor firestrike equpiment

Let us start explaining the forest fire prevention campaignbudget model. All calculations and graphics in our model are performed by coding in the*Wolfram Mathematica* software, 0.For the purpose of the model, let us define three linguistic input variables with their corresponding Fuzzy sets: '% of village households' (small, medium, big), 'number of forest fire factors' (low, high), '% of area under forest' (low, high), and the output variable 'budget' (small, medium, big). The graphics of the membership functions of the input and output variables are given in Fig. 1. The code for obtaining the membership function graphic for the '% of village households' is shown at Fig. 2, whereas the other graphics can be obtained very similar. The corresponding Fuzzy rules are given in Table 2. As already mentioned, the Fuzzy rules are in the form *If-Then*. For example, *Rule 1* reads as:

If the percentage of village households is small and the number of forest fire factors is low and the percentage of area under forest is small, then the bugdet for the forest fire prevention campaign is small.

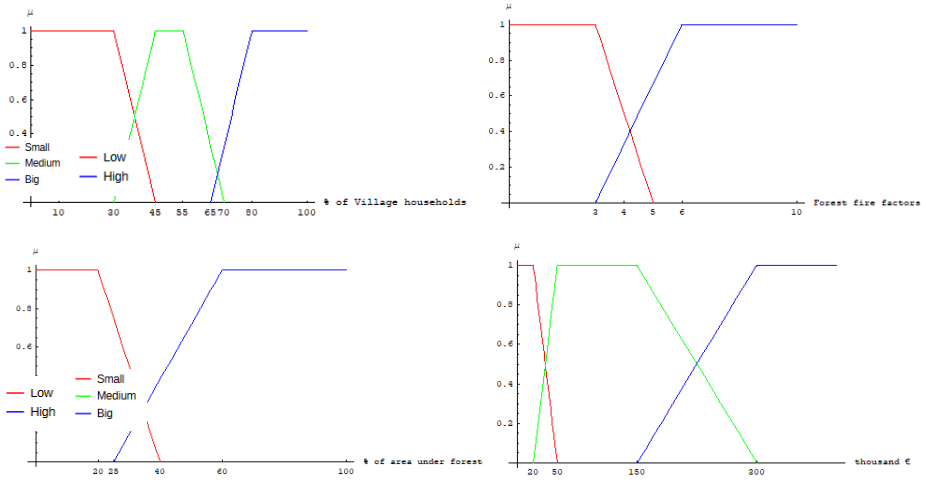

Figure7 – Input and output variable membership functions

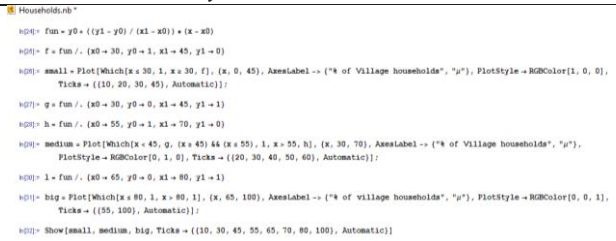

Table 2- Fuzzy rules

No.	% of village households	Number of forest fire factors	% of area under forest	Budget
1.	Small	low	low	small
2.	small	low	high	small
3.	small	high	low	small
4.	small	high	high	medium
5.	medium	low	low	small
6.	medium	low	high	medium
7.	medium	high	low	medium
8.	medium	high	high	big
9.	big	low	low	medium
10.	big	low	high	big
11.	big	high	low	big
12.	big	high	high	big

Now, let us determine the campaign budget for the Republic of Serbia if we know the following facts:

% of village households :41

Number of forest fire factors :7

% of area under forest : 27

First, we haveto determine the membership function values for the above given data. For that purpose, we can use the code shown at Fig. 3, below. Note that the code corresponds to the '% of village households' variable, whereas the memebership function values for the other variables can be obtained very similar.

```
membership_small = f /. x → 41 // N

0.266667

membership_medium = g /. x → 41 // N

0.733333
```

Figure3 – The code for determining membership function values

This gives the following memebership function values:

% of village households : [0.26(small) ; 0.73(medium) ; 0 (big)]

Number of forest fire factors :7 [0 (low); 1 (high)]

% of area under forest : [0.65 (low) ; 0.057 (high)]

As we can see from Table 2, we have four Fuzzy rules that devote to our case: 3,4. 7 and 8. The given rules consist of a conjuction of three conditions, so we take the minimum of the three memebership function values of the variables, as alerady explained by Table 1.

Rule 3: small budget $0.26 \wedge 1 \wedge 0.65 = 0.26$

Rule 4: medium budget $0.26 \wedge 1 \wedge 0.057 = 0.057$

Rule 7:medium budget $0.73 \wedge 1 \wedge 0.65 = 0.65$

Rule 8: big budget $0.73 \wedge 1 \wedge 0.057 = 0.057$

Sincewe have two rules which give a medium budget, we have to determine thedisjunctionof the two values: Medium budget: $0.057 \vee 0.65 = 0.65$.

Now we have the following values of all three variables:

Small budget: 0.26

Medium budget: 0.65

Big budget: 0.057

At the end, we have to perform the deffuzification step by using following formulae:

$$Budget = \frac{\Sigma[MV_i \cdot FMV_i]}{\Sigma[MV_i]}, \quad (1)$$

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 shapes 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 shape of the membership function, we take the average value of all values with the full membership of the set. For example, in our case, the membership function of 'small budget' is Z shaped, 'medium budget' is T shaped, whereas 'big budget' is S shaped.Thus, using the code from Fig.4 gives us the value of the budget.

```
In[21]:= budget = (20 * 0.26 + 100 * 0.65 + 300 * 0.057) / (0.26 + 0.65 + 0.057) // N
Out[21]= 90.2792
In[22]:= Round[%]
Out[22]= 90
```

Figure4 – The code for the deffuzification step

Here *Round* [%] rounds the obtained result. Hence we obtain that the desired budget is approximately 90 000€.

3. CONCLUSIONS

The Fuzzy model presented in the previous section has shown that a country like Serbia, with a medium percentage of village households, with a high number of forest fire occurrence

factors and a low percentage of area under forest needs a medium budget for a forest fire prevention campaign. This model can easily be extened in order to include even more factors that could influence the occurrence of forest fires. Also, a similar model can be used to calculate the budget of prevention campaigns for other types of fires.

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FIRE SAFETY AND EVACUATION IN INDUSTRIAL FACILITIES – CASE STUDY OF COMPLEX "JAT TEHNIKA"

Abstract: The greater understanding of the issues and dialogue between the varieties of disciplines can help the industrial facilities be safer and more sustainable. Fire safety and technological development has common interest in making sure that fire protection is achieved in most effective way. This paper argues the need for standardization of evacuation plans in facilities of industrial complexes. The research is based on a review of the role of evacuation plans made in accordance with ISO 23601: 2009 for "JAT Tehnika", as well as the role of warning signs and other warning methods.

Key words:evacuation, industrial facilities, fire safety,escape plans, standardization

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1. INTRODUCTION

Fires have always been a major threat to human lives, as well as to built and unbuilt structure. Threats are increasing along with the increase in the number of people living and working in growing facilities. People involved in fire safety and security need to know and anticipate how fire behaves so that they can apply appropriate safety and hazard analysis.

When a fire occurs, the safety of the affected depends on their preparedness and the performance of the escape routes, which, if they are smoke and fire-proof, can be successfully evacuated. The readiness of the users of the facility depends to a large extent on the knowledge acquired and the observance of the instructions for dealing with emergencies, but human behavior cannot be completely predicted because it is based on the psychology of the behavioral process. [1]

Escape plans are an integral part of a facility's system of safety signs and play an integral role in a building owner's fire safety management plan. But there is more, as escape plans are an essential component of the communications with guests and visitors and if managed properly a smart way to create feelings of safety and comfort.

2. SAFETY IDENTIFICATION – ESCAPE AND EVACUATION PLAN SIGNS

The International Organization for Standardization (ISO) is an international standard-setting body composed of representatives from various national standards organizations. The work work of preparing Internation Standards is normally carried out through ISO technical committees. ISO 23601 was prepared by Tecnical Committee ISO/TC 145 Graphical symbols, Subcommittee SC2, Safety identification, signs, shapes, symbols and colours.

ISO 23601:2009 establishes design principles for displayed escape plans that contain information relevant to fire safety, escape, evacuation and rescue of the facility's occupants. These plans may also be used by intervention forces in case of emergency. It has already been widely adopted throughout Europe and Worldwide.

Any escape plan should be designed in accordance with the evacuation strategy of the facility to addresses specific needs. An example of the design criteria includes:

- The exact location of the user shall be indicated on the escape plan;
- All defined areas and floor plan details shall be illustrated consistently;
- Standard ISO/EN safety signs to identify safe condition and fire-fighting equipment;
- The minimum size of an escape plan shall be A3 and A4 in rooms;
- Assembly points as part of the escape plan and should be identified; and
- Escape plans shall be up to date.[2]

This type of preparation has proven to be very successful for smaller establishments, mainly in restaurants and hotels. (Figure 1)

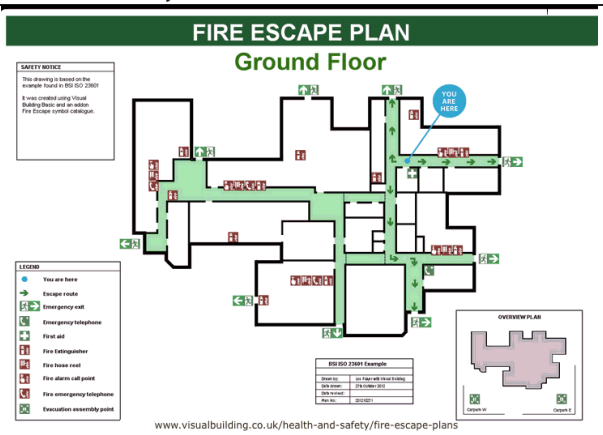

Figure8 – Fire escape plan, ISO 23601:2009

However, in large industrial complexes, these plans, regardless of the design and size of the plan, appear to be insufficiently legible due to too much information presented in one place. (Figure 2)

Figure9 – Fire escape plan in JAT Tehnika, BSS 2019

If some kind of redesign were to be implemented, the plans could be legible, but in such situations they seem actually unnecessary. Industrial complexes are rarely visited by people who are not employed by them, that is, people who do not know the space. For visitors to such facilities, light signs and other safety signs pointing to an evacuation exit as well as equipment used for extinguishing fire are more important, assuming that visitors are trained to use it. This paper argues that organizing employees within the complex is actually a better way to prevent injury to people if a fire occurs.

3. PROGRAM AND PLAN MAINTENANCE

Evacuation plans are intended to assist emergency responders in implementing flexible and scalable procedures and methodologies for addressing a range of emergency conditions that occur in isolation or as part of a larger, multi-entity response initiative.

A critical element of all evacuation planning is the identification of the organizational structure. Protocols set forth in any evacuation plan derive from the roles and responsibilities contained within the organizational structure.

Although there may be some incidents that involve only those personnel on-site at the facility; when an evacuation of the facility is required, the local community becomes a part of the response structure. In order to provide awareness of plan details and ensure the appropriate participation by all stakeholders, local adoption of or formal agreement to the plan is recommended.

The Evacuation Plan will be maintained, reviewed, and updated following the preparedness cycle: Plan, Train, Exercise/Respond, Evaluate and Mitigate. All stakeholders should participate in all phases of this cycle to ensure the plan reflects the current operational strategies, organizational sand methodologies utilized by response personnel. Following each event, training, or incident an evaluation of all response actions and in-place mitigation measures should be performed. This will allow for the identification of areas to be sustained, improved, or added enhancing the facility's overall preparedness. [3]

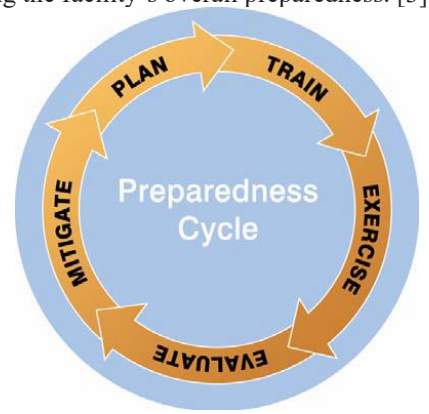

Figure 3 – Preparedness cycle, NASCAR Mass Evacuation Planning Guide

4. CONCLUSION

Emergency evacuation plans are developed to ensure the safest and most efficient evacuation time of all expected residents of anobject. Evacuation plans are designed to familiarize the occupants with the fastest evacuation routes, the location of fire extinguishing equipment, and safe gathering places outside the facility. Industrial facilities are larger in size and their users are mostly employed within the complex and familiar with the structure of the facilities. Plans should be larger in scale so that they are readable to first-time site visitors who are unfamiliar with their organization. In addition to the Evacuation Plans, other signs marking the evacuation routes are required. Most importantly, employees within the complex are

familiar with the Evacuation Plan should a fire or other emergency occur. Experts need to plan evacuations and train and exercise occupants of the facility in what is the safest way to evacuate from the facility and complex, thus preparing and ensuring that no injuries occur to people caught in the facility in the event of a fire and other emergencies.

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FIRE AND LIFE SAFETY IN HOTELS – CASE STUDY *COURTYARD* BY MARRIOTT, BANJA LUKA

Abstract: First part of the paper is dedicated to general introduction to hotel fire and life safety in global and local context. The case study will show the design challenges and learning opportunities when it comes to fire and life safety in high-rise hotels. Besides demanding technical design of facilities and installations, design for hotel Courtyard in Banja Luka had to comply both with local building code and Courtyard by Marriott Standard; Module 14 – Fire protection and life safety, which were sometimes in collision, and as such, a great example for comparative analysis. Integrated safety engineering implies that all facilities are intertwined and working together simultaneously as one organism: fire detection and alarm, extinguishing (sprinkler, portable extinguishers, hydrants), back-up power, emergency lighting, kitchen hoods, smoke control, evacuation – means of egress, as well as the PFP (passive fire protection).

Key words: fire safety, evacuation, hotel, Courtyard, Banja Luka, integrated safety

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1. INTRODUCTION

5.1. Hotel Fire and life safety (FLS) - review

In the UNWTO (World Tourism Organizaton) Tourism Highlights for 2018 it's stated that tourism is the world's third largest export category with total international tourist movement of 1,326 milion, which shows the growth of 7% in 2017, the highest increase since 2009 global economic crisis and bell above UNWTO's long-term predicted forecast of 3.8% per year for the period of 2010-2020. [1] Simply put, in 2020 we will be looking at much larger numbers than predicted 1,600 milion travelers.

Regarding these numbers, hotels and motels are becoming increasingly important subjects of research and innovation in fields of design, applied technology, managment, efficiency and overall safety. Also, given the sheer number of people who either visit or work in a hotels around the globe, the safety of the hotel constitutes an area of high importance to both consumers and hotel owners. Fire safety in hotels must be viewed as a factor of competitiveness on this rapidly growing market, because clients value highly a hotel's general safety standards, an issue that often makes a difference when it comes to choosing their holiday destination.

The different risks and threats that the consumers may experience in European hotels have not changed since the adoption of the *1986 Council Recommendation on fire safety in existing hotels*. Technological developments and increasing awareness of the risks have however decreased the probability of accidents and injuries [2]. Fire is still seen as the biggest risk, as it can potentially lead to a high number of casualties. The large amount of contemporary instalations, as well as the increased use of inflammable material, such as plastic and fabric, in the interior of hotels increases the risk of fire related accidents.

Statistics show that perhaps fire safety needs to be given greater priority by some hotel owners and chains. An average of one in every 12 hotels in the US reported a fire every year and an estimated average of 3,700 structure fires in hotels and motels is reported annually, resulting in associated yearly loss of 12 deaths and injury to 143 other people [3]. In an analysis of the causes of fires in hotels during the period 2002–2005, the NFPA revealed that 37% of them originated in the kitchens, 12% in the heating system and 10% in drying and washing systems. However, in an analysis of economic losses, the highest percentage of fires, 33%, were started deliberately, 9% were caused by electric systems, 8% by heating systems and 6% by cigarettes [4].

NFPA reports also show that the majority of civilian deaths in a hotel fire result from fires that started in the bedroom.

5.2. Hotel – specific fire risks

Hotel lobby is a busy place, we can even argue it is a public space – huge number of people pass through it every day: guests, restoraunt&bar visitors, staff, suppliers, conference attendees, etc. Hotels can be defined as residential occupancies that are primarily transient in nature.

- Most occupants have little or no familiarity with the building

- Sleeping occupants are unaware of the developing fire
- When awakened and alerted to the emergency, occupants might be confused and prone to panic

In cases of fires in guest areas, especially rooms, typical hotel building configurations often require escaping guests to traverse an interior corridor.

- Danger of suffocation due to exposure to heat and smoke in corridors

In modern hotels we can find apartments serving certain long-staying guests residing for months or years. In those cases, the apartments are equipt with pantries or kitchenette equipment for minor cooking.

- Unattended cooking process in hotel room may lead to fire accidents
- Malfunction in electrical appliences in rooms (heaters, kettles, hairdryers)

Laundry facilities in hotels are equipped with many factory like large electrical and mechanical installations such as folding machines, flatwork ironers, pressers, compressors, dry cleaning machines, washers, etc. (Hung, 2006)

- Presence of chemicals and large exaust volumes increases the risk of fire accidents
- Poor maintance and the dust on motor surfaces can cause ignition due to overheating

Contemporary hotels host various types of mass events in *front of the house* - lobbies, restaurants and conference halls such as brunches, coctails and celebrations, as well as major bussines meetings, product launching or conferences.

- Sudden gathering of a large crowd of people inside and outside of hotel can potentially be dangerous in emergency situautions.
- Without efficient crowd control, panic during evacuation of mass events can lead to non-fire related injuries (cuts and lacerations, broken bones, concussion, sprains, etc)

Hotels operate 24 hours daily for the year around. This is a main outstanding difference compared to other bussiness or public buildings. The additional load on all the systems and facilities caused by the neccessity to be operational around the clock requires a qualified maintance team that would handle any situations without endangering the fire safety standard.

6. CASE STUDY - HOTEL COURTYARD BY MARRIOTT

Courtyard by Marriott is a brand of hotels owned by Marriott International. The franchise opened in Banja Luka during summer 2019 as a first contemporary four star branded hotel which is oriented toward business users in that region.

The hotel has surface of 1282 m^2, features 118 rooms, a conference hall with around 200 seats, a restaurant, a wellness facility, a fitness gym and other features proscribed by this hotel chain's strict standards. Marriott International corporate standard must be used in every aspect of the design process, including the Module 14 – Fire and life safety (FLS), and hotel must be approved by an authorized FLS expert as a condition for the opening. At the same time, the object must fulfill national fire safety legislative of Republika Srpska.

6.1. Fire safety in corporate chains

In constant market fluctuations, some hotel owners find themselves faced with a dillema – spend more on safety of the customer regardless of cost, or keep the expenditure to a minimum in order to maximize profits? The latter approach can result in investment made in fire safety meeting only the minimum requirements of the national legislation. Others continue to meet rising expectations and demands of their corporate customers.

Authors mention the statistic where travel managers insist on the highest safety standards, with 25% refusing to book rooms with hotels that do not have the highest standards of fire protection for their guests [5]. We can conclude that the matter of safety is at the same time a matter of profit.

Brands such as Courtyard by Marriott operating across the globe face even bigger problems when dealing with fire safety:

- In different countries throughout the world the design, implementation, use and maintaince of fire protection systems is under the jurisdiction of many different regulatory authorities and their standards.

Constantly improving technology available and inconsistent legislative requirements in FLS makes simple adherence to the appropriate standards difficult. To tackle this inconsistency, global hotel chains adopted corporate FLS standards based on automatic detection and alarm, integrated with all other systems.

- These standards have to be sufficiently high in order to be competitive with all the diverse national regulatory differences affecting their hotels.

6.2. Marriott International COURTYARD standard and its implementation in Banja Luka

Goals of every firefighting are, in the following order – life safety, property protection and continuity of operation. The basic strategy is to provide occupant warning in case of fire and limit fire and smoke spread by carefully selecting the materials used in interior, providing proper compartmentation and smoke control.

Courtyard in Banja Luka is a renovation/adaptation of an existing structure intended for non-brand hotel, which further complicates the application of the standard in terms of egress path lengths, remote distance between stairs, width of the stairs, dimensions of utility shafts – some elements essential to FLS concept could not be changed since were already a part of built structure. This was extremely challenging task because it required a sequence of operations:

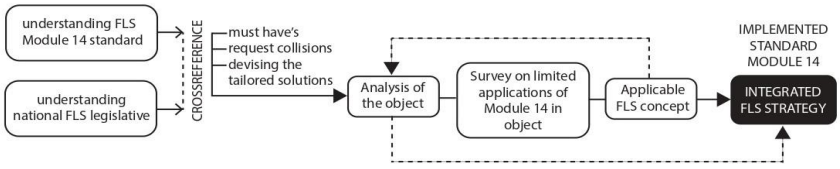

Figure 1 – FLS concept design process for Courtyard by Marriott, Banja Luka; an algorithm (authors)

As shown in the Figure 1, the process required constant review of the solution and the return of the analytical part. The integrated FLS strategy in hotel Courtyard implies:

6.2.1. Risk factor, such as the occupancy load factor (OLF) and the fire load density (FLD)

Occupancy loads are a very usefull tool when dealing with renovation/adaptation projects. Some spaces in this hotel weren't according to standard requests in dimension-function relation, so maximum occupancy load restriction was used in these spaces to avoid correctional construction works.

6.2.2.Passive fire protection (PFP)

Fire safety for any kind of object should be focused on prevention. PFP form a major part of the hotel construction and structure againts the effect of fire. Aim of this approach is to secure fire prevention, safe means of egress for all occupants, provide basic safety for the firefighters.

- **Well-maintained fire compartmentation** confines fire and smoke to a limited area in the building.

Every floor forms a single fire compartment, as well as the each occupancy type / function area. High-risk areas such as server rooms, electrical rooms, laundry, technical rooms, storages etc. are located in separate fire compartments. Safe means of egress are enclosed by fire rated walls and doors. Vertical openings (stairs, elevators, utility shafts) are enclosed by fire rated walls and doors.

- **Safe means of egress**

In order to protect people against toxic effects and heat impact of smoke resulting from a fire, only a limited evacuation distance is allowed through which one can be exposed. After this evacuation distance, people should be able to evacuate through safe means of egress to the outside. Safe means of egress are separated from the rest of the building by walls and doors with sufficient fire rating.

- **Interior finish**

The provision of safe evacuation routes is one of the more important life safety aspects in hotel buildings. A correct choice of interior finish materials in in these routes, hallways and public places is a key aspect to reach this goal.

- **Sealing of openings**

All other openings (cables and cable trays, plastic or metal pipes) should be sealed with a material that provides a fire rating equal to the fire rating of the wall. These materials must have an approved certification.

6.2.3. Fire safety instalations

- **Fire detection**

Automatic fire detection system is instaled throughout hotel, even in rooms where national legislative doesn't require detection (bathrooms, roomservice storage, etc). Upon receiving a detection, FACP (fire alarm controled panel) starts series of executive functions towards other systems in goal to work simultaneously (for example it closes all the fire rated doors on electro-magnetic hold devices, shuts down the elevators, etc). Fire detection has following components: smoke and gas detectors, alarm sirens and speakers, voice notification signal and flash strobes for hearing-impaired guests.

- **Agregate**

Main power is shutting down and back-up diesel agregate is powering all the emergency systems. This transition mustn't be longer than 10 sec.

- **Smoke control system**

Upon the alarm signal, ventialtion shuts down and fire dampers are automatically closing. Smoke control system extractes smoke from egress routes while simultainously provides fresh air. Pressurization system in stairwells induces large volumetries of air in short time period thus creating an overpressure of at least 50 Pa that keeps the smoke out of the safe egress path (not more than 100 Pa, because it creates a difficulty while opening the door).

- **Emergency signage**

All exits should be well marked: signage should be provided above the exit doors and directional signs should be installed judiciously throughout the building. The signs should be illuminated by dedicated emergency lighting provided from the back up agregate. Due to the often wide variety in nationality of hotel guests, it is recommended to install internationally accepted evacuation pictograms. In addition to the signage along the evacuation routes, a floor diagram shall be posted on every guest room door with information on: actual floor arrangement, exit locations, location of fire extinguishers and hose reels, procedures in case of an emergency (in local language and English).

- **Fire supression**

The objective of a fire suppression system is to control or extinguish the fire in its early stage. These means of suppression can be manual (fire extinguishers, hose reels) or automatic (sprinkler systems, gas extinguishing systems, etc.) Courtyard has both manual and automatic systems instaled, with the fact that automatic ones aren't accepted durring FLS Marriott inspection because it wasn't an equipment from an approved vendor in Module 14 FLS standard. Even with sprinkler, this hotel was treated as high-rise non-sprinkled during the test.

6.2.4. Fire safety managment

The FLS managment incorporates the supervision of whole fire safety concept during the design, construction and operation of the hotel.

Driven by the market and insurance companies, the hotel industry is currently placing a strong focus on risk prevention. In general, most hotels today will take neccessary organizational measures to deal with fire alarms. These include various steps – from providing a fire officers among staff, to the most detailed guidelines for any possible evacuation. Nevertheless, personnel measures alone, cannot be depended on to deal with all of the critical needs for a successful emergency evacuation. As a reinforcement, the use of technology helps companies overcome the 'human factor' in the fire safety challenge. It is of great assistance

and has an increasing role to play. This is an area in which the whole hotel industry can cooperate with and learn from other industries, in order to ensure efficient incident management. Also, consulting services of relevant engineers should be requested as well as regular system controls. [6]

7. CONCLUSSION

One way that these other industries are dealing with the issue is by installing solutions which empower response processes to be automated. Apart from the wxtinguishing szstems, it is becoming progressively more frequent for fire detection systems to be integrated with emergency lighting, voice alarm and massnotification systems along with the building management systems - to control smoke extraction, fire doors and lifts in development of any potentially dangerous occasion.

Aforesaid integrated systems are programmed to automatically deliver clear, step-by-step instructions for what to do in case of an emergency: with whom to make contact, where to seek escape and where to assemble. Every significant alarm and lighting systems will automatically become activated, in order to instruct every individual involved precisely what to do next. The other industries have displayed that it is essential to abandon the traditional ground of fire safety technology and slowly move in the direction of a more integrated systems.

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SIMULATION ON BUILDING EVACUATION

A CASE OF AN ELEMENTARY SCHOOL IN TIRANA

Abstract: Building Evacuation modeling is a new concept in Albania. Within this context, in this paper is introduced a building evacuation through computational simulation. In particular, the completed evacuation time is assessed for occupants of an elementary school when going into evacuation circumstances. The simulation is done using Pathfinder software.

Besides, in Albania, there is a lack of available data and theory in a school building environment on occupant behavior for use by evacuation models to estimate evacuation time results and their uncertainty. For this purpose, a literature review is done to refine the concepts and outline certain actions possible to occur. The objective is to promote building evacuation modeling in Albania, both now and in years ahead.

Key words: child behavior, elementary school, evacuation, Pathfinder, simulation

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1. INTRODUCTION

1.1. Background

In most of the cases, the Albanian elementary school premises are not compliant with fire safety regulations or their initiative to the emergency is superficial [1]. The challenge here becomes to adapt the architectural or material design to safety standards to improve the building environment safety. Based on this, there is a need to evaluate different evacuation strategies [2]. However, a generalized practice within safety in the built environment is the use of design and construction norms and standards [3].

First, it is important to define the relation between evacuation processes and safe designs (specifically, in terms of fire safety) [4]. An essential point in occupant safety is the calculation of evacuation times. Evacuation time values are frequently associated to design criteria of buildings since its calculation is based on the architectural shape and dimensions of the building under consideration and because of its easiness of calculation [2].

The decision of the Council of Ministers VKM no.699, dated on 22.10.2004 [4] provides a complete list of the available normativity applicable to safety in the built environment only for tourist accommodation. According to this document, safe design of a building considers issues related to its location, shape, dimensions (e.g. emergency routes, doors, travel distances, capacity) but also construction materials and their dimensions [2] [5]. However, common international construction or design codes and standards are well-defined in Europe for all the building types [2].

Understanding and representing evacuee performance is a difficult and complicated task. The clue here is a comprehensive theory of human behavior in fire. Researchers have long been interested in explaining the process by which people respond to environmental cues or socially transmitted warnings about environmental hazards and disasters.

Such a comprehensive theory of human behavior in fire is the Protective Action Decision Model or PADM [6]. The model attempts to characterize the way people “typically” make decisions about adopting actions to protect against environmental hazards. The PADM provides a framework outlining the processes in which an individual engages in their attempt to achieve safety.

However, the literature review suggests that age is a critical factor that affects evacuation dynamics [7]. Children's decision-making ability is not as strong as that of adults due to differences in physiology, cognitive level, and social level.

This study was conducted as a group project on behalf of the ARCH 428 Evacuation Calculation Modeling course. The scope of present work is limited to the following considerations:

- To refine the concepts and outline certain actions possible to occur in Child behavior during the evacuation,
- To promote building evacuation modeling in Albania.

There have been a few studies that focus on child behavior during evacuation. However, the level of understanding of child evacuation dynamics is still relatively limited [7] [8]. One of this study, is the one conducted by Aldís Rún Lárusdóttir in Technical University of Denmark, Department of Civil Engineering [8]. This project comprises evacuation experiments in daycares for children 0-6 years old and elementary schools for children aged 6-

15 years. This study focuses on the descriptive analysis of child behaviors during evacuation. Behavioral facts and the main findings of this study include:

- Children are most comfortable with familiar people and routes.
- Children could also be seen following the adults and children form their group, throughout the evacuation where possible, indicating a preference.
- Young children only evacuated when an adult came to get them.
- Children tend to redirect to another exit or stair due to congestion.

The study concludes by stating that when designing buildings and evacuation procedures the age and the composition of the occupants should be considered to ensure their comfort in daily use and safety in emergency cases.

2. METHODOLOGY

2.1. A case of an Elementary School Building in Tirana

The chosen elementary school as a case study is located in Tirana. The school has a regular rectangular geometric shape. It is made of two floors and a partial ground floor. On floor 0 and 1 are positioned the auditorium, laboratories, offices, classrooms, libraries, etc. while the sports gym is located underground. The whole school is 3773 m^2 and has two main entrances. The floors are accessed between them by 2 main stairs. There is also a stair with the primary function of an emergency exit and an elevator.

The current protection against fire of the school is designed to cope with the current situation in two forms to extinguish fires case of emergency:

- Active fire protection,
- Passive fire protection.

An Emergency Evacuation Plan is also provided which includes the action to be taken by all in the event of a fire. The action takes the form of a simple fire action sign placed in visible positions. These signs indicate the direction that reassembles the behavior “Go to any exit”.

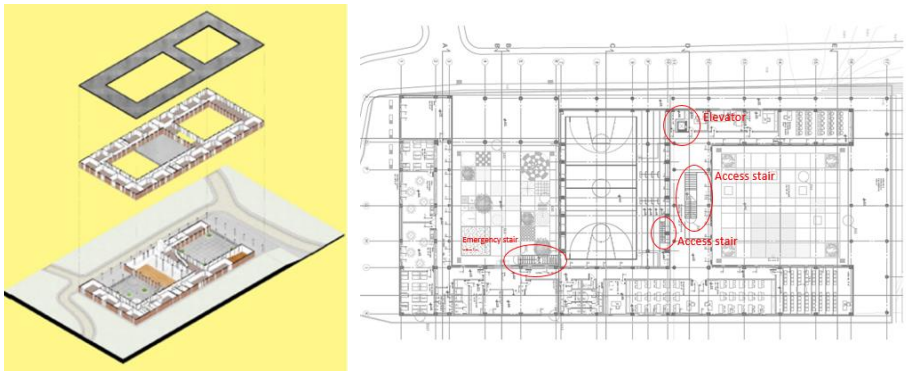

Figure 37 - Volumetry of the building (left); layout of the first floor (right).

2.2. Considerations

Before starting the simulation an evacuation framework must be set up. This framework as suggested by the literature review is shown in figure 2. Following this framework, the association "fire alarm signal = leave immediately", is not automatic for every situation. It is paramount to consider this time delay to start evacuation in assessing the risk to life in a building.

For calculation purpose of a total evacuation time, a delay time to start has to be calculated. A good reference here is the SFPE Handbook of Fire Protection Engineering [9]. Another consideration belongs to the pre-evacuation time which is the time that passes from when the alarm is raised until leaving the current room. Once the decision to evacuate is made, occupants will engage in other actions before leaving, such as getting dressed, gathering children, or finding valuables. After the perception-interpretation-action process has taken place, then the occupants will start to move.

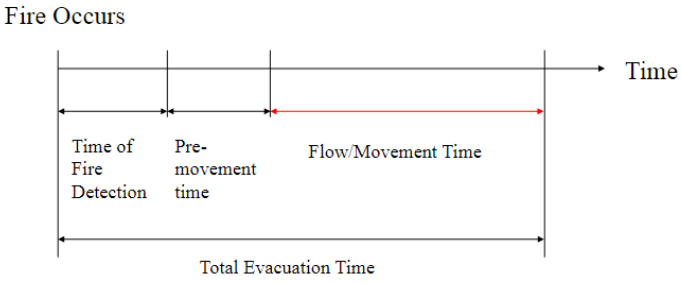

Figure 38 - A typical evacuation framework for a building.

Also, the optimal time concerning the daily routines must be chosen. Even though in reality an evacuation might be initialized at any time, an optimal time concerning the daily routines must be chosen for schools. Last but not least are the behavioral aspects. The main challenge here is to understand child behavior during evacuation.

2.2. Simulation with Pathfinder

The simulation is done using Pathfinder software. Main steps of simulation using Pathfinder are:

- Geometry: the creation and preparation of geometry of the chosen school for simulation were imported from Autodesk AutoCAD 2015 software. Adjustments are made to arrange the imported layouts into rooms for each floor and stairs are modeled to provide access between them. Also during this step, the doors are added as well. Occupants are added as well and the proper 3D model is assigned for them (Children and teachers in our case). The elevator is modeled too.

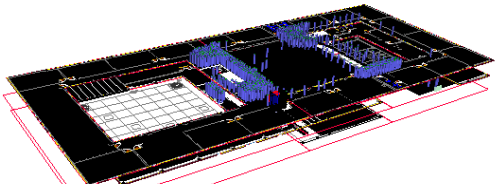

Figure 39 – Geometry of the simulated building.

- Model definition: behavioral aspects are assigned for the occupants.
- Run of the simulation.
- Post-processing: performing visualization and quantitative data analysis of the obtained results.

The model includes such input data as the optimal time concerning the daily routines, and the travel speed by following the framework on the figure 2. These input data affect the evacuation time by adding or subtracting times and are based on the study of recognized literature on the interaction of child behavior of evacuation and the fire in actual fire drills. The model also incorporates time delays due to voice alarm systems, sprinklers, compartmentation, etc. Input Parameters for Evacuation Simulation are described shortly in Table 1.

Table 4- Input Parameters for Evacuation Simulation

Time delay to start an evacuation	The optimal time concerning the daily routines	A commonly used free travel speed in the horizontal plane for children
For Schools = 240 s (Table 3-13.1, pg. 3.351, SFPE Handbook of Fire Protection Engineering) [9]	The simulation to be held around 10 am, at that time school almost all children are supposed to be in class with their teacher (859 occupants in total)	1.2-1.3 m/s [8]

To validate the model, behavioral characteristics are assigned to groups of the school population (children and teachers) by considering the most likely scenario to occur in the evacuation. For that purpose, the behavior is performed in the model in the form of actions, which are each associated with a delay time. In total, the model includes 3 possible scenarios:

- "Go to any exit! (By default)" (Scenario 1, Current Fire Emergency Evacuation Plan),
- "Familiar routes" (Scenario 2, Main Entries of the school),
- "Follow the teacher!" (Scenario 3, Children preference).

3. RESULTS AND DISCUSSION

Table 2 shows the obtained results for the 3 scenarios of the simulation.

Table 5 - Summary of the results for the 3 scenarios of the simulation.

Total Occupants	Behavior (scenario)	Max Completion time for all Occupants (s)	Traveled distance for all the Occupants (m)
859	Scenario 1: "Go to any exit!"	572,8	173.2
859	Scenario 2: "Familiar routes"	703.0	252.9
859	Scenario 3: "Follow the teacher!"	679.6	297.1

From table 2, the max completion time for all occupants is greater for scenario 2, "Familiar routes" in comparison with the two other scenarios. This may be related to the fact that the pre-evacuation time may be greater in this case because on this behavior the children indicate a decision then start to move.

Also, the max traveled distance for all the occupants belongs to scenario 3, "Follow the teacher!" in comparison with the two other scenarios. This may be related to the fact that the children instead of starting to move quickly they chose to follow a leader and after that, they move to the nearest exit. Another factor here may be related with the geometry of the building which incorporates long corridors up to the nearest stair or main exit.

Also, as we can see from figure 4, the number of occupants evacuating and their flow rates differ for each scenario. The main reason for these variations is the reaction and decision making which is conditional to the different behavior aspects for fire response.

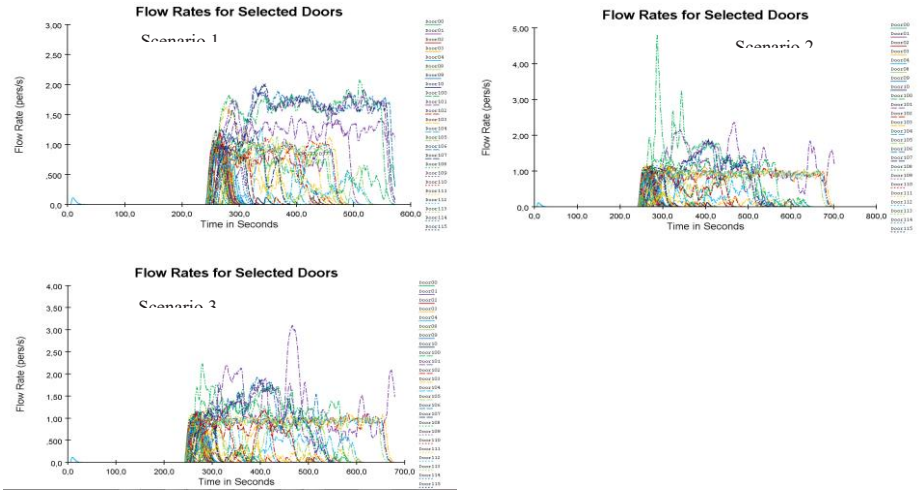

Figure 40 - The resulted plots for each of the scenario for the flowrates of all the doors of the school.

Another finding is related to the congestion points reflected on the occupant path in Figure 5. It is seen that doors and stairs are typical congestion points during evacuations.

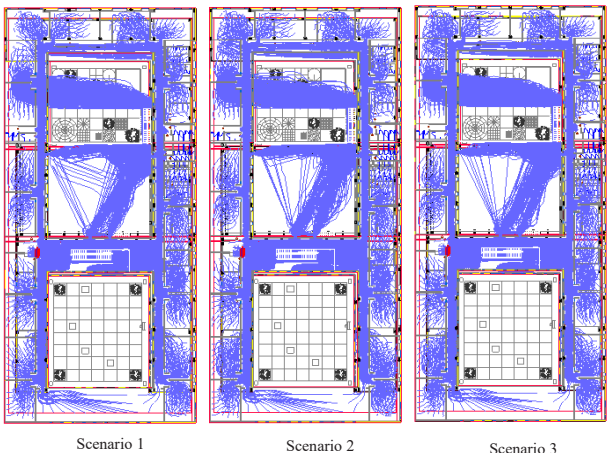

Figure 41 - The resulted plots for each of the scenarios for the occupant's trajectory during the evacuation at floor 1.

Using this observation, some improvement can be done in the architecture of the building, considering the addition of emergency stairs, so as the children in case of congestion can redirect and use another path.

4. CONCLUSIONS

This work provides an assessment of building evacuation modeling of an elementary school in Albania. The model provides a simulation of the evacuation by visually presenting the location of the children as a function of time. The simulation is done using Pathfinder software. Examples of the output include the number of people that have used an exit, the total evacuation time, the maximum traveled distance, and the visualization of congestion areas.

The main objective of this study is to bring focus to the topic of the evacuation of children and to provide new data and knowledge on children's evacuation in Albania. In this context, this work can serve as a guide for other specialists to consider while studying the safety of building with high occupancy like schools. The results indicate that Pathfinder can evaluate the efficiency of a school's evacuation and informing the school's administration about the problem areas in the evacuation process.

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PERCEPTION AND PREPAREDNESS FOR NATURAL DISASTERS. THE CASE OF THE STUDENTS OF THE UNIVERSITY OF TIRANA

Abstract: In the last decade Albania has witnessed a significant increase in the intensity and frequency of extreme weather events such as floods, droughts, earthquakes, fire which are expected to increase even further in a future warmer climate. Higher education institutions, in which a large number of people are exposed to, must provide a safe and nurturing environment to help academic and social development. With this increased emphasis on safety, it is imperative that higher education institutions understand their students' perceptions of disaster response and emergency.
The students' perceptions regarding emergency preparedness efforts and the preparedness of their faculties, which are part of University of Tirana have been examined through this study. The data were collected through 26 semi-structured interviews which were done with students of three out of six faculties that are part of University of Tirana. Findings of the study would recommend that UTA needs to establish a disaster management system to help its faculties to mitigate any natural risk and to provide comprehensive training and courses to widen the knowledge on managing disasters in order to inform/ prepare/ make students aware of how to response to such events.

Key words: natural disasters, students, perception, emergency preparedness

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1. INTRODUCTION

At colleges and universities across the world, millions of bright young minds regularly bask in a safe learning environment. But despite being a sanctuary for education, colleges and universities are just as vulnerable to disasters as anywhere else. Floods, earthquakes and other disasters can halt classes, disrupt campus life, damage buildings and leave students stranded with nowhere to go. In order not to encounter such a situation planning and preparation are indispensable. Although awareness of disasters has increased among some parts of society, the concept of disaster preparedness and response has not been sufficiently explored in universities. The aim of this paper is to assess the students' perceptions regarding disaster preparedness as well as to examine whether faculties of University of Tirana are prepared for disasters or not.

The risk of natural disasters continues to rise in the twenty-first century ([5], [13]). Herman (1963) described a disaster as an immediate, unexpected event that involves both danger and opportunity and provides a limited amount of time for administrative response. Natural disasters are very difficult to prevent, but that does not mean that no measures are to be taken in this respect. Effective risk communication and preparedness can help mitigate the effects of a disaster event. A disaster interrupts the normal operations of an organization and threatens the wellbeing of students ([5], [13]). In a study by Kapucu and Khosa (2013), only 35 % of colleges and universities in USA had mitigation plans that met federal guidelines. With the increased instances of disasters that characterize the twenty-first century, every higher education institution needs to make disaster response plans as an institutional priority ([1], [14]). Albania is ranked on a global scale as one of the countries with the greatest economic consequences caused by natural disasters. Its annual average losses are about 2.5% of its GDP [19]. Developing and implementing an efficient disaster risk management strategy also for Higher Education Institution is necessary in the light of preventing and mitigating disaster effects.

The students ' perceptions regarding emergency preparedness efforts and the preparedness of their faculties, which are part of University of Tirana have been examined through this study.

The first section of this paper will offer an overview of literature in the field of students' perception of natural disaster plans and emergency preparedness in universities. It will be proceeded with the presentation of the research methodology and its main results. The final part of the paper will link the results of the study with recommendations on the implementation of effective preparedness for natural disasters in University of Tirana.

The goal of this study was to provide a platform for students to share their perceptions and concerns about emergency plans in their respective faculties, part of University of Tirana. It was chosen a topic related with natural disasters experienced in the University, because it is the place in which students spend a considerable part of their everyday life. This is the reason why we are interested in the safety from natural disaster and emergency preparedness of this institution.

To that end, we hope that the findings of this study will be valuable for higher education administrators in terms of the analysis and improvement of current emergency management procedures.

2. A LITERATURE REVIEW OF STUDENTS' PERCEPTON ON NATURAL DISASTER PLANS AND EMERGENCY PREPAREDNESS IN UNIVERSITIES

Limited research has been conducted on the perceptions of university students regarding natural disaster preparedness within higher learning institutions (Sadiq & Weible, 2010; Schachter, 2006). A natural disaster was defined as a sudden and often unexpected natural event that interrupts the "normal operation of institutions or its educational mission and threatens [8] the well being of personal property and financial resources" [12].

In general terms, perception of risk can be considered as an interpretation or understanding that the individual gives to particular threats that could potentially cause loss of life or property [11]. Risk perception includes the process of collecting, selecting and interpreting signals about uncertain impacts of events, activities or technologies [16].

Research suggested that universities disasters could be grouped into three categories: environmental (natural), human, and facility ones ([12], [13]). The scope of this research utilized a case study format to investigate only issues that fall under the environmental (natural) category of university disasters.

For universities, the protection of the life and safety of students, faculty and staff should be a top priority. This is the reason why the concept of disaster preparedness and response should be in the center of attention of these institutions. Due to the fact that natural disasters continue to increase in the twenty-first century ([5], [13]), more than ever before, university and college students are recognizing the need to be better prepared for disasters. Students are becoming aware of the risks associated with emergencies either due to their experience or by having been informed through media. They have realized that disasters can damage homes, schools, businesses and ultimately cause long term damage to our countries' economies. Due to the increase in both the frequency and magnitude of natural disasters in recent years, it is essential to understand students' perceptions on disaster response plans and emergency preparedness efforts at higher education institutions ([1], [6], [7], [9]).

Understanding students' perceptions can not only serve to validate current practices, but could also help to update emergency response and disaster management systems at higher education institutions, thus enabling preparedness to save students' lives during natural disasters [3].

In a study by Kapucu and Khosa (2013), only 35 % of colleges and universities queried had emergency and mitigation plans that met federal guidelines. Kiernan (2005) pointed out that while higher education institutions have placed an increased importance on disaster preparedness, their plans are still inadequate.

It is recommended that universities should develop an emergency plan which provides the following essentials elements to cope with any disaster [4]:

- Action steps that give campus officials the roadmap of what to do depending on a crisis;
- The scope of the plan that explains the roles and responsibilities of staff and students at different stages;
- Communication methods including a communications center that will ensure effective information exchange;
- Recruitment of efficient staff with proper preparation for emergency management;
- Clarified media responsibilities to avoid misinformation
- Clarified roles for campus security and outside agencies

- Addressing the needs of vulnerable populations such as special needs of populations that might have certain disabilities or might experience language barriers.

Disaster management and emergency management plans must include four distinct phases: preparedness, response, recovery and mitigation efforts. As suggested by Mitroff et al. (2006), institutions must: - plan for a wide range of disaster types, - provide mechanisms for not only detecting but also communicating early warning signs of disaster, - include a collaborative disaster management team with a great deal of training experience,- incorporate internal and external stakeholders within all disaster plans and policies.

It is not enough to merely have a plan in place [14]. These plans must be continuously evaluated, challenged, adapted and communicated to students, staff, administrators. Communication during natural disasters is especially important for higher education institutions. Natural disasters can include a number of incidents occurring simultaneously, which creates a great deal of uncertainty. Effectively communicating information may help solidify operational procedures and collaborative efforts for emergency responders ([5], [7], [8])

Based on a review of the literature, it was concluded that higher education leadership in many Higher Education Institutions lacks inspirational motivation and idealized influence with regard to communicating disaster preparedness plans and emergency response procedures to students ([1], [3]).

An Emergency Response Plan predicates that those within the organization know what to do, where to go, and how to find and utilize the resources available to them during a disaster [14]. Research suggests that this information should be understood before the onset of a disaster ([14], [16]). A lack of communication and information sharing can be problematic for the response and recovery efforts of an organization [3]. Also it should be said that Emergency Response Plans become out of date quickly when there is a lack of activity [11]. Every year, there are new students enrolled in Universities who need to be informed on disaster preparedness of their institution.

3. RESEARCH QUESTIONS

The research questions of this study and qualitative research design were as follows:

- What are students' preceptions on natural disasters that might be experienced in their higher education institutional environment?
- To what extent does University of Tirana effectively communicate disaster response plans and emergency preparedness efforts to its students?

4. Methodology of the Study

Purposive sampling was the method for selection of study participants as it is a non-probability sampling technique used to recruit study participants from a specific predefined group, as suggested by Pettus-Davis, C., Grady, M. D., Cuddeback, G. S., & Scheyett, A. (2011).

With purposive selection (there were selected students from three faculties which are part of University of Tirana, Albania, it was made possible to gain access to a segment of its population in order to understand the problem and their perceptions and to shed light to the research questions. The purposive sample for this case study involved students chosen from Faculty of Economy, Faculty of Law and Faculty of Natural Sciences, which are all part of University of Tirana. 26 students were part of this study, the response rate is 100%, because all individuals who are asked for participation in the interview have given their approval and have become part of the study. A sampling division by faculty, gender and age is presented in Table 1.

Table 1. Sampling division by faculty, gender and age.

Faculty	Gender			Average age
	F	M	Total	Total
Faculty of Economy	18	2	20	23
Faculty of Law	3	1	4	24
Faculty of Natural Sciences	2	0	2	22
Total	23	3	26	23

- The students taking part in the study are divided into two categories with regard to background/information related with natural disasters: The first group consists of: - students of Faculty of Natural Sciences, who have been informed on natural disasters from Environmental Chemistry; - students of Scientfic Master in Risk Management.
- The second group consists of all other participants who have less information about natural disasters, because it is not part of their curricula.

This study have used qualitative data analysis. The data was collected through semi-structured interviews. With the aim of better understanding the behavior, perception and responses that the students have given, face-to-face interviews were conducted. (Flick, O. (2009) links the importance and success of semi-open face-to-face interviews with the fact that participants' views are more complete and clear as compared to a non-face-to-face questionnaire). A total of 26 semi-structured interviews were completed. The interview included 18 open questions, which were adapted from a questionnaire conducted at the University of Florida [3].
During the interview process there were often formulated additional questions related to the perception of students. Questions were open-ended and semi structured to help them answer the central research question. The questions which were asked to the participants where related with these topics: - personal data such as age, gender, number of years attended in UTA[12]; - type of knowledge/information about natural disasters, emergency preparedness plans; students' perception about risk of natural disasters in their higher education institution, area of their living in Tirana, and Albania; - participants' perception about the level of security and preparedness perceived by their faculties; - information, communication and awareness of emergency preparedness plans provided by faculties in UTA; students' perception about the best ways of communicating the emergency plans from faculties for the student population.

[12] University of Tirana, Albania

Participants were engaged in in-depth interviews, not to substantiate any hypothesis or to answer questions, but to understand the experiences, perspectives and perceptions of each participant, and the meanings imlied in their experiences. Through the interviews conducted with 26 students from University of Tirana, talks and observations were provided in the form of words and sentences. All the participants were informed that the answers to the questions were voluntary and withdrawal from the study could be done at any time without any risk to them. They were given the opportunity to ask questions about study objectives and interview procedures. All participant responses were coded to ensure proper confidentiality with respect to the study. Each of the 26 interviewed names was removed from the data to be analysed and replaced with numbers to protect their identity and ensure confidentiality. Interviews were recorded and lasted from 30 to 40 minutes.

The thematic analysis was chosen as an appropriate method because it is commonly used to describe, analyze, and report topics and models, as suggested by (Braun, V., & Clarke, V. (2006). Table 2 describes the steps through which the analysis was conducted. Using this theoretical approach as the interviews were conducted, responses to the questions of the former interviews provided information to design new questions that could be addressed to participants in the latter interviews. The purpose of this qualitative study was not to generalize the results but to study the phenomenon in depth. Moreover, it would be very useful to conduct other studies in this area in other Western Balkan or European countries, to gather data and knowledge and to compare them with the findings of this study.

Table 2. Data analysis phases and description of the process

Data analysis phases	Description of the process
Following the recommendations made by Braun,V. and Clarke,V. (2006).	Each author read and reread the transcripts, took notes about their initial interpretations, and generated codes, classified the codes into possible topics, reviewed themes and named each of the topics. This stage was accomplished by each author working separately.
Analysis session to discuss the codes and topics identified by each author	At the joint meeting the authors described their individual interpretations. The findings were compared and differences in findings were discussed. Finally, the final themes were decided.
Final Review of Data and Validity of Findings	Each author read transcripts again to ensure that the final themes really reflected the collected data.
Writing a report	Each topic identified was included in a report including specific terms used by the study participants as examples to describe each topic.

5. FINDINGS OF THE STUDY

"Emergency Preparedness" by the interviewed students is perceived as the set of measures taken in the event of a natural disaster in order to avoid its consequences, to to protect themselves and people who are close to them.

"Emergency Preparedness" according to students is related to:

- Protective measures taken by themselves.
- Protective measures taken by the faculty, higher educational institutions.
- Measures taken by civil emergencies.

• Mainly "Emergency Preparedness" is perceived as: Emergency plans with concrete steps that faculty or university have to communicate to the students and to implement in case of occurrence of natural disaster or preliminary measures for capacity building (operational, response, etc.) dealing with the provision of operational assistance to avoid fatalities, minimize damages and recapture the area where the natural disaster occurs.

The safety that students perceive from faculties of UTA which have been part of this study and their emergency preparedness for natural disaster is low or at moderate levels. They have given different answers regarding security and preparedness for faculty emergencies. Their responses range from 0-40%, but most of them perceive very low safety and emergency preparedness in their faculties.

Respondents were asked about the information they have about natural disasters, in order to somehow measure their awareness and culture of information about natural disasters. The Students had different levels of information and knowledge regarding natural disasters, for example the students attending MSRM[13] in Faculty of Economy and students of Faculty of Natural Sciences were more informed and aware of the risk of natural disasters, due to the fact that they have done school subjects related with natural disasters. Nonetheless, their level of information about the purpose of emergency plans in their educational institutions is relatively low. Almost all of them do not either have information about their existence.

Students' perception about safety and security from natural events is closely related to the level of communication and awareness that they get from the University. Almost all of them said that information and communication about emergency plans are almost non-existent in their respective faculties.

According to them, there are no basic safety elements such as emergency stairs, alarm systems, quick aid kits. The only auxiliary elements that are present in the faculties and which according to students' perception can easily be accessed are the fire extinguishers, which are insufficient in the faculties of the University of Tirana. According to the interviewed students the faculties of UTA do not have a published emergency plan and the students are not even aware whether or not these plans exist.

Students perceive Albania as a country with an above-average risk in terms of natural disasters, with a moderate probability of occurrence of these events, especially for floods and earthquakes. On the other hand, although they perceive a low level of safety and preparation of faculty on natural emergencies, they seem not to have been made previously aware to seek information and to ask to be communicated about emergency plans in faculty structures. This

[13] Master of Science in Risk Management

is an indication of their low level of safety culture. However, almost all participants have expressed willingness to receive information from their faculty staff regarding the preparedness on natural emergencies.

According to the students there is no Disaster Response Team or a security department in their faculties, and consequently they do not know where they can get the right information about the institution preparedness for natural emergencies.

A Disaster Response Team or a department of security in the faculty could be part of faculties structure according to the students' perceptions and suggestions. Their main functions could be related with:

- planning and implementing of disaster emergency plans.
- communicating emergency plans through the most appropriate ways for students and staff.
- part of Disaster Response Team could be as well technical assistance provided by some disaster management experts that operate in case of real emergency occurrence.
- many of the respondents think that the department of security in their faculty can have a small staff that reconciles plans with the civil emergency institution of Tirana.

Some of the methods/strategies that faculty/ university could use to inform and prepare students about emergency plans (resulted by students' perception) are listed in the table below:

Table 3. Communication of University/ Faculty emergency and preparedness plans

Strategy of Communication	Frequency and place of communication[14]
Trainings, seminars, workshops by field experts who conduct demonstration with practical and understandable steps for students.	• Twice per year • Developed in the first few hours of the bachelor's first year. • Several open lectures annually
Frequent and continuous information about emergency preparedness in social media as a good way to get in touch with them, to provide intellectual stimulation and awareness and to communicate important information.	• frequently, continuously
Obligatory informative lesson hours developed by subject lecturers.	• in some of the introductory lectures in the first bachelor's year.
Creation of a dedicated space on faculty and UTA website pages for emergency. preparedness plans	• permanently
Placement of stands and tables to display specific information and action steps in case of natural emergencies.	• be placed in easily accessible spaces by students, close to the information office in the faculty • or in any of the two floors of the faculty building.

• Distribution of brochures is perceived by the participants of this study as less effective because the information received from them tends not to have a lot of effect on their

[14] There could be some options

awareness, they have expressed the need for a more frequent and continuous information and communication strategy which would be more effective in increasing their awareness about emergency preparedness plans.

Furthermore, the students admit that emergency preparedness plans should exist in faculties, but their level of awareness regarding these plans results not to be great, as they say they have thought about this subject very rarely during the period of staying at these institutions. Placed in the scenario of the real occurrence of a natural disaster, students admit that they would be unprepared in such circumstances, not informed at the appropriate level, unaware of the measures or steps to be taken, stressed by the lawlessness of the ways of rescue.

Often they have argued that the only place where they could go to get information on such a topic is the information office, which is not considered as much helpful by them to provide the information related to faculty/university emergency preparedness.

6. CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to understand students' perceptions on natural disaster response and preparedness efforts at University of Tirana. Throughout the analysis, few major themes emerged with regard to students' perceptions on natural disaster and emergency response procedures at their faculties/ UTA: (a) Definition of Emergency Preparedness by students, (b) Lack of Knowledge, Information and Aware of disaster emergency preparedness, (c) Self-Preservation and Individual Safety Responses, (d) UTA's lack of Administration and Disaster Management, (e) Eminent Threats, (f) Safety/Feelings of Security, (g) Perceived Safety Efforts, (h) Unawareness of the safety measures, (i) Social media, workshops, lectures as a Way to Disseminate Information, (j) Desire to be informed and prepared (k) Lack of safety culture.

The results from this study suggest that University of Tirana needs to do a better job in disseminating natural disaster and emergency preparedness information to the student body. Research indicates the need to effectively communicate and collaborate emergency preparedness efforts to faculty, staff and students (Kapucu & Khosa, 2013). The results from this study specifically the themes of "Lack of Knowledge, Information and Awareness of disaster emergency preparedness", "Self-Preservation and Safety Response", "Desire to be informed and prepared" and "Lack of safety culture" suggest that the students at University of Tirana are unclear about proper safety procedures but will try to take self-preservation actions during a natural disaster.

We recommend that UTA needs to establish a disaster management system to help its faculties to mitigate any natural risk and to provide comprehensive training and courses to widen the knowledge of managing disasters in order to inform/ prepare students how to response to such events.

There is a need for the government in general and the universities in particular to increase awareness (of students, staff of the university/ faculties) towards preparedness in managing the disasters through education programs. However, UTA/ faculties are not yet fully prepared for disasters and need more efforts in this field.

Finally, it is considered necessary that this study can be extended further by researchers, who can include in their studies also staff' perception and preparedness for natural disasters.

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DISCUSSING FLOOD DAMAGE ASSESSMENT IN THE CASE OF ALBANIA

bstract: The possibility that a community may experience a potential life loss, injury or asset damage a catastrophic event in a specific period of time sheds light to the aim of this paper which is to discuss lood damage assessment, focusing in the case of Albania. Thus study identifies problems of damage assessment methodoogies and aims to propose an effective approach of the process, considering the lies and methods used by other countries. The importance of flood modelling and ex-ante evaluation to ndle cases of flood disasters seems to be inherently necessary in developing countries as Albania. The ollowed methodology in this paper is mostly based on the literature review and policy analysis. The variety of findings and recommendations outline how crucial is the concept of ex-ante damage costs estimation to minimize the impact of flood disasters and to enhance the post-flood recovery.

Key words: disaster risk, risk modelling, risk management, catastrophes, flood, damage assessment

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1. INTRODUCTION

Disasters have a major impact on the living conditions, economic performance and environmental assets and services of affected countries or regions. These 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 [6]. 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. Consequences may be long term and may even irreversibly affect economic and social structures and the environment.

More than $7 trillion is accounted for the economic damage caused worldwide as a result of natural disasters from 1900 to 2015 (The Karlsruhe Technological Entity, 2016). In terms of human loss the study reports that 8 million people have died throughout this time frame from disasters such as earthquakes, volcanoes, droughts, fires, etc. Sahin (2011) using data on 171 major disasters for the period between 1990 and 2007 discussed their global and regional impacts by using a Computable General Equilibrium (CGE) model (GTAP). They argue that the economic losses produced by the Global CGE model exceed the sum of individual country loss reported by Munich Re Statistics for each simulation year which means that considering the natural disasters as separate events may lead to an underestimation of natural disasters impact on the world economy. The conclusion of this model is that the economic burden of natural disasters is not confined to the region where the disaster physically occurs; in the short to medium term, natural disasters lead to new global balances through trade linkages and price effects [14].

Focusing on flooding events, this paper will discuss disaster damage assessment in Albania. The first part of the paper, through a literature review, will give an overview of methodologies applied for the assessment of disaster costs. The remaining of the paper will discuss the practice of damage assessment in Albania, focusing on specific cases and discussing the lack of ex-ante damage assessment in the case of floods and other disaster events.

2. LITERATURE REVIEW

Disaster risk management is process composed of many components. The different phases of this process outline the necessity of informed decision making. Essiential to achieve this is the assesment of potential damage of disaster events. According to the findings from the 35,000 natural disaster database in over 115 years, floods are considered to be the main cause for economic and human losses. Since 1960, storms and hurricanes have replaced the floods as the most devastating force that struck buildings and infrastructure. It can not yet be determined whether this is due to climate change (The Karlsruhe Technological Entity, 2016). Over the past decades, a great variety of different methods for the ex-ante estimation of flood damages have been developed [11]. However, different methodologies have been applied in different countries, making it difficult to compare damage assessments with each other [9].

Analysis of flood damages can be made on a macro-, meso- and micro-scale. Macro-scale analyses consider areas of national or international scale and should provide decision support for national flood mitigation policies. Meso-scale analyses deal with research areas on

regional scale, i.e. river basins or coastal areas. Here, the planning level refers to different large-scale flood mitigation strategies. Finally, the aim of micro-scale analyses is the assessment of single flood protection measures on a local level. The main differences between the three approaches relate to the spatial accuracy of damage potential analysis, to the differentiation of land use categories and to the damage functions used [11].

The challenge of flood research is to develop a wider perspective for flood damage evaluation referring to the fact that the flood damage analysis mainly focuses on the economic valuation of tangible flood effects while neglecting the important economic, social and ecological aspects of flood – related vulnerabilities [11]. In this regard Giupponi et al (2015) discuss how the estimation of risk should not only be based on direct tangible costs, but it should also go beyond to contain indirect and intangible costs. The later should take into consideration the social indicators, the capacities of local communities to cope with risks and adapt to them. Cosidering all of the above will produce the total costs estimation. They discuss the usage of the KULTURisk as a conceptual framework and SERRA (Socio-Economic Regional Risk Assessment) as the implementation methods. Another study on the estimation of damage and recovery costs considering human losses in the Republic of Korea develops a linear regression equation that connects these factors [15]. Its estimation equation considers human losses, damage costs, and recovery costs.

Often the literature makes a distingtion between models of loss calculation and risk assessment in urban areas and rural areas. Li et al (2016) argue that flood risk analysis is more complex in urban areas than that in rural areas because of infrastuctural caracteristics of urban areas, different kinds of land uses, and large number of flood control works and drainage systems. For the purpose of flood risk analysis and damage assessment, they use a comprehensive analysis based on the concept of disaster risk triangle. Two models were intergrated for this purpose: Urban Flood Simulation Model (UFSM) and Urban Flood Damage Assessment Model (UFDAM). They show the relatioship between flood control measures and flood risk based on flood return period. By applying scenario modeling in the Pudong area in Shangai (China), they showed that the flood prevention measures may cease to be effective when the flood scale exceeds the flood control standard [10]. Another study which applies damage assessment methodologies in urban areas was conducted by Genovese (2006) usign Prague as a case study [5]. Vojinovic et al (2008) attempt to incorporate the GIS technology with computer-based flood modelling results for flood damage assessment and disaster planning in the case of urban floods [16]. Bouwer et al (2009) discussed a method that is able to simulate inundation in polder areas which can be used for detailed scenario studies of the impact of future socio-economic and climatic developments on flood risks. They noted that the usefulness of the hydrodynamical modelling is limited for high spatial resolution loss estimates for large areas. They use the inundation depth assessment for different scenarios to illustrate the potential range of flood losses and to assess the relative impact of land use and socioeconomic changes. By using loss probability curves they try to calculate maximum losses, as well as the expected annual average losses, also discussing uncertainities of the results of the method [2].

Following the challenges of damage assessment and different methodologies applied for this purpose, Huizinga et al (2017), applied a comprehensive methodology which aimed at developing normalised damage curves for each continent, based on an extensive literature survey. They computed a consistent set of maximum flood damage values for all countries using statistical regressions with socio-economic World Development Indicators. They also

give guidance on how the damage curves and maximum damage values can be adjusted for specific local circumstances, such as urban vs. rural locations or use of specific building material. They argue how this dataset can be used for consistent supra-national scale flood damage assessments, and to guide assessment in countries where no damage model is currently available [9].

3. FLOODS AND DAMAGE ASSESSMENT IN ALBANIA

Albania has a high exposure against disasters. The causes of disasters are various, ranging from natural causes, to anthropogenic and ecological causes. The consequences of disasters in different groups of society may reach serious levels. The levels of vulnerability have significantly risen with the increase of the number of population and with massive migration of population especially to coastal areas, which are exposed to higher risk of natural disasters. Among disaster events, flood have the major number of occurrence.

Albania has experienced many flood cases during the last century. Especially, the western lowland seems more affected. According to the registered and published data of the Disaster Information Management System (DesInventar), it results that there are 504 registered flood cases on the five regions of the western lowland during the period 1900-2018, where 65 flood cases are located in Tirana region, 77 flood cases in Durres region, 133 flood cases in Lezha region; 183 flood cases in Shkodër region and 46 flood cases in Vlora region. Flooding events of November 1962-January 1963 are considered the most serious on the proofed cases, considering the surface of the flooded zone, time duration and caused damages [1]. The increase of the sea level and weather scenarios are thought to increase floods risks, especially for the inhabitants of the coastal areas.

Anyhow, still nowdays there have been no studies and no developed methodology on ex-ante disaster damage evaluation, regardless the fact that the country is constantly affected by these events that cause a serious preassure to its economic development. The evaluation of damages is conducted only after the occurence of the catastrophical event and not always is made public. Also, data for damages, when made public, have been aggregated to a total value, without diffrentiating values for different damages categories. Moreover, also because of political factors, damage values are very often underestimated.

Some data on damange assessment have been reviewed from public documents. As stated above, the registered data of flood damages costs seem to be limited. Flooding evends of December 2010 in Shkodër region in Albania have the most accurate data on damage comapred to all other events affecting Albania. According to the ex-post damage evaluation in the area, the documented total number of affected evacuated inhabitants was about 12,145 and the number of affected houses was about 7,120 (4,540 flooded houses and 2,580 houses surrounded by water), while the number of assets at risk in this area was more than 400 of different types. According to the evidences of the Directorate of Agriculture in the Region, during the flood events the cultivated land and croplands were highly affected (about 10,280 ha from which about 4,887 ha of cultivated land) and the economic damage was about 500,350,000 ALL. While for the livestock the situation can be considered more dramatic as some of the animals were surrounded by water and drowned (about 32,634 animals were evacuated) [8].

The lowest part of Kurbin and Lezha have also experienced many flooding events. Some data on damage experienced in the area have been also made public. This area epxeriences a different kind of flooding, caused by sea level rise The variations of the non-normal rainfalls and their distribution have resulted in aggrevated erosion levels and intensification of floods. In September 2002, a surface from 26.000 ha working land was flooded and the general loss for the affected families and the country infrastructure is evaluated to be approximately 17 mln dollars. The floods of 4 December 2004 destroyed in total 1500 ha of the working land. The houses near the river banks of Drini and Buna suffered from aggrevated damages. The damages affected bridges, and national and rural roads too. Floods also influenced the biodiversity of the area, as a tendency of natural communities to move inland was observed. Also, specific communities, including the exisiting coastal dunes, salted marshlands and legatines decreased their surface. The last case of the massive floods in the area has happened during the winter 2009-january 2010. The increase of the sea level, accompanied with the increase of the whirlands and rain, caused aggrevated flood in many fields. As a result, more than 600 ha of land were flooded, causing an economical loss estimated for 14 000 000 lek (150 000 USD) after the occurrence [4].

One of the few attempts for conducting an ex-ante damage evalution was realized in the framework of the project "Identification and Implementation of Adaptation Measures in Drini-Mati River Deltas", financed by GEF (Global Environmental Faciltity) and implemented by UNDP Climate Change Program. In focused on a study area positioned on the deltas of Mati and Drin rivers, including the counties of Lezha and Kurbin. In the framework of this project, the damages experienced by the local economic units (families) from the floods in the area for a time horizon of 100 years, were evaluated. The experts of the project have developed a prediction of the consequences for the flooded people until the 2100 year (Table 1).

Table 1: Forecasting of flood damages

Parametres	Entity	2030	2050		2080	2100	
Flooded people	*1000/year*		0.019	0.040		0.006	0.007

Source: Muçaj, 2010

The developed scenario predicts a decrease in the number of the flooded people as a consequence of the reduction of the area population. By using these data and the benefit trasnfer method, the damage calculation in the 100 years time horizon was made available. The benefit trasfer method uses data from international studies for the damage evaluation and applies this data to specific local areas, after making adjustments to the reported values. A study of Meyer and Messner (2005) has estimated the costs of the damage for a flood event in the Netherlands. They calculated the damage value of 172.000 EUR/economic unit during a flooding event. This value was adopted for the case of Albania by adjusting it based on the level of GDP of both states. Through the usage of the GDP ratio of both states on the year when the study was conducted, the transferred value of 308085 EUR/family of floods damages in the study area was obtained. With the help of the regression equation that represents the trend of the flooded families during the time horizon the value of damages ranging from 1.7 mln to 1.9 mln EUR for the study area was calculated [12]. This estimation has not taken into consideration the social damages of floods.

The forecasting and the used method summarized above has its own shortcomings, as identified in the project report, but the case under consideration outlines one of the few attempts for the calculation and prediction of the famages from floods in Albania. The use of the benefits trasnfer method was necessary, as there is no specific data or developed methodology in Albania for the calculation and evaluation ex-ante of damages from the floods that the families experience.

This lack of among the caused in this field has been especially conditioned by the lack of risk maps for the vulnerable areas, which are essential for applying methodologies of damage evaluation presented in the first part of this paper. In this framework, an important contribution has been given for the development of the flooding maps for the region of Shkodra through the support of this initiative from international projects. The project "Climate Change Adaptation in Transboundary Flood Risk Management in the Western Balkans", implemented by GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit), aimed to support the systematic identification and mapping of main flood risk areas in the Drin River Basin in compliance with the EU Flood Directive and to assist the local authorities to implement adaptation measures as part of their flood risks management plan. The flood risk maps serve as an input on the process of flood risk assessment where the current versions of local flood risk maps of the Shkodër region give an overview of affected areas as well as affected infrastructural assets [8]. The products of this project set a cornerstone to the impmentation of methodologies for ex-ante disaster risk assessment in Albania in the future.

4. CONCLUSIONS

This paper discusses the importance of damage assessment on flood events in Albania. The role of the damage assessment process is displayed through different global estimation methods where the forecasting of the damage costs in cases of flood events seems to be necessary. According to the findings is noticed that the modelling of flood risk and damage assessment in Albania is executed after the flood event and the available data related to the damage costs is limited or non-existent. Referring to the worldwide practices and methods, it is proposed that the flood damages costs estimation should include the indirect costs such as the social indicators to reflect the total costs and the impact of the consequences of the flood events. Also, the usage of GIS mapping technique and its incorporation with the numerical model results is essential for the damage calculation caused by flood events. The economic analysis of costs and benefits of flood protection and mitigation measures should be included in the forecasting methods for flood risk management and the economic, social and ecological impact should not be underestimated.

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THE ROLE OF INTERNATIONAL STAKEHOLDERS IN DISASTER RISK MANAGEMENT- CASE OF FLOOD IN ALBANIA

Abstract: The aim of this paper is to create a framework regarding the role of Non-Governmental Organizations and other international institutions in Disaster Risk Management, with a focus in floods case in Albania. Floods are the most common natural hazard in Albania and during the years the country has faced floods situations in different districts, with a great economic and social impact. There are several stakeholders when a natural disaster occurs, including central and local government, NGO-s, financial market and other national and international organizations. In this case study will be explained which are these stakeholders in Albania and what are their role and weight in DRM. How these international institutions and organizations are contributing and what is to be done better. The study is based in literature and review of public data from national and international sources. The paper offers recommendations on how we can improve risk management.

Key words: *Disaster Risk Management, NGO, Financial Resilience, International Stakeholders, Albania*

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1. NATURE OF HAZARDS IN ALBANIA, CASE OF FLOOD

Albania is a disaster-prone country, exposed to most hazards of: A. Natural origin: geologic (earthquakes, rock falls, landslides); hydrologic (flooding and torrential floods); atmospheric (snowstorms, high snowfalls, windstorms, draughts); biophysical (forest fires, epidemics) and snow avalanches; B. Man-made origin: floods and hazards of technological origin; C. Technological hazards, CBRN etc [1]. Given that Albania has many kinds of natural hazards, it is not possible to make a summary in one paper. For that reason in this paper we are focused in one of hydrologic hazards: floods. Hydrological system of Albania has a surface of 43.305 km2 and includes 8 big rivers, 3 big natural lakes and a huge number of small lakes and reservoirs. The river system is the biggest hazard of flooding and Albania has a long history of flooding [2]. The flood of 1962-1963 is one of the biggest in Albania where 70'000 hectares of agricultural land were flooded. Another flood occurred on 2002 covering 30'000 hectares of agricultural land. According to the World Bank, the damage was US$23 million. The flood of 2010 is the biggest of the last 50 years [3]. 14'100 hectare and 4'600 houses flooded, affecting 59'600 habitants [4]. Another flood in 2015 affected 9 regions and 53 municipalities. Over 10'000 hectares of planted area was flooded and the damage and needs for recuperation was US$110 million.[1] Floods in 2002 recorded economic damage of US$17.5 million. The maximum potential losses from a disaster with a 250-year mean return period are estimated at US$1.3 billion for floods and US$2.3 billion for earthquakes [5].

2. MAIN APPROACHES IN CASE OF DISASTERS' OCCURANCE.

Governments find solution at different sources of financing following a disaster, usually categorized as ex-post and ex-ante instruments. Ex-ante financing instruments require advance detailed planning and include reserves, budget contingencies, contingent debt facility and risk transfer mechanisms. These risk transfer tools are of great importance and much emphasized in literature, financial strategies and international institutions recommendation, as a key factor of risk management that should be considered and proactively implemented in developing countries. They include insurance and reinsurance, parametric insurance and Alternative Risk Transfer (ART) instruments such as catastrophe bonds (CAT) [6]. Ex-post instruments are sources that do not require pre-planning. In fact they are mostly used to fill the gap left from not having planned properly the ex-ante instruments. This includes budget reallocation, domestic and/or external credit, increase in taxes and donor assistance. The public sector relies on such ex-post instruments, where international assistance has been especially highlighted. Even though funding from donors and international development banks can be an important part of government catastrophe risk management strategy, overreliance on this approach has often been the cause of the lack of economic incentives for countries to engage in proactive disaster risk management. The emphasis on ex-ante disaster risk management instruments, especially in terms of financial planning is very crucial [7]. As for Albania, catastrophe bonds do not apply given that there is no adequate stock exchange and financial market is not quite developed. Insurance and reinsurance of life and property is in low levels especially in high risked areas. This for certain of reasons; the society in these areas is not informed and aware of such instrument and the insurance companies do not provide service in such high risked areas. In a survey we made in August 2018 in 32 families in flooded areas in Shkodra region regarding insurance, 31% of the families claim that insurance is not available at all from

insurance companies while 25% do not have any information regarding insurance as a risk management option. 22% say that insurance fees are very expensive to pay and only 6% admit they have life or property insurance. If we make a short analyze of the responses they are contrary between them as some claim insurance is not available from the companies and others admit insurance is an expensive option or that they already have insurance. From this we can conclude that the society in these areas is poorly informed and educated regarding the protective ways from catastrophes, like insurance. With the CAT and insurance out, as ex-ante instrument there is only government contingency budget.

3. INTERNATIONAL STAKEHOLDERS IN ALBANIA

In Albania the ex-ante approach of disaster risk management is not as much followed by stakeholders as ex-post approach is. Ex-post instruments remain of a great importance and have a vital role. They include budget reallocation, domestic and external credit, tax increase, and donor assistance. Two of most important are credit and donor assistance, that is why, in this paper we are focused in these stakeholders/institutions included in these cases. As shown in the figure 1, national implementing institutions like ministries or organizations get the founding sources by budgetary allocations, from EU assistance (IPA) or by soft loans by World Bank. On the other hand the international implementing agencies like United Nations agencies or GIZ get financed by international donations especially from EU countries governments. Refering to the structure of Civil Emergency Stakeholders in Albania. The Council of Ministers leads everything and coordinates the activities between stakeholders. On the Monitoring Institutions, a significat role is played by Red Cross and other NGOs, that show the importance of these organizations in Disaster Risk Management. Knowing so far the great importance of NGOs and other international institutions, the aim of this paper is to emphasize what is their specific role and level in DRM. What do they exactly do and what are the effects? Do they act as proactive players prior to disasters to minimize or to avoid the catastrophes or they act more as ex-post actors? We are focused at the most important international actors; Instrument for Pre-Accession (IPA), United Nations Development Program (UNDP), Red Cross and World Bank. IPA acts mostly as a donor by financing different specific projects in Balkan countries. World Bank is a credit / loan institution that finance in these cases by lending money to governments on soft rates. UNDP acts mostly as project implementing organization, so it puts in use the money offered by international donors. Red Cross has a similar role as UNDP, but it is limited in post disaster activities, like providing shelter and food to the affected people.

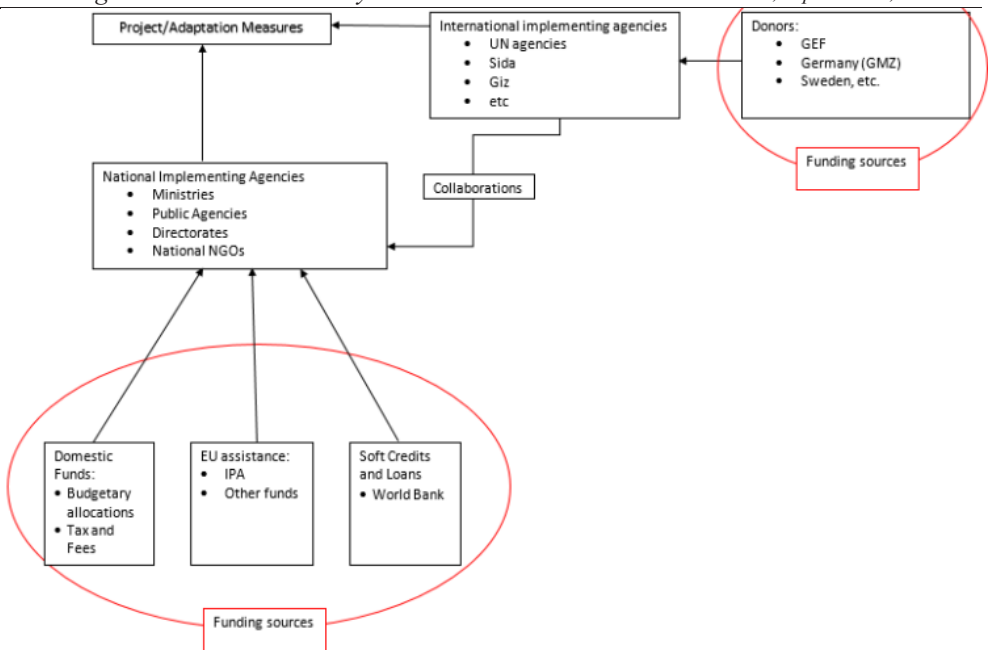

Figure 42: Disaster Risk Reduction and Civil Protection Financing Schemes in Albania. Source [7]

3.1. Instrument for Pre-Accession (IPA)

International assistance remains very important for disaster Risk Reduction. European Union's assistance is a key factor in financing in these cases. The mechanism used by EU is the Instrument for Pre-Accession, which provides financial assistance for specific investments in EU candidate countries like Albania and other Balkan countries. From 2014 to 2020 IPA has donated €649.4 million, of which 68 million set for environment and climate action and 92 million for agriculture and rural development. The priority sectors for funding in this period are mention in Table 1.

Table 1- Priority sectors funded by IPA [8]

Albania (EUR million)	TOTAL 2014-2020
Democracy and governance	223.5
Rule of law and fundamental rights	97.0
Environment and climate action	68.0
Transport	56.0
Competitiveness and innovation	44.0
Education, employment and social policies	69.0

Agriculture and rural development	92.0
TOTAL	**649.4**

We don't know in details how it is spent but we know that €160 million are spent in agriculture/rural development and environment/climate action, which is 25% of total spending [8]. Based on PDNA findings, EU reprogrammed part of its IPA allocation for assisting the recovery effort and aimed at restoration of flood control infrastructure, upgrading civil defense preparedness and recovering agricultural productive capacities.

3.2. World Bank

The World Bank has been assisting countries to recover from catastrophes and to reduce vulnerability for 35 years financing more than 600 projects with more than US$26 billion. The assistance has been given after the disasters occurred but recently it changed focus toward actions on preparedness and mitigation. Albania Disaster Risk Mitigation and Adaptation project is one of most important in Albania, with US$10 million [5]. It was focused on flood protection and was implemented by Ministry of Interior and Institute of Energy, Water and Environment Albania. The objective was to strengthen institutional capacities: to reduce Albania's vulnerability to the natural and manmade hazards and to limit human and financial losses. It had 5 components: First, the disaster risk management and preparedness with the objective to support capacity building for emergency response through necessary equipment, and strengthening planning. The second is the strengthening of hydro meteorological services to make accurate hydro meteorological forecasts important for weather-sensitive areas. The third component is the development of buildings, to reduce risks from seismic activities. The fourth is catastrophe insurance, to provide access to private insurance to households and SMEs. The fifth component consists of project management costs and reporting and audits [9]. The beneficiaries are the public and businesses in risked areas. Ministry of Interior, Ministry of Education and Science, Ministry of Public Works and Transport, and Ministry of Finance benefit as their staff gets trained and their capacity developed. The project is profitable as both methods used show positive results, benchmarking method shows a Net Present Value of US$14.6-196.6 million and sectorial analysis US$ 4.1-16.7 million [5].

3.3. Albania Red Cross

In 2010, 11,500 hectares and 4'100 houses were flooded, 4'600 people evacuated. Albania Red Cross made assessments that revealed damages on houses, equipment and furniture and livestock. 30 volunteers were involved in evacuating people, raising awareness, collecting information. Red Cross branches organized local fund-raising campaigns. ARC was able to help 2'200 families. These families were selected by these criteria: They were evacuated and accommodated elsewhere, they had serious damages in house and reserves or they were Roma families. Each family got 50 kg of flour, 10 kg of rice, 10 liters of oil, 10 kg of sugar, 10 kg of beans, 6 bottles of water, 4 blankets, 1 mattress, clothes and shoes and other small products. Each family got around US$100 and the overall cost was approximately US$300'000. Approximately US$130'000 and tons of products like hygiene materials, food parcels and clothes were donated from Red Cross of different countries, Vodafone Albania and USAID

[10]. 54% of flooded families were assisted. In 2017 floods 1'575 persons were evacuated, 3'500 houses and 15'000 hectares of land were flooded. Approximately 4'700 families (21'000 people) were affected. 450 volunteers were involved in awareness raising, collection of information, preliminary assessments. ARC first sent to each of 700 most-affected families: 20 kg flour, 20 kg food, 4 blankets and 1 hygiene kit. ARC organized two awareness-raising workshops. In total, ARC assisted 2'150 families from this DREF allocation, while an additional 1,000 affected families were assisted from other Red Cross Red Crescent Movement support. 3,150 affected families were reached together. In total were distributed 43,000 kg flour, 2,150 food parcels, 8,600 blankets and 2,150 hygiene kits reaching US$ 195'000 [11]. Red Cross assisted approximately 45% of affected families or 40% of affected people.

3.4. UNDP

On January 2015 there were big floods in southwest of the country. The Government requested international support for emergency assistance and recovery and reconstruction needs. EU, UN and WB jointly engaged in the development of a post-disaster needs assessment (PDNA) in coordination with relevant instances. The PDNA report provided an impact and needs assessment across key affected sectors, a preliminary recovery strategy and a roadmap that prioritizes early, medium and long-term needs. The total population in the flooded areas amounts 397'316 persons. 15'000 farming households were affected and 9'993 ha of agriculture land damaged. The report estimated the damages and immediate needs to €110 million. The first component of this intervention is implemented by UNDP. It consists of rehabilitation of priority infrastructure such as river embankments and damaged irrigation & drainage channels. UNDP acts as the implementing partner and adds to the action, inclusive to additional own resources, the social and environmental angle of raising awareness and providing capacity building for strengthened resilience through participation, social inclusion and integration of climate change adaptation measures in local development planning. The impact was felt in agriculture, local governance and livelihoods.
The project was financed by EU €6 million and UNDP €300'000 euro offered by UNDP [12].

4. CONCLUSIONS

International assistance is vital in facing risks from catastrophes. WB, EU, UNDP and ARC are most important actors and it seems to be a great cooperation between them and government. Red Cross acts like a post actor and provides food and shelter to most vulnerable affected families. UNDP acts prone to disasters and after. It makes assessments of needs and damages, works with government institutions to prevent and mitigate risks by building infrastructure, raising awareness and also provides goods after the disaster to the families in risked areas. World Bank on the other hand has shifted its focus in preparedness and mitigation of risk rather than assisting after the

occurrence. It is also a bank with soft rates for the government. On the other hand EU contributes according a prepared schedule and mostly to prevent and mitigate risks. This should be followed by all stakeholders, to act as preventive factors not as assisting ones after the catastrophes occur, because floods are very similar in terms of locations and timing from year to year. EU remains the biggest in budgetary terms. But if we refer to real looses, we are far from compensating 100%.

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FLOOD RISK MANAGEMENT BASED ON RISK SCENARIOS FOR VJOSA RIVER, ALBANIA

Abstract: In several decades, earthquakes, floods, forest fires, snow storms and other natural disasters have frequently threatened growth and developments by becoming a source of poverty around the world. The necessity for disaster risk reduction measures and studies is also evident in Albania, taking into consideration recent events of high frequency and the vulnerability of the communities toward such risks. This paper analyses Vjosa River in Albania, as a hotspot for disaster both natural and man-made combined. It examines the effects that floods have on the fields and population that is located near the river by evaluating the risk profile of the area and by exploring the factors that contribute to the situation. The study assesses the flood risk by creating possible scenarios based on previous events and secondary data. In the second part of the paper, an overview of emergency plan that should be implemented in case of overflow of the river is given.

Key words: Vjosa River, flood, disaster risk management, emergency plan, contingency plan.

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1. INTRODUCTION

The necessity for natural hazard risk management has significantly increased over the last years, as an important issue for achieving sustainable development. Several studies reveal that disaster management requires effective community-based strategies which include programs and measures to prevent and mitigate disaster effects (WMO, 2012). Disaster risk management and prevention depends on wider social and political conditions that affect the ability of governments and civil organizations in this process, such as planning capacity, regulatory institutional environment, chains of responsibility and interaction with stakeholders (Ruiz-Rivera and Melgarejo-Rodríguez, 2017). However, it is the responsibility of the governmental institutions, both at national and local level, to address the appropriate implementation of disaster risk reduction measures and resilience programs, to achieve relevant outcomes. The government structures, in all levels of governments, should integrate the disaster risk management activities with the community planning and recourse capabilities assessment (UNISDR, 2012). The main hazards affecting Albania are: floods, earthquakes, forest fires and snowstorms (UNISDR, 2009). The two main hazards are identified as: high rate of seismicity and risk of flooding in the river system (the National Strategy on DRR, 2014). Floods are more frequent during the November–March period, when the country receives about 80–85 percent of its annual precipitation. Due to topographic patterns, these floods occur rapidly after water has run through the main river hydrographic network for around 8–10 hours. The annual average population affected by flooding in Albania is about 50,000 and the annual average affected GDP about $200 million (World Bank, 2014).

In this paper we assess Vjosa River as a hotspot for natural disasters and aim to recommend an emergency plan to minimize the negative effects of a reoccurrence of massive floods on this area. The study assesses the flood risk by creating possible scenarios based on previous events and secondary data from Institute of Statistic in Albania, as well as by reviewing previous literature studies. In the second part of the paper, an overview of emergency plan that should be implemented in case of overflow of the river is given. The necessary actions examined in this paper include: the pre-disaster preparations, the warning signs, the responsible institution's actions, the fund allocation pre and post disaster, and lastly the effective usage of available equipment in the area.

1.1. Risk profile of Vjosa River

"Vjosa River" is one of the greatest rivers in Albania. It is explained as a result of the geological and geographical longitude and position. The water catchment area of this river is 6710 km2, of which 4365 km2 are included within the territory of the Republic of Albania meanwhile the other part is located on Greece. Vjosa Valley lies in the districts of Korça (8.75%), Gjirokastra (50.47%), Vlora (30.59%), Fier (10.13%), and Berat (0.06%). However the most affected areas by the floods are located in Fier and Vlorë. The population in the Vjosa basin is 184,781 inhabitants. Over 70% of the population is settled downstream. In these areas the elderly population predominates the overall population. Moreover, 60% of the local population relies on farming as their main source of incomes, which implies the great effect that floods have on the area (Co-Plan, 2017). Other factors that contribute to the negative effects of the floods are related to the lack of financial literacy and economic conditions of rural and urban population to buy private insurance policies for disaster protection. Such factors create more obstacles in the recovery from disasters, both for the citizens and for the

state that faces full costs that would be avoided with the provision of property for the inhabitants of the region. Moreover, the Albanian insurance marked has no practices of Disaster Bonds. Another problem is related to the water sector maintenance that is fragmentized across national and local government. The issue of water system management affects data and information systems due to the location of Vjosa River that is branched on different districts (NCEP, 2004). The phenomena of extreme events does not happen often but some events caused severe economic damages, such as the floods of winter 1962/1963, December 1970/1971, December 2005, February 2015 and floods of 2017.

2. FLOOD RISK MANAGEMENT IN VJOSA RIVER

Based on the risk profile we presented in the first section, we conclude that an emergency plan is essential for the flood risk management in the region of Vjosa River. Taking in consideration special traits of the region, we aim to propose necessary actions in case of occurrence of massive flooding. Flood risk reduction measures should include the objectives:

- Providing security to all residents in the area;
- Reducing the risk of disasters caused by human error, deliberate destruction and construction or equipment failure;
- Ensuring the area's ability to continue operating after a disaster;
- Provision of comprehensive social service and supplies to the affected population before and after the flood emergency;
- Development of awareness programs on social issues.

For the purposes or disaster risk analysis in this paper and proposing measures of disaster risk management in events of massive floods, we have come up with the assumptions as explained below:

1. The first and most important assumption in this paper is that the state of civil emergency is declared and consequently the Civil Emergency Staff is fully mobilized (usually in the past, only partial state of emergency is announced)

2. We have assumed that the extent of flooding will be similar to that of the 2015 and 2017 floods (having significant damage consequences).

3. In the absence of accurate meteorological data on the amount of rainfall causing these types of floods we have considered a probability of 0.016 based on mass flood data in the area occurring every 50 or 75 years.

4. Due to the lack of data related to the surface of the cultivated land and the crops cultivated there, we made approximations by obtaining data from INSTAT (Institute of Statistics) on the characteristic crops of the localities where the Vjosa River crosses.

5. In the absence of publications of previous contingency plans, the estimation of the number of affected families is based on preliminary assessments and media publications.

6 In the absence of accurate data on the number of human resources available, assumptions have been made based on previous publications of the civil emergency events in our country.

In general, flood risk management consists of the cooperation of public institutions, both local and central government, non-governmental organizations, the community and the private sector. For the Vjosa River region the stakeholders are listed as further:

Headquarters of Civil Emergencies - Gathers and analyses information. Recommends actions to be taken by organizing work force and providing resources for emergency rescue or normalization operations.

Vlora, Fier, Tepelena, Municipalities - Collect expert information and recommendations to plan the evacuation: what type, when to do it and how it should be implemented. Seek help from neighbour countries and governments through mutual aid agreements or other methods.

Police, fire-fighters, first aid doctors and rescuers - They coordinate the volunteers. Also they provide information on damage on the location and identify needed resources and ways to rescue affected individuals. Ensure security for homes/businesses once they leave. They also provide ancillary services such as providing support during evacuation process.

National non-governmental organizations and international organizations such as Red Cross and Fundjavë Ndryshe that assist the evacuated people with food supplies and clothing.

2.1. Descriptive analysis of the risk scenario

In the scenario below we will examine the floods that affected the Vjosa area in 2015 and 2017, considered as floods that occur once every 50 or 75 years. Regarding the causes of these cases, they are mainly affected by heavy rains associated with erosion and exploited river inerts, blockage of drainage channels, depreciation of pumps and embankments, and most importantly unappropriated construction and interference in the river (REC, 2015). Firstly, we examine the impact of floods on the local community who consists of the 1035 families affected by these floods. This situation causes stress because it is related to the ongoing uncertainty, which is directly related to the uncertainty about their incomes and financial situation. This due to the fact that the main source of funds for these flood-affected individuals comes from agriculture and farming. Floods also cause lots of distress because they may constrain residents to move out of their homes. As floods occur in the winter, when the weather is cold and often combined with heavy rain, it makes the displacement even more difficult and stressful. In addition, it is observed that these weather conditions can cause respiratory diseases and pneumonia or bronchopneumonia.

Table 6 - Expected damage in agriculture in three main regions

Damage Description	Prob.	Fier	Gjirokastër	Vlorë	Total severity	Calculated damage
Wheat	0.016	11.9	18.1	2.1	32.1	0.5136
Corn	0.016	7.5	10.7	3.9	22.1	0.3536
Forage	0.016	2.6	4.1	0.9	7.6	0.1216
Rye	0.016	0.1	0	0	0.1	0.0016
Patatoes	0.016	1	0.4	0.3	1.7	0.0272
Beans	0.016	3.4	0.2	0.5	4.1	0.0656
Vegetables	0.016	6.4	0.9	1.5	8.8	0.1408
Fodder	0.016	46.3	12	6	64.3	1.0288

According to the data collected from the floods of 2015-2017 and assumptions that we set for the study, these floods have a probability of occurrence of 0.016. The description below shows the damage forecasts for a similar situation that can be repeated in the future. Data have been obtained for the cities of Fier, Gjirokastra and Vlora, assuming that there would be a

major flooded area, since we were unable to obtain data on how many Ha of land will be flooded and in the absence of data on how much damage can be caused to agriculture and livestock. The total severity for agricultural land would be 230000 Ha and the expected value of the damage would be 3680 Ha. In terms of forests, meadows and pastures, the total severity would be 529000 Ha and the expected damage would be calculated to 8464 Ha. Floods have always caused damage to agriculture, including the categories as listed in the table 1. In terms of severity and expected damage to livestock we have estimated the results as presented in table number 2. The highest estimated damage affects the category of cattle, with an approximation of 2.3 in terms of damages.

Table 7 - Expected damage in livestock in three main regions

Damage Description	Prob.	Fier	Gjirokastër	Vlorë	Total severity	Calculated damage
Cattle	0.016	57	63	24	144	2.304
Bovine	0.016	32	31	46	109	1.744
Pigs	0.016	1.8	6.9	1.7	10.4	0.1664
Poultry	0.016	9.3	24.9	3.7	37.9	0.6064
Unilateral	0.016	11	7.9	5.1	24	0.384

Some of the humanitarian needs that could be emerged by flood situations would be:

- Need for homes and shelters for evacuation of families affected by the flood.
- Doctors are needed as there may be emergency cases to save the lives of the injured. The residents may be injured during the evacuation or may be in poor health.
- Policemen to secure the site, since flooded homes will be abandoned after family members have been evacuated. These areas could fall prey to robber attacks.
- Need for livestock evacuation facilities (livestock section).
- Rapid intervention forces for the evacuation of population.
- Helicopters, as emergency rescue vehicles should be on alert and ready to perform at any given moment.

It is anticipated that the floods will repeat itself at the same heavy rainfall characteristics also with no major changes made to the Vjosa River basin. Therefore the flood will extend to the same areas (Fier, Vlora and Gjirokastra). The number of families affected by the flood situation would be around 440 families in Fier region, 500 families in Vlora region and approximately 95 families in Gjirokastra with a total of 1035 families. Regarding time and progress of the event, we assume that precipitation will fall for 10-15 days, as is usually the case when continuous rainfall causes heavy floods. Regarding progression of events, initially due to heavy rainfall the river swells and then gets out of bed, initially occupying agricultural lands and then affecting houses up to 1-2m, as well as agricultural and livestock.

Figure 43 - Map of approximate alignment, according to the evidence of the flood (google map)

2.2. The strategy of response

In order to have an effective response, the city council supported by Emergency Headquarters and non-profit organization such as Red Cross, should start the preparation for the potential emergency status since November. These activities of risk management consist of: assessment of number of people prone to be affected by floods; also development and verification of data on possible affected people in flood sensitive areas. In the second step, during December, it is necessary to start the negotiation with big supplier firms for supplies in case of emergency. This action includes creating a list of the equipment needed and the procurement of food and non-food items for people affected by the disaster. Throughout emergencies, other activities are needed such as: setting up tents and temporary shelters; establishing the required transportation for distribution of aid; distribution of food and non-food items and enrolment of population on tends to make sure no one is left behind. A major problem that needs to be taken care of in these situations is also the water and sanitation emergency, which might cause: water resource pollution; inadequate water supply; increase in health issues and diseases like cholera, diarrhea and dysentery. Therefore preventive actions must be taken in order to provide drinking water to the affected population and to prevent and control epidemics outbreaks in the affected population.

2.2.1. Implementation plan in the region

Novosela area, with its villages Novoselë, Fitore, Bishan, Poro, Dëllënjë, Mifol, Aliban, Akërni, has a surface of 137km^2 and it has 8209 residents. It is an area threatened by the rainfall of November - March, especially by overflowing of the Vjosa River bed and usually gets flooded every five years (Selenica et al, 2011). The Prefecture Institution (the tier of government in charge for disaster risk management at local and regional level) uses several specific measures as warning for an upcoming flood:

A) If rainfall density on the Vjosa River catchment area, is 60-70mm of rain in 6 hours and if the wind blows from the sea and there is a tide, civil emergency structures should be ready; B) If the water level from the sea level at the foot of the old bridge over the Vjosa River, is 1m less than the water level from the sea level measured in the hydrometer at the foot of the

Memaliaj Bridge, the warning sign should be considered; C) If the water level from the sea level at the foot of the old bridge over the Vjosa River is about 4m, and in the areas of Leskovik, Këlcyra, Gjirokastra, there is rainfall.

If these conditions are true, then the Civil Emergency Staff meets and declare Stage I actions "Alert for increased alert". The Prefecture organizes the following actions:

1. Informs the Ministry of Defence (Directorate of Civil Emergencies) about the situation created. Informs the members of the Civil Emergency Staff. From the first moment when alarm is set to the begging of the flooding there is a 7-12 hours period to start taking action;
2. Informs the population about the created situation and informs local structures such as: Municipality, Drainage Board, State reserves, Delta Force, Hospital and military Ward;
3. Local structures monitor the water level of the Mifol Bridge, the railway track and the two gates that enable blocking of the flow of water from the eastern part of the track in the Bridge-Mifol section;

In 2005 the track split near the Train Station and water endangered the Village Novosela, the Water Pumping Station, drinking and the fields around it also happened in precipitation of December 2017 but was caught in time. Therefore, in this situation there has to be an excavator and solid materials to close the crack if necessary.

4. Controls communication tools, megaphones, cell phones, radios, phones, sirens, tools and battery-powered lighting; also checks if vehicles are on standby.

If the likelihood is that the situation will worsen, it is considered necessary to move on Stage 2 "setting the standby". This is when an impending event is considered unavoidable and may be associated with damage to people and material. According to the practice of 2015, 2017 and 2018, Operating Structures and Supporters, line up in front of the Novosela Administrative Unit and wait to start action. While inspecting the weakest points (canals, bridges, etc.) and intervene by blocking with solid materials the flood sensitive areas. According to pre-arranged plans, if the Stage 3 “Activation” is announced, population of the flooded area should be evacuated from their properties and be transferred to former military aviation town (Akron), at Mifol Village (near the Decorative Brick Factory) or at the Bunavi Training Center. Cattle should be evacuated through assistance from Armed Forces, Delta Force etc. with the help of residents. To protect the village of Novosela, the village of Fitore from waters that may break the railroad tracks or gates of irrigation canals in two places, the gates must be closed to prevent the water flows collected from the railway track on the east side of the village of Novosela.

3. CONSIDERATIONS FOR PREVENTION AND ACTIVATION WHEN VJOSA RIVER OVERFLOWS

Monitoring and evaluating the situation, whether worsening or improving, always is estimated by the water level in the old bridge over the Vjosa River. That's because its height 6.3m above sea level can serve as a comparison for the situation in the area, compared to the altitude of the villages in the area. Complex flood dynamics especially after the construction of the Fier-Vlora highway must be taken into consideration. Special attention should be given to new elements that emerged after the construction of the highway Fier-Vlorë. The catchment section (the distance between bridge foot) built on the highway is much smaller than the section of the old bridge and the bridge over the railroad. Self-elevation of the highway in the

Novosela area (Bishan village) creates concentration of the water in certain places and particularly threatens the village of Fitore and Bishan.

Table 8 - Emergency fund allocated to Vlora Region, Source: Vlora Prefecture

	Emergency Fund (ALL)		
Local Government Unit	Year 2016	The year 2017	The year 2018
Vlora Regional Council	1500000	1500000	1500000
Vlora Municipality	50000000	50000000	7500000
Himara Municipality	3725000	3700000	2000000
Selenica Municipality	6519278	1907880	1907880
Saranda Municipality	50000000	50000000	50000000
Delvina Municipality	700000	500000	1000000
Finiq Municipality	2200000	2000000	1000000
Konispol Municipality	700000	900000	700000
Total for Vlora Region	115344278	110507880	65607880

If the Vjosa River gets out of riverbed, the Fier - Vlora railway track (in the eastern part of Novosela Village) serves as an ambush protecting Novosela Village and lands under the railway track. It was designed not to obstruct the flow of water and it was built in the form of a bridge. The same concept was implemented on the highway too, but the spaces for water crossing are much smaller, also the section where the water of the Vjosa River passes on the highway bridge is smaller than the one on the bridge that joins Levan with the village of Novosela. This causes water to "stumble" and increase its level, adding to the threat of flooding of the Ferras village and its fields. The construction of the bridge over the highway has shown another phenomenon of changing currents threating Bishan village (which appeared in 2015 floods). Lacking information on the total allocated fund for the Vjosa area, bellow we have presented a table with funds provided for emergencies for Vlorë region only.

Table 9 - Logistical resources in the Vlora Municipality, Source: Vlora prefecture

Item	Staff	Excavator	Diggers	Cranes	Boats	Ambulance
Quantity	1237	6	2	4	4	18
Item	**Lab. for analysis**	**Tents for shelter**	**Blankets**	**Firefighter**	**Trucks**	**Emergency Fund (in ALL 000)**
Quantity	3	148	5100	12	10	29926

4. CONCLUSIONS

The necessity for disaster risk reduction measures and studies is evident in Albania, taking into consideration recent events of high frequency and severity of floods and the vulnerability of the communities toward such risks. An important part of disaster risk management strategies and actions, is the identification of stakeholders that are affected from the disasters and their roles. In general, flood risk management consists of the cooperation of public institutions, both local and central government, non-governmental organizations, the community and the private sector. In this study the examine the risk profile of Vjosa River and

propose a flood risk management scenario taking in consideration the vulnerability of this area toward floods and the financial damages due to such events in the last years. In order to have an effective response toward flood disasters, the city council supported by Emergency Headquarters and non-profit organization such as Red Cross, should start the preparation for the potential emergency status since November. Throughout emergencies, further actions are needed such as: setting up tents and temporary shelters; establishing the required transportation for distribution of aid; distribution of food and non-food items and enrolment of population on tends to make sure no one is left behind. In this study we present and assess measures for prevention, strategy of response and implementation of emergency plans by the local institutions for the Vjosa River region.

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IMPLEMENTING MCDM AHP IN TECHNOLOGY SELECTION PROJECT – RENEWABLES CASE STUDY

Abstract: Decision making is a really complex process, especially in the planning phase of a new project. The most prominent challenge is the amount of criteria, objectives, preferences and alternative to account for. From technology options to the specific brand, cost or availability; the set of choices is large and with different utility values in the eye of the developer.
Multi criteria decision methods, and in specific AHP, offer a quantitative tool to account for every relevant detail in this process. Apart from quantitative criteria, it offers the possibility to account for qualitative criteria which are equally important. The aim of this paper is to offer an overview of the advantages MCDM, AHP offers in evaluating all the options available in new project selection.

Key words: Decision making, MCDM, AHP, project, energy, renewables

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1. MCDM AND DECISION MAKING

Decision making is never easy; especially in a dynamically evolving environment. Information asymmetry and imperfect decision making and measuring tools make us stand far away from the perfect solution, settling though for the optimal one. On the other hand conflicting objectives contribute to different levels of difficulties for decision makers.

MCDC- multi criteria decision making methods offer a way to account for more variables and set of choices and opportunities. The most popular are AHP, PROMETHEE AND ELECTREE.

Among them we chose to represent AHP which is commonly used in literature and a growing number of studies.

1.1 AHP – Analytical Hierarchy Preferences

AHP was first developed by Thomas Saaty in 1980. Its logic consists of a set of decision making criteria and a set of options that are being considered. The decision makers outweigh the criteria in terms of importance relative to each other, based on their judgment, and make pairwise comparisons in relation to specific criteria. The option with maximal value is the optimal.

It is the weight criteria vector that indicates the priorities of the criteria, and level of importance between them.

2. IMPLEMENTATION OF AHP – CASE STUDY

2.1 Overview

AHP can become really handy in the planning phase of a new energy project. Small energy generating capacities are developing fast in Albania; with small hydropower (less then 5MW) facilites flourishing through the country.

Through AHP we will illustrate the decision process of an entrepreneur in this case. The region selected is in the upper river flow in Osum, discussing three renewable technologies alternatives. The proposed capacity of installment is 1 MW for each technology.

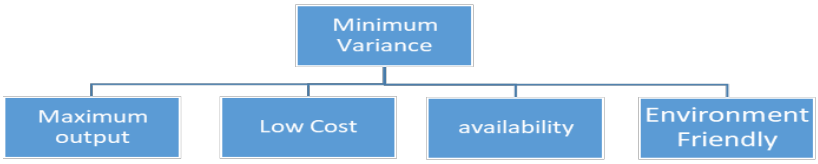
Weather data from Weather Analytics are used to model techology performance for Wind and Solar, and data on the Criteria were generated from SAM. Modeling on Hydro power is made through an EXCEL spread sheet program TurbinePro.

A small energy capacity has a production schedule to fulfill. Production schedules on renewable energy resources are subject to risk, since they depend on natural resources availability: sun radiation; wind speed and flow volume and speed.

ERE uses special prices (feed in tariffs) to buy energy from small plants, and since the price is fixed and regulated by the state Energy Regulatory Agency; to maximize profit main objective is to build the facility around the technology that has the most reliable schedule of output. In this case AHP helps us identify the competitive advantage of renewables in the area.

If we can illustrate the different objectives we consider:

Priority of Objectives Diagram



The set of alternatives consists of:

Every technology has its advantage and disadvantage in comparison to each other. For example, hydropower is less costly, more available, more comparable similar projects in Albania, but less reliable and less environment friendly[15].

Solar panels are most reliable[16], most environment friendly, but cost more, and often require larger areas to be installed.

Wind is the most promoted by EU policy, medium cost, higher output, more environment friendly than hydropower and less costly. But no operating experience in Albania, and less availability.

By implementing a simple form of AHP we can map a decision making trail. First we build a matrix to state the importance of each decision making criteria. We have taken only four criteria in consideration, to simplify decision making.

The matrix input is specific to the case and influenced by the developers judgment and perceptions.

Criteria Relevance Matrix

	LCOE	Output	Variance	Availability
LCOE	1.0000	0.5000	0.2500	2.0000
Output	2.0000	1.0000	0.5000	10.0000
Variance	4.0000	2.0000	1.0000	12.5000
Availability	0.5000	0.1000	0.0800	1.0000
sum	7.5000	3.6000	1.8300	25.5000

Authors calculations

[15] We are considering a project run of river

[16] Albania accounts in average for 256 days with sun

After manually entering the values of the relative relevance of each criteria to another we have set our priorities that the most important criteria is variance, output, cost and the last is availability.

Weight Vector

					Weight
LCOE	0.133	0.139	0.137	0.078	0.122
Output	0.267	0.278	0.273	0.392	0.302
Variance	0.533	0.556	0.546	0.490	0.531
Availability	0.067	0.028	0.044	0.039	0.044

Authors calculations

After setting our priorities, the weight vector is calculated. We can evaluate if the priorities and their respective relevance is according to our judgement.

Our next step is to evaluate the set of choices

EVALUATION OF CHOICES:					
Wind	28.2800	1.20	12.5000	1.00	
Solar	45.7000	1.10	20.4000	5.00	
Hydro	2.3300	1.50	33.1300	8.00	
sum	76.31	3.80	66.03	14.00	

Authors calculations

For the three first criteria we enter generic data like cost, output and variance. For the last criteria, Availability, we value on a scale from 1-10 based on difficulties of providing the technology, operating expertise, and data. Since there is more experience in operating/ evaluating hydro powers availability has the highest score.

AHP, compares each alternative in the light of priority criteria ranking.

	COLUMN-NORMALIZED MATRIX:						Weights
Wind	0.370594	0.315789	0.189308	0.071429		Cost	0.122
Solar	0.598873	0.289474	0.30895	0.357143		Output	0.302
Hydro	0.030533	0.394737	0.501742	0.571429		Variance	0.531
checksum	1.000	1.000	1.000	1.000		Disponibility	0.044

Authors calculations

The highest score is the best offered solution.

	SCORES:
Wind	0.244
Solar	0.341
Hydro	0.415
checksum	1.000

Authors calculations

From the scores matrix we can see that the best solution is to invest in hydropower. To make sure that the solution offered is consistent to our preferences (minimum variance); we calculate consistency index.

In our case; this would be necessary to prove the usefulness of the method. Remember hydro had higher operational risk than wind and solar but still is proven to be the best solution. Nevertheless AHP in this case helps us identify that this technology in this specific area has higher competitive advantage in comparison to the others.

3. CONCLUSIONS

- MCDM and in particular AHP offer to the decision maker an important tool that incorporates many objectives and criteria in the decision making process.
- AHP advantage is that it accounts for qualitative criteria and gives weight to the developers preferences
- The risk in this kind of decision making is that the solution offered might not be consistent with the priorities set.

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IDENTIFICATION OF ENDOGENOUS FACTORS IN REAL ESTATE MARKET: CASE OF TIRANA, ALBANIAN CAPITAL CITY

Abstract: This study analyzes the most important endogenous factors that determine the price of housing in the city of Tirana in Albania. Literature reviews on analysis of immovable property, specifically for dwellings, classifies four major groups of factors that determine their price: (1) economic factors; (2) governmental factors; (3) geo-climatic factors; and (4) socio-demographic factors. The focus of this paper is to analyze the economic factors, with data series 2002-2018 (with 3-month frequency). The analysis used is based on the Unrestricted Vector Auto-regression (VAR) method and the statistical significance analysis of the parameters. According to this analysis, the Tirana Housing Market Price Index has statistically significant positive and negative correlations with the past price trends also statistically significant positive relation with: EUR / ALL exchange rate, Remittance and Index construction condition.

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1. INTRODUCTION

Real estate market is affected by so many factors. The degree level of these factors is subject of different markets and regions, national or international as well (Car.2009). Although, the development of the real estate market of a country on its own, is affected by the development of other markets, to and from which there is a cultural or economical interaction, especially this is remarkable in a legal or governmental issue perspective (Clois and Joan, 2009)

As far as individuals is concerning, buying of a dwelling, is considered as one of the biggest investments in a lifetime (Glindro, Subhanij, Szeto and Zhu, 2008). One the other hand, referring to business entities, the buying of a real estate, is considered as one of the most important decision within their budget capital (Gitman and Zutter, 2012). In this context, the variability of the prices and rents of the real estates is considered as very important information which affects the consumers', businesses' and decision makers' behaviors.

Actually, the Albanian real estate market is characterized by a high level of informality, since post-communist period (1990) till now. The only study regarding the real estate market is referring to buying or renting the dwellings as this is focused only locally. The only official institution that publishes the index of prices and rents of dwellings in Tirana (capital city of Albania) is Bank of Albania. According to Kristo and Bollano (2012), it is difficult to study the prices of dwellings in Albania, due to the following reasons:

a. The buying of a dwelling is mainly the highest expenditure of a family, so the transactions of this type are timely rare.
b. It is very difficult to find two identical dwellings in a time difference.
c. If a "basket" of dwellings will be fixed in a certain time, further changes in a dwelling, such changes as the building of another public or private facility near the dwelling or any qualitative change will direct to a variability of the price.

The variability of dwelling prices surely affect the welfare of families as well as their ability to borrow in order to invest in residential estate, having a further affect in macro economy.

2. LITERATURE REVIEW: FACTORS IN REAL ESTATE MARKET

Theoretical and empirical studies have resulted that a high increased level of credit portfolio, accompanied with a sensitive increase of dwelling prices is one of the most consistent and warning indicator of future financial crisis (Borio and Lowe, 2002). Some comparative studies among countries with different economical and financial development (Tsatsaronis and Zhu, 2004;Annt2005; Egert and Mihaljek, 2007), concludes that the elasticity coefficients of changes in dwelling prices toward main factors sensitively varies according to country's measure, its financial markets development and the period of the study as well. Egert and Mihaljek (2007), while comparing Central East European Countries and OECD ones, analyzed that besides the abovementioned factors, the dynamic of the dwelling' prices is affected by some specific ones such as: the lack of the institutionalization of the dwelling markets; the limited supply of the new dwellings in the moment of the market liberalization; the improvement of the qualitative of the dwellings; the increased demand of nonresidents etc. Some other studies in the field of real market estates, such as Hilbert et.al. (2008); FTI

Consulting (2012) mention 4 main group factors that affect the demand and supply of the market:

a) Economic Factors
b) Governmental factors
c) Geo – Climate factors
d) Socio-demographic factors

Economic Factors: Main economic factors are (Minsk, 1982; Kindlerberger, 1978; Valverde and Fernandez 2010; Suljoti, 2014; Ibrahimaj and Mattarocci, 2014):

The Unemployment level or the employment one, (in a local of national context) indicates the potential of a country to generate the individual income, affecting this way the demand for real estate.

The personal income level shows the ability of the individuals to invest in real estates (for dwellings or business use). This is measured mainly by the average level of wage, and is considered as a key element of the real estate demand.

Construction costs are considered as the main factor of determining the real estate supply. This factor is considered in determining the initial price of these real estates and in Albania this is measured by the "Construction cost index" published by INSTAT. This index is focused on the direct costs of the construction (material costs, wages expenditures, machinery costs, transport costs, electricity costs etc.) and indirect ones.

Credits, is another supply factor (when credits is demanded by the construction companies) and demand factor (when credits is asked by individuals, as a financial tool to buy his/her real estate). Kindlerberger (1978) and Minsky (1982) have analyzed the role that credits have in the price of dwellings history. So, if the credits are in terms of cheap conditions, this will affect the behavior of real estate markets in these countries. In Albania, this can be measured either due to the value of the credits dedicated to buying dwelling estates or business estate , or due to the multiplication of the real estate credits published by the Bank of Albania or Statistical Reports. This can be measured as well by analyzing the facilitated or limited conditions published by the second level banks in the country.

Interest rate: the same as the credits is the factor of demand as well as the factor of the supply. Interest rates are an important factor of residential' investments decision, sensitively influencing the demand for real estate. The measurement of the effects that interest rate have, can be analyzed through crediting rates of the economy. In Albanian case, the financing of the real estate for dwelling or services intentions has the lowest credit rates, compared with other credit rates for other intentions. (Bank of Albania, Statistical report, 2005-2015).

Treasure bonds rates. In Albania the interest rates of treasure bonds,12months' maturity terms, represent the essential quota, from which it is indexed each credits rates or other deposits in second level banks. This means that this rate is considered as the initiation phase of every change in interest rates even for the long term individual credits, which in 90% of the cases is destined for buying dwelling estate. Since in the beginning 2012 and ongoing, this rate has been considerably deduced, while the interest rate of credits in banking sector has not reflected this kind of deduction, this one has remained in the almost sustainable situation (Bank of Albania, Statistical Reports 2005-2015).

Remittances: In Albania, the remittances are a key factor as far as domestic demand is concerning. Since 2013 and ongoing, the remittances level has decreased compared to its level

in GDP (Bank of Albania, Statistical Reports 2005-2015). Even though, it doesn't exist any statistical indicator to show us which part of remittances that enters Albania is destined to the real estate market and which portion of it goes to consumption. Considering this explanation, it is not clear enough to judge for the correlation of this variable with real estate market trend, for all the post-communist period in Albania.

Exchange rate is another important demand factor (domestic currency is ALL) and supply factor; due to the fact that the majority of construction materials are imported in Albania. (General Custom Directorate, Albania 2002-2015). Referring to the internal reports of second level banks in Albania, such as: Raiffeisen Bank, National Commercial Bank, Credins Bank etc, the currency of the credits issued for real estate issues is not in national currency ALL, but manly it is in Euro (Manjani, 2014). As Euro, is the main currency used for exchange in real market estate in Albania, the exchange rate Euro/ALL, is considered to have an important impact in the real income level for all those buyers, whose monthly income are in ALL. During 2006-2010, the exchange rate Euro/ALL, has been considerably increased, but ongoing it has remained in a sustainable level within the interval 138-140, which means that the Albanian currency is constantly devaluated comparing with Euro, which means that Euro has become more expensive for Albanian buyers, whose income are in ALL (Bank of Albania, 2015).

Inflation: as an indicator of decreasing buying power, it affects the disposable income of individuals, so far the demand for real estate. Although, the investments in real estate, are considered as investments which deduct the effects of inflation either in the estate of individuals or businesses. In Albania, the inflation rate is kept stable with the parameters of 2-4% (Bank of Albania, Statistical Reports 2005-2015).

Financial services: are those services linked with: initial credit commissions for real estates, other commissions and tariffs, which refers to the payment for notary services due to buying –selling process.

Governmental factors: The developments in Albanian real estate markets, still remain the hostage of so many legal and institutional problems that these markets have; such as problems with property rights, the registering of the land and properties, legalization etc.(Suljoti and Hashorva 2011). Although, the governmental factors are very complex, but still affective, such as:

Fiscal Policies: Taxes and tariffs on real estates are included here. Fiscal policies are treated as factors, in the contexts of their evaluation process, the legalization etc. In Albanian contexts, these have been accompanied with so many changes and high level of informality (General Taxation Directorate in Albania, 2015).

The literate impact of Government in real estate market. This has to do with the governmental policies toward the decrease of e costs of credits to buy dwelling estate, in the case when the individuals are being financed for buying a single dwelling and not a second or third one, or for a certain classes of the society, or certain regions of the country.

Educational development, the quality of education is directly linked with the buying of real estate for living purposes. If there is a high level of education in a city or in a university area, it is more attractive for residential investments purposes. So, the development of educational policies by the government impacts the demand for real estate for living or services' purposes.

Development of unions: this is an indicator which reduces the risk of undo for the employment contracts by the employee's side, so it affects the employment markets and as result, the stability of the disposable income of the employers. So, the development and the

function of the unions may be a sustainable factor of the demand for real estate, mainly for dwelling purposes.

The quality of public services: there are included here many different public services, but those which counts more are: Health public service, security issues, firefighters services, public transport etc. Many studies have classified these services as very influential toward the real estate demand, especially for living purposes.

Geo – Climate factors: These factors have a convincing importance in real estate market, such as:

Locality: has to do with the local position of real estate markets, such as different geographic or regional areas. Capital cities, main trade centers (customs), port cities, airport cities, big industrial cities, touristic areas etc. has a higher demand regarding real estate, comparing with other city types.

Transport: This factor impacts the demand for real estate and has to do with many types of transport such as: the nearby location with the highways, trade centers, working centers etc.(Smersh, Smith and Schwarts, 2003).

Topography: This factor has to do with the topographic position of the area where the real estate is located and is a factor that impacts the demand. Such areas may be: seaside areas, or under the sea level, lake –side areas, river-side areas, mountain areas etc.

Climate conditions: even this factor is a demand one. Climate conditions are linked with the cost for a normal life, transport problems, energy. Internet etc. So these issues will affect the living costs or costs of doing business.

Socio-Demographic factors: Lastly, within the factors that affect the price of real estates are the ones of socio-demographic nature (Miles et al, 2000), such as:

Population: This refers to the population number in a certain area, the density per square kilometers, average age etc. This factor impacts the demand in a real estate market, mainly for the estates used for living purposes. Albania is a country with young age population and the average age is 35.5 years old (INSTAT, Census 2011), this shows for the high potential need for dwelling estates and services ones.

Family composition: is another incentive or inhibitor demand factor in real estate markets. In reality, families with one or two children may inherit estates from their parents or grandparents; in this case they were not obliged to buy other estates. Although, Albania is a country, which is characterized by a population in increase, mainly in families composition with more than one or two children (including here the capital city).

Conceptual changes of living and work conditions: As the post-communist period is going on in Albania, the concept of the dwelling space for household is changing, so far, the measures of a house has begun to extend its limits 2-3 time more than before, now we can talk for studio, or office space within the house etc. This influences the demand for real estate.

The holidays' culture. This is linked with a new phenomenon, that has its beginnings in Albania since 1990's, so far it is discussed for even a holidays house, for a study children room which is different from sleeping room, which is a new culture, especially for big cities, and this has potential impacts the increase of demand and needs for more living space. While, in the context of business purpose, even the office's culture has begun to adopt the European standards, the companies has established its own campuses, many businesses, even small ones, are adopting themselves with the conceptual changes of the spaces, evaluating the architectural aspects and so on.

The perception of life and property security: this can be facilitated by the insurance companies, the level of security for private properties of individuals in Albania, is one of the most fragile in the Europe, as far as insurance culture is concerning. Although, the idea that an area is percept as one with high level of risks and criminality, holds back the buying of estates for living or business purposes as well as the development of business, especially the small and medium business.

Being friend with the environment: This is a recent time phenomenon and is expected to be part of the Albanian culture, even though in some cities it is already settled. We are speaking here for the friendly constructions in the environment, using of sunny energy etc., often, these kind of buildings are accompanied with additional costs compared with traditional constructions, so that, they impact the supply and demand of real estate.

3. METHODOLOGY OF STUDY

This study we will use the techniques and analysis of linear multiple regression by model VAR, with some macroeconomic independent variables and one specify dependent variable "house price index". The data are taken from official statistics published in statistical reports and institutional studies. These data represent a 3-month time series, for 2002 - 2018. The analysis will begin with finding significant statistical relationships of the unit root and VAR estimate.

ADF Test of Unit Root:

ADF Test of Unit Root. This test is the fundamental of testing the series and return to a stationary series. To realize this, we have used the Augmented Dickey-Fuller test (ADF). According to this test, we test whether a time series of data is influenced by its initial value, by the trend of time or by both simultaneously. The basic equation of ADF test linked with the constant and the trend is:

$$\Delta X_t = \lambda_0 + \lambda_{1t} + \lambda_{2t} X_{t-1} + \sum_{i=1}^{n-1} \lambda_i \Delta X_{t-1} + \varepsilon_t$$

This equation shows a time series (variable in the study) in the form of the first difference $\Delta X_t = X_t - X_{t-1}$ in the period *t*, where is the constant and *t* is the trend, with the null hypothesis, H_0: $\lambda_2 =$ (time series data is non stationary).

Unrestricted Vector Auto-regression (VAR):

Unrestricted Vector Auto-regression (VAR). Through this model we analyze endogenous links of the variables for each variable, meaning that each variable becomes a regression equation of the cross correlated type. The step of control for the connections in retrospect of endogenous values referring VAR model named lag and it is determined by the usable criteria: (1) AIC: Akaike information criterion and (2) SC: Schwarz information criterion. According to this criteria the best lag is 4 (1 year or 4 quarter). The base form of VAR equation with p-lag and k-dimensions (with independent variable X_j for $j = 1, 2, ..., k-1$) is:

$$\begin{cases} Y_t = \sum_{i=1}^{p} \alpha_{1i} Y_{t-i} + \sum_{i=1}^{p} \alpha_{2i} X_{1,t-i} + \cdots + \sum_{i=1}^{p} \alpha_{ki} X_{k-1,t-i} + \varepsilon_{1t} \\ X_{1t} = \sum_{i=1}^{p} \beta_{1i} Y_{t-i} + \sum_{i=1}^{p} \beta_{2i} X_{1,t-i} + \cdots + \sum_{i=1}^{p} \beta_{ki} X_{k-1,t-i} + \varepsilon_{2t} \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ X_{k-1,t} = \sum_{i=1}^{p} \lambda_{1i} Y_{t-i} + \sum_{i=1}^{p} \lambda_{2i} X_{1,t-i} + \cdots + \sum_{i=1}^{p} \lambda_{ki} X_{k-1,t-i} + \varepsilon_{kt} \end{cases}$$

Initially, we will identify the basic equation of the study and then this equation will be tested for all the residual problems. To evaluate the parameters will be used the usual small square method. If this assessment serves to find conclusions with high statistical reliability, we will base on Central Limit Theorem or the Low of Large Numbers. A regression model is useful for economic analysis if complete the main conditions:

The first condition: The linearity should be accordin to parameters.
The second condition: Expected value of the term of error should be E (ε_i) = 0.
The third condition: Variance of of the term of error should be V(ε_i) = E(ε_i^2) = constant.
The fourth condition: Cov (ε_i; ε_j) = 0 for every i ≠ j.
The fifth condition: Nomulticolinearity, for every *i = 1, 2, ..., n*.

By completing all of these conditions, the model is regulated by all the immeasurable deviations and immeasurable casualties.

4. EMPIRICAL ANALYSIS AND RESULTS

The analysis of this study is based on quarterly frequency of time series from 2002 to 2018.The meaning of the variables in the model and their description as well as the source of information is shown in the following table 1:

Table 1. Meaning and description of variables of the VAR model.

The variable code	*Description of the variable*	*Source of information*
Dependent variable:		
ICB	Housing Price Index in Tirana (Capital of Albania), measured in base index, year 2002 = 100.	Bank of Albania
Independent variables:		
IKN	Construction Cost Index (measured in % change, includes all types of direct and additional costs for construction).	INSTAT
KURS	Currency exchange rate EUR/ALL (the housing market has the	Bank of

	price in Euros and the Albanian income in ALL).	Albania
CPI	Consumer Price Index (this indicator measures the level of inflation).	INSTAT
BTH	The treasury bill's yeild rate (measured in %, is the basic index of credit rating in the banking albanian system).	Bank of Albania
PUN	The unemployment rate (measured in%, shows the ability of citizens to repay mortgage loans).	INSTAT
REM	Remittances (the value in million Euro, shows the citizens' ability to purchase housing).	Bank of Albania

Source: Author's summary

After processing the data in Eviews 9, (the time series was transformed into stationaryby the first differences) using the VAR technique in identifying endogenous factors in explaining the dynamics of the housing price index in the city of Tirana (the capital of Albania), the results are as in the table 2, below:

Table 2: Statistical estimation of the model VAR

Dependent Variable: D(CMIM)
Method: Least Squares

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	13.83043	26.79470	0.516163	0.6091
D(CMIM(-1))	0.338502	0.175887	1.924540	0.0627
D(CMIM(-2))	-0.197992	0.168366	-1.175960	0.2478
D(CMIM(-3))	0.244138	0.150008	1.627501	0.1129
D(CMIM(-4))	-0.522106	0.149003	-3.504004	0.0013
D(CPI(-1))	0.442936	1.068677	0.414472	0.6811
D(BTH(-2))	-1312.808	1020.443	-1.286509	0.2070
D(BTH(-3))	-157.3405	833.5701	-0.188755	0.8514
D(BTH(-4))	664.6610	943.6154	0.704377	0.4860
D(KURS(-1))	5.651885	3.317352	1.703734	0.0976
D(KURS(-2))	-0.594742	3.386066	-0.175644	0.8616
D(KURS(-3))	7.845162	3.609722	2.173342	0.0368
D(KURS(-4))	-2.060465	3.888163	-0.529933	0.5996
D(IKN(-1))	-1457.946	1197.974	-1.217010	0.2320
D(IKN(-2))	-867.0168	1737.300	-0.499060	0.6210
D(IKN(-3))	1083.041	1749.840	0.618937	0.5401
D(IKN(-4))	3470.110	1308.325	2.652331	0.0121
D(PUN(-1))	148.1772	1429.521	0.103655	0.9181
D(PUN(-2))	1243.274	1391.218	0.893658	0.3778
D(PUN(-3))	-197.0662	1583.071	-0.124483	0.9017
D(PUN(-4))	-1051.251	1536.296	-0.684276	0.4984
D(REM(-1))	0.645233	0.273131	2.362355	0.0240
D(REM(-2))	0.108341	0.328184	0.330122	0.7433
D(REM(-3))	-0.024732	0.279793	-0.088395	0.9301
D(REM(-4))	-0.122138	0.207333	-0.589091	0.5597

AR(1)	0.203163	0.193516	1.049850	0.3012
AR(2)	0.577651	0.193026	2.992610	0.0051
R-squared	0.675031	Mean dependent var		8.036900
Adjusted R-squared	0.426525	S.D. dependent var		57.82857
S.E. of regression	43.79250	Akaike info criterion		10.69753
Sum squared resid	65204.64	Schwarz criterion		11.63186
Log likelihood	-299.2748	Hannan-Quinn criter.		11.06370
F-statistic	2.716356	Durbin-Watson stat		1.846755
Prob(F-statistic)	0.003356			
Inverted AR Roots	.87	-.67		

Source: author's calculations in EViews 9.

This result is the final out-put of the VAR model, after adjusting any problematic residues of the model mentioned in the methodology of this study. The equation of the VAR model for estimating the change of the housing price index for the city of Tirana is:

$\mathbf{\Delta CMIM_t}$ = 13.83 + $\mathbf{0.34*\Delta CMIM_{t-1}}$ – 0.20*$\Delta CMIM_{t-2}$ + 0.24*$\Delta CMIM_{t-3}$– $\mathbf{0.52*\Delta CMIM_{t-4}}$ + 0.44*ΔCPI_{t-1} – 1312.81*ΔBTH_{t-2} – 157.34*ΔBTH_{t-3} + 664.66*ΔBTH_{t-4}+ $\mathbf{5.65*\Delta KURS_{t-1}}$ – 0.59*$\Delta KURS_{t-2}$+ $\mathbf{7.85*\Delta KURS_{t-3}}$ – 2.06*$\Delta KURS_{t-4}$ – 1457.95*ΔIKN_{t-1} – 867.02*ΔIKN_{t-2} + 1083.04*ΔIKN_{t-3}+ $\mathbf{3470.11*\Delta IKN_{t-4}}$ + 148.17*ΔPUN_{t-1} + 1243.27*ΔPUN_{t-2} – 197.07*ΔPUN_{t-3} – 1051.25*ΔPUN_{t-4}+ $\mathbf{0.65*\Delta REM_{t-1}}$ + 0.11*ΔREM_{t-2} – 0.03*ΔREM_{t-3} – 0.12*ΔREM_{t-4} + 0.2*ε_{t-1} + 0.58*ε_{t-1} + ε_t

From this equation we identify the endogenous links of the factors determining the price of dwellings:

Housing Price Index (CMIM): The dwelling price for the previous periods has a statistically significant positive relation (with a level of 10%) and a negative (with a level of 5%) with the value of its values:

- If the prices of 3 months earlier (preceding 3 months) increase, they will increase the housing price index for the current period. So if the 3-month index of the previous period will increase by 1% this will be accompanied by a 0.34% increase in the price index for the current period (under other unchanged conditions). This link shows that the housing market in Tirana is positively related to short terms behavior, in determining the price equilibrium

- If the prices of the period 1 year ago (the fourth quarter preceding) increase, they will cause a decrease in the housing price index for the current period. So if the 3-month index of the 1-year period will increase by 1% this will be accompanied by a 0.52% reduction in the price index for the current period (under other unchanged conditions). This link shows that the housing market in Tirana is closely linked to the 3-month price behavior of the previous year in determining the price equilibrium. This is justified by the fact that the increase of the price of this period has reached the point of saturation which has been found not to be absorbed by the demand. As a

conclusion we can say that we have been in imbalance conditions continuously after the saturation point.

We conclude that the endogenous effect of the CMIM variable with its value is characterized by the short-term (trend) tendency of the preceding period, while the 3-month long-term prices (1 year or more) have the opposite trend . This fact makes the trend of housing prices in Tirana very dynamic and not stable in time. An influencing factor of the dynamics of the housing price index is the high informality associated with this market and the high level of liquidity in the economy, thus significantly reducing the efficiency of the controlling markets of monetary policy. The low efficiency of the monetary policy impact on price stability is also indicated by the lack of statistical significance of the consumer price index and treasury bill rate (as the interest rate indexed for credit in the banking system in Albania).

Euro / ALL (KURS) "exchange rate " Variable: The price of housing in the city of Tirana is influenced by the exchange rate as the transactions in the housing market are almost exclusively in the Euro currency (also influenced by the fact that mortgage loans from the banking system are almost exclusively in Euro currency). The exchange rate has a statistically significant positive relation (with a level of 10% for 3 months in retrospect and a level of 10% for 9 months in retrospective) with the price rise of the apartments. Changes in the exchange rate are important in the endogenous effects of the housing market for two reasons:

- The first reason is the direct impact of purchasing power, the income of individuals (wages, profits, etc.) are in LEKE currency whereas the loan or purchase price of the apartment is in Euro. This shows the positive statistic linkage of the house price with the exchange rate of the previous period (the previous 3 months). If the 3-month exchange rate will increase by 1% this will bring an increase of the price index by 5.65%.
- The second reason is the impact of the exchange rate on the purchasing power of construction companies, on building materials, reflected in the cost of construction. It is expected to have a delayed connection over a year or more of the cost of building housing, but it resulted 9 months, as construction companies' payments to their vendors are delayed by more than 3 or 6 months. If the third-quarter exchange rate will increase by 1% this will bring an increase of the price index by 7.85%. Related to this, the exchange rate has a higher impact on the cost of construction rather than on the final consumer price. This is justified by the greater elasticity of demand compared to the offer.

We conclude that the endogenous effect of the KURS variable in the housing price index maintains the economic principle of purchasing power of the builder and the final consumer. This variable strongly reflects its positive impact on the housing price trend (exchange rate is one of the main risks for construction companies that most of the purchases of raw materials are imported from countries of the European Union , reflecting in perspective the change of the price only as a result of exchange rate fluctuations especially in depreciating terms of the domestic currency).

Building Condition Index (IKN) Variable: The price of housing in the city of Tirana is also influenced by the construction cost index (this indicator is measured in percentage). This

variable has a positive and statistically important link (with a 5% significance level) in the value of the housing price index. If the IKN variable a year ago increased by 1% (eg. from 2% to 3%), this will be accompanied by a 34.7 point increase in the house price index (the average value of the CMIM variable is 620 and the increase by 34.7 brings about an increase of 5.6% of the current housing price). Under normal market conditions, the impact of the IKN variable on the CMIM variable was expected to be overdue for 1 year or more, for the specifics that the housing market has.

Remittance variable (REM): The price of apartments in the city of Tirana is also influenced by remittances (this indicator is measured in million Euros). This variable has a positive and statistically important link (with a 5% significance level) in the value of the housing price index. If the REM variable of a previous 3 months would have increased by 1%, this would be accompanied by a current increase in demand from citizens for home purchase, under conditions that the bid is not very flexible, therefore in the 3-month period it will have an increase in the housing price index by 0.65%.

5. CONCLUSIONS

Real estate is considered one of the most discussed issues among researchers and experts in the economic field, both in microeconomic and macroeconomic aspects. The analysis of investments in real estate are complex because of the several factors which determine this market, such as: economic, governmental, social and demographic, geo-climatic factors etc.

The level of complexity in the real estate market in Albania is significantly higher because the purchase of a dwelling is considered the largest capital expense for Albanians. Notwithstanding this fact, this market is characterized by a high level of informality and lack of statistical data. The only official data on the housing and rental price index in Albania can be obtained by the publication of the Bank of Albania and the data are limited to the market in Tirana. There is no other official data available.

In this paper, three-month time series from 2002 to 2018 were analyzed to identify time lag factors affecting the price index of the Tirana city dwellings. According to the econometric analysis of the VAR model, the endogenous factors with a positive effect on the change of the housing price index are: EUR / ALL exchange rate; building conditions index; and remittances. Also, an endogenous bipolar impact has the retrospective index values. In near-term periods, the index's prevailing values affect its trend (positive link), whereas in earlier periods the indexes are trivial. In these circumstances, the housing market in Tirana is characterized by an unsurpassed price fluctuation, influenced by the high level of liquidity in the economy. A problematic phenomenon is the low efficiency of the monetary policy impact on the stability of the housing market price, which is indicated by the lack of statistical significance of the consumer price index and the treasury bill rate (as the interest rate indexed for credit in the banking system in Albania).

As we have been pointing out, the performance of housing prices is a specific market which is driven by many factors not only economic. As a conclusion we can say that the offer continues to remain inelastic despite the change of other factors. In this aspect it is to debate the over capital resources generated for this sector and there is an open debate on economic circles, and not only, of money laundering in this sector.

In our study were not included the quantitative analysis as a result of the lack of official data of those variables for this market. This involves limitation of this work so scientific discussion remains open in this regard.

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CURRENT DEVELOPMENTS OF ALBANIAN ENERGY SECTOR

Abstract: Energy sector in Albania is of national importance, being under the continues challenges to supply the increased industry and household consumption, by also being in compliance with the legal and regulatory framework of the Energy Community, part of which Albania is since 2006. Notwithstanding Albania has high potential of alternative sources of energy such as wind and solar energy, biomass, geothermal, currently the lion share of electricity production pertains to hydropower: exposing the country to highly dependency to weather conditions just giving the example of the last 2 years production levels fluctuation as in 2018 was produced electricity from hydropower in the level of 8`552GWh or 89% higher than 2017 of 4`525GWh, which by other hand implies the trade balance of electricity. The purpose of this paper is to provide the framework of the current developments of the energy sector including the transformation of the role of the 3 main actors KESH, OSHEE and OST, first steps in investing in alternative renewable energy sources, creation of the Albanian Power Exchange and liberalization of the Albanian energy market.

Key words: Albanian Energy Exchange, renewable energy, HPP, energy sector, Energy Community.

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1. INTRODUCTION

In 2001 Albania started the restructuring of the electric power system, which previously was entirely managed by the state- owned company KESH sha. The division of the activities started in 2002 and was completed by 2008 and as a result were created 3 separate entities: KESH sha in the role of producer of energy through the management of the Fierza, Koman e Vau Dejes HPP-s and through the purchase of energy from the private producers, OST sha in the role of transition of energy, OSHEE sha in the role of distributor of energy. Currently, all the three entities are joint stock companies, state owned (OST is owned by KESH). Energy Regulation Entity (ERE) is the market regulator. In the same year (2002) were given also the first concessions of the HPP-s construction. In 2015 with the new law [9] on the energy sector the legal framework of the sector is being reformed with the aim of market liberalization and compliance with EU Directives on the Energy sector and Renewal Energy Source. In March 2018 was launched the new energy strategy in 2030 prepared in the framework of USAID programme in support of long-term low emission development strategy [5].

2. CURRENT SITUATION OF ELECTRICITY SECTOR

Albania is almost entirely depended on hydropower for its electricity supply [2], based also on the favorable hydric resources as the country has more than 152 streams which compose 8 large rivers and the hydric network is of about 44K km[1]. The hydrographical territory of Albania has an average of 400mm rain per year distributed 70% of flooding during the winter and 30% in summer and autumn. Nevertheless, it makes the country highly vulnerable to climate changes by being generally a net importer of electricity. Based on Instat data [7] below is reported the energy balance (in MWh) for the last 5 years (2014- 2018).

	Indicators	2014	2015	2016	2017	2018
A	**Available electricity (A=1+2-3)**	**7,793,736**	**7,265,089**	**7,094,061**	**7,439,609**	**7,638,848**
1	**Net domestic production (a+b)**	4,726,246	5,865,671	7,135,914	4,524,981	8,552,154
	% change		*24%*	*22%*	*-37%*	*89%*
a	*Hydro*	4,726,246	5,865,671	7,135,914	4,524,981	8,552,154
	KESH (net of losses)	3,408,556	4,451,975	5,091,616	2,916,990	5,850,934
	% on overall production	*72%*	*76%*	*71%*	*64%*	*68%*
	HPP-s	1,317,690	1,413,696	2,044,297	1,607,991	2,701,220
	% on overall production	*28%*	*24%*	*29%*	*36%*	*32%*
b	*Other sources*	0	0	0	0	0
2	Gross import (including exchanges)	3,355,987	2,355,358	1,826,753	3,403,043	1,771,740
3	Gross export (including exchanges)	288,497	955,941	1,868,605	488,415	2,685,045
	Net Trade Balance	**-3,067,490**	**-1,399,418**	**41,853**	**-2,914,628**	**913,306**
B	**Consumption of electricity (B=1+2+3)**	**7,793,736**	**7,265,089**	**7,094,061**	**7,439,609**	**7,638,848**
1	**Electrical losses (c+d)**	2,783,182	2,195,837	1,985,901	1,876,138	1,783,118
c	Losses in transmission	160,942	158,581	190,008	157,906	242,705
d	Losses in distribution	2,622,241	2,037,256	1,795,892	1,718,232	1,540,412
	Technical losses in distribution	*1,459,175*	*1,366,520*	*1,346,501*	*1,247,678*	*1,070,560*
	*Non technical losses in distribution**	*1,163,065*	*670,736*	*449,391*	*470,555*	*469,852*
2	**Consumption of electricity by domestic users (e+f)**	5,010,553	5,069,252	5,108,160	5,563,471	5,841,106
e	Households	2,501,800	2,522,261	2,587,259	2,655,417	2,681,875
f	Non households	2,508,754	2,546,991	2,520,901	2,908,053	3,159,232
3	**Consumption of electricity by non-customers**	0	0	0	0	14,624
	Production/Consuption (1/B)	**61%**	**81%**	**101%**	**61%**	**112%**
	Losses level	**36%**	**30%**	**28%**	**25%**	**23%**

Figure 44: Energy Balance 2014-2015. Source: Instat (http://www.instat.gov.al)

As noted from the above data the domestic production shows high fluctuations year on year, impacted by the weather conditions, by reaching the lowest level of energy consumption supply at 61% in 2014 and 2017. On the contrary 2018 was a good year as the production increased by 89% compared to 2017 and the country results with a positive trade balance (imp-exp). An important fact to point out is also the loss level reduced to 23% in 2018 (from 36% in 2014), which is one of the important objectives of the energy market strategy through the efforts to curb theft and non- collection.

An interesting fact is also the increase of production share from the privately owned HPP-s, with a maximum share reached in 2017 with 36% of domestic production. As per AKBN[10] data since 2002 are signed 183 concessionary agreements for the construction of 524 HPP-s with capacity of 2`165 MW and yearly production 9`342 GWh with the following summarized situation:

	No	Installed power	Max Annual production
HPP in operation	117	322 MW	1`428 GW
HPP in construction	43	454 MW	1`571 GW
HPP not yet started	364	1`389 MW	6`342 GW
	524	**2`165 MW**	**9`342 GW**

Figure 45 HPP-s concessions situation: Source: AKBN (akbn.gov.al)

3. DIVERSIFYING ENERGY SOURCES

One of the main challenges of the Albanian energy sector is the diversification of the energy sources and fulfillment of the needs by own country resources, by decreasing the import dependence. According to European Commission report Albania thanks to its geographical position and natural resources has a high development potential to exploit country renewable resources [4], which can also create a broad range of ancillary benefits for Albania, including energy self- sufficiency and job creation.

- TEC

In the past in Albania operated also thermo centrals such as Fier TEC with production capacity of 80K KWh, Kombinat in Tirana with production capacity 5K KW, Maliq in Fier with production capacity 5K K, Metalurgjik in Elbasan of capacity 100K Kw. In 2011 a new TEC construction in Vlora was financed by the World Bank of a value of USD 130M, but the structure has never become operative, either due to a technical problem and high costs of diesel fuel. The implanthas return to attention with the TAP project with the idea to enter in production with gas. Moreover TAP project has increased the odds for potential usage of new sources of energy in the south of the country and/or reactivation of Korca and Kucova implants.

- Renewable sources:

a) Wind and solar energy:

The law nr. 7 of 2017 on "Production and usage of renewable energy" [8] foresees the implementation of a set of investments to enhance production of wind and solar energy by setting as objective that within 2020, 38% of internal consumption to be supplied by renewal energy. Indeed according the situation as of end of 2018 provided above from Instat statistics the possibilities of this to occur are quite remote. ERE has also established the prices for the purchase of energy from solar and wind plants set to EUR 100/MW for the solar energy produced by plants up to 2MW power and EUR 76/MW for the wind energy produced by plants up to 3 MW power. Notwithstanding all the Adriatic coast is quite favorable for the construction of solar and wind plants and moreover several licenses are approved by ERE, no investment has been made for the construction of wind plants. More attractive for the investors has been the part of solar plants since several plants are under construction in Banja, Fier (reportedly this one located in the area of Seman has started production and trade of energy in 2019) and a future project is on the way in Vlora. Several months ago the Ministry responsible for the energy market has suspended the permits for the solar plants under 2MW since the presented requests exceeded the production forecasted by the National Plan for the renewable energy sources.

b) Biomass energy:

Biomass is organic material that comes from plants and animals, and it is a renewable source of energy. Biomass is considered as a potential alternative renewable energy source in Albania since 36% of the country territory is covered by forestry and the total reserves of fuel wood in Albania is estimated about 6 Mtoe, in addition there are also estimated good possibilities of energy production from agriculture, animal and waste residuals [4].

4. THE FUTURE: MARKET LIBERALIZATION AND ALPEX

As a result of a new market model has been approved in July 2016 [3], however full implementation is yet to be performed, the energy flow is reported in the below schema:

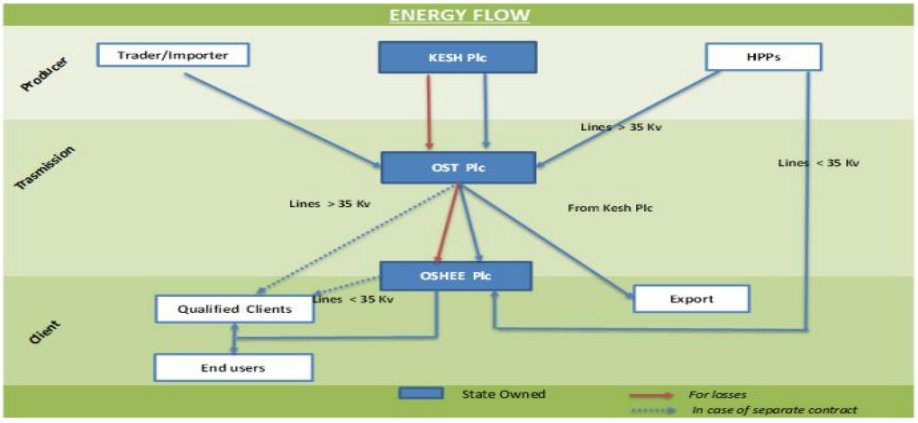

Figure 46: Energy Flow. Source: Chart prepared by authors.

- KESH Plc operates as a Producer of Energy. The energy is sold to OSHEE at a fixed price (EUR 21.4 MWh) for the energy needed by the market. KESH can sell the excess energy to OSHEE at market price (KESH has preemption right, based on a Feb-15 agreement between the parties) and/or export it.
- OSHEE Plc is the Energy distributor and transmission operator for the lines below < 35 Kv. The energy purchase by OSHEE is used to cover the market need and also to cover the losses of energy in the system.
- OST Plc is the Transmission operator for the lines > 35 Kv;
- HPPs – Hydropower plants. Those HPPs, with max installed power of 15 MW, that have an off-take agreement with OSHEE sell the energy to OSHEE at a price decided every year by ERE (average price of the Hungarian Power Exchange Energy Budapest Stock Change + 1.24 spread). For the HPP above 15 MW the price seems to be set by individual contract.
- Qualified clients – energy consumers, which are connected to different level of energy (110 Kv – 0.4 Kv). Such consumers have different purchase prices decided by ERE.
- Trader / Importers – Provider of energy for OSHEE after a bidding process. Such energy is used by OSHEE to cover the losses in the system.

Starting from 2006 when Albania becomes a member of the Energy Community, the country has been in process of restructuring of the regulatory environment in the energy sector as a result of undertaking the obligations in the context of Stabilization and Association with EU and with the purpose to increase efficiency and develop an organized electricity market[6]. One of the most important novelties of the new law in the power sector is the introduction of the Albanian Power Exchange. With the introduction of the new market model in 2016 it was said that ALPEX would be operative starting from 2017, by as of the end of 2019 the project is not yet brought to life. However, since the new market model provides concrete steps toward the creation and functioning of the ALPEX it can be estimated that the future cash flow of the market will be as per the below schema.

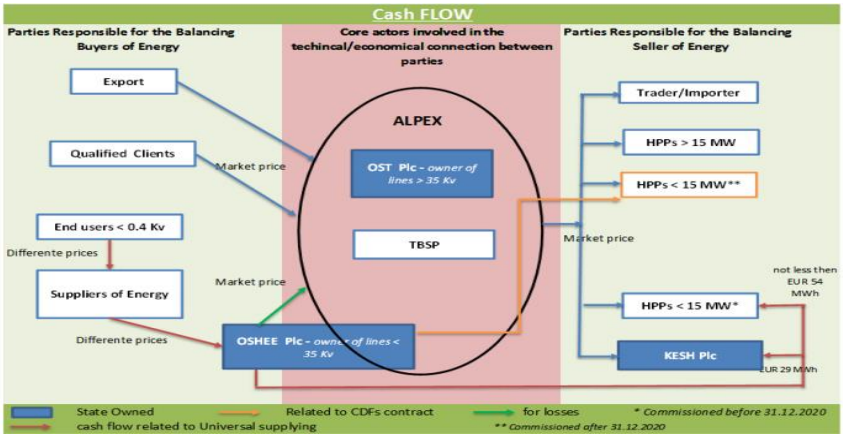

Figure 47: Energy cash flow. Source: Chart prepared by authors.

Energy Regulation Entity (ERE) is/and will continue to be market regulator. The licenses for the operator in the market are and will continue to be granted by ERE. Currently the energy prices are set by ERE, while as per the liberalization of the market the price will be set by the market. OST which will provide transmission and dispatching services for the line above 35 Kv. – almost the same role as the current one. In addition an internationally experienced Technical Balancing Service Provider (TBSP) should enter the energy market, which is expected to provide market technical balancing services for the Albanian Power Exchange (ALPEX). Initially, until entering into full operation of the ALPEX, the economic aspects of the transaction will be conducted by TBSP. OSHEE will provide transmission and dispatching services for the line below 35 Kv and will be also responsible to cover the losses in the market (as per current situation). KESH will be only a producer of energy. Existing HPPs with installed power below 15 MW or the one which have ended the commissioning process of the plant within 31.12.2020 will continue to have their energy purchased by OSHEE based on a price determined by ERE, however not below EUR 54 MWh, for the remaining part of their off-taking agreement. Previously the energy balances/imbalances in the market were settled between the state owned companies. With the new law also the HPPs are responsible for the settling of the imbalance.However, until the entering in the full operation of the Energy balanced market, but not later than 31.12.2022 the HPPs will not be responsible for the imbalances costs. Such cost will be covered by OSHEE [3].

The new market model presented above is yet to be implemented. Considering the current level of information available it can be roughly estimated the following implication to the existing actors of the market:

KESH

1. Decrease of the turnover as a result of the fact that the HPPs directly sell their energy to OSHEE;

2. Improve of the margin as a result of the fact that the HPPs directly sell their energy to OSHEE (KESH was buying at min EUR 54 MWh and was selling it at EUR 27 MWh (on average))

Constructed HPPs:

1. As long as they have an off take agreement with OSHEE, no much changes are expected in their turnover (price will not go down to EUR 54 MWh / OSHEE will still be obliged to buy the energy produced by the HPPs for the remaining time of the off take agreement);

2. Not later than 31.12.2022 the HPP will be responsible of the settlement of the imbalances in the energy market. Remains unclear how this might influence the profitability of the companies.

Unconstructed HPPs:

1. If they are commissioned before 31.12.2020 the implication are the same as above.

The implementation of the new market model of the Albanian Electricity market represents a huge and serious challenge for the Albanian Government and all the involved actors, which should act accordingly to the rules of the new market model. The main objectives of the new market model as set as a) organization of a full opened market toward the full market liberalization and integration, b) increased and improved participants in the market, c)

customers protection by providing qualitative energy with fair and competitive market prices [11].

5. CONCLUSIONS

Based on our understanding the main challenges of the Albanian Electricity sector are as listed below:

1. Promote the increase of domestic production by diversifying the energy sources beside hydropower, mainly by utilizing the potential of the renewable energy sources.
2. Establishing an organized day ahead electricity market, which will increase the efficiency of energy management, by setting transparent and competitive prices. The establishing of the Albanian Exchange Power might possible incentivize also the trade of financial instruments such as futures and hedging.
3. The 2 above points will contribute in creating a sector with a favorable environment for attracting new investments and financings, improving energy quality and increase value to all the actors in the market and final consumers.

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IT TEACHING TOOLS FOR BUILDING FIRE SAFETY

Abstract: This paper illustrates two integrated codes developed as supporting tool in teaching structural fire safety at DTU. The first software, called SteFi, is a verification tool for ensuring the resistance of steel elements against a parametric fire. The second software, called SEID-BIM is a Dynamo code capable of exporting the geometry of selected structural elements from REVIT to STEFI and then importing back into the REVIT model the insulation calculated in STEFI. Both software present innovative aspects in that they support and integrate into the BIM environment a verification tool for a simple but reliable design of structural elements against parametric fire. In particular, such tools fill the current design gap represented by the almost exclusive use of the standard fire as design fire for structural fire safety, which was favored by the possibility of using simple design tables, but is known to be non-conservative in several cases.

Keywords: Structural Fire Safety, Parametric fire, Building Information Modeling, SteFi, SEID-BIM

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1. INTRODUCTION

This paper illustrates the functioning of two integrated codes developed as supporting tool in teaching structural fire safety at DTU. The codes have been developed with the aim of addressing two current design issues of structural fire safety: the lack of a fast tool for parametric fire design of structural elements (software called SteFi) and the difficulties of importing and exporting the structural data from and into a Building Information Modeling (BIM) software (software called SEID-BIM). Both issues are described in the following paragraphs, while a description of the two software is provided in Chapter 2. The conclusions are presented in Chapter 3.

1.1. Parametric fire design for structural fire safety

In most European countries, structural fire safety design is carried out by ensuring the fire resistance of structural elements for a given time of standard fire exposure, defined by the resistance class of the elements (ranging from 15 to 240 min and indicated as R15, R30, …, R240). The standard fire (ISO834 [1]) is a nominal, monotonically increasing, temperature time curve, which should supposedly encompass the vast majority of compartment fires. However, the maximum temperature reached by a structural element during fire is affected more by the duration of the fire than by the peak temperature of the fire. Therefore, the conservativeness of the standard fire is utterly dependent on the conservativeness of the required resistance class.

Resistance classes are defined at national level, often on the basis of the compartment occupancy. However, resistance classes required by the same type of compartment differ strongly from one country to another [2]. A striking example is the resistance class of open car parks, which varies from 15 min in UK to 90 min in Italy. A comparison of the resistance classes required by different European country is provided in an Italian report from 2006 [3].

In addition to such variability of the safety level across Europe, the conservativeness of the standard fire curve has also been challenged by the low-energy requirements of modern buildings, which often present more insulating linings of the compartments and have double or triple glass layered windows, which do not easily break during fire, thus limiting the ventilation of the premises.

This is well illustrated by the chart in Figure 48, reproduced from a M.Sc. study carried out at DTU in 2013 [4]. The blue lines in the charts represent the parametric fires corresponding to a traditional compartment (left chart) and a compartment in a modern low-energy building (right chart). The red lines represent the equivalent durations of the standard fire for the respective parametric fires. It is seen that the R120 requirement (indicated with a vertical dotted line on both charts) is conservative for the traditional compartment (left chart), but strongly unsafe, if applied to the new compartment (right chart), where a R240 should be instead required.

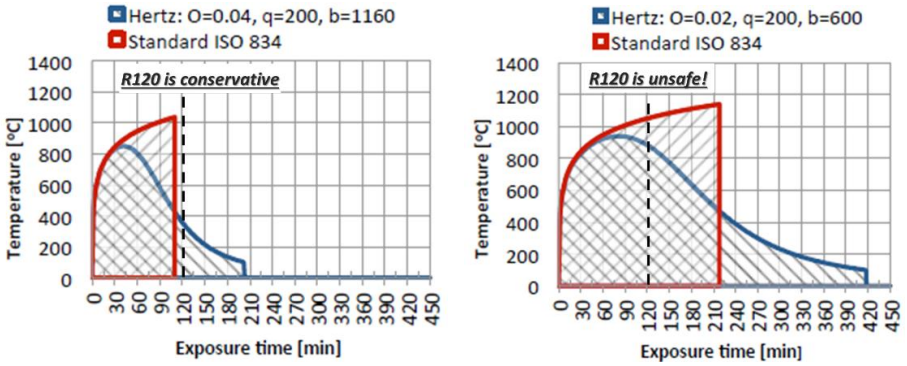

Figure 48 - Conservativeness of the standard fire for old (left) and new (right) building compartments [4]

Unfortunately, standards and regulations hardly follow the pace of technological innovation and resistance classes prescribed by national codes have not been updated on the basis of the increased fire duration expected in the compartments of modern buildings. As a consequence, a design based on standard fire cannot be considered sufficiently reliable and is not conservative with respect to more realistic design fire, as a simplified design method should be.

For this reason, teaching of structural fire safety at DTU (in course 11023, Structural Fire Safety Design) has been based on parametric fire design. However, the use of parametric fire is challenged by the fact that it requires more time than the standard fire design. This is not due to an intrinsic higher complexity of the parametric fire, but mostly to the lack of ready-to-use design tables, which are instead commonly available in case of standard fire design (e.g. in the Eurocodes [5] for concrete elements and on information material distributed by the producers of insulating materials for steel elements). Some design tables for parametric fires are available on an old report written by the Swedish founders of the method [6]. However, the tables are related to a specific material model and require numerous interpolations to be used for the values of current parametric fires, as both the fire load, thermal inertia and ventilation of common compartments have changed with respect to the 70'ies.

The development of the software SteFi [7] was meant to address this problem and implement a simple tool for verification and design of steel elements based on parametric fire, similar to what indicated in [6].

1.2. Integration with Building Information Modeling

Building Information Modeling (BIM) is a 3D model-based process for creating and managing information on a construction project across the project lifecycle. The use of BIM software in the Architecture, Engineering and Construction (AEC) industry is rapidly increasing [8] across Europe and is particularly developed in the Nordic Countries, such as Norway, Denmark, Finland, and UK. In particular, the BIM method has been mandatory in Denmark since 2011 for a vast number of building typologies [9].

The key aspect of BIM success lies in the possibility of monitoring all aspects of the design process and of anticipating design choices at earlier design stage, thus allowing for a more efficient optimization of the overall project costs. The lack of an efficient design

optimization is also a problem in current design methods for structural fire safety of steel elements. Typically, ultimate limit state (ULS) and service limit state (SLS) conditions are considered for designing and optimizing the structural elements. Only at a later stage, the elements are verified against fire. As a result, a significant amount of insulation must be used to protect open and slender steel profiles, such as I-profiles, which possess great resistance at ambient temperature, but are heated much faster than closed and thicker profiles during fire [10]. A recent study carried out at DTU [11] has shown that, in case of a steel car park insulated with intumescent paint, a reduction up to 36% of the material costs could be achieved, by anticipating the fire verifications at an earlier design stage, where the choice of a different steel profile was still possible.

Despite such great potentiality in reducing the project costs, the use of BIM is still not developed as it could and often does not include all different design aspects. This limitation is mostly due to the lack of integration between the BIM software and the other software used in the different building engineering disciplines (building energy, fire safety, structural calculations, geotechnics, etc.) [12]. The reason is that, although all major BIM software can import/export the building geometry into Industry Foundation Classes (IFC) files [13] [14], the geometrical data can hardly be directly imported without modifications into another software [15]. In most cases, the modifications are so cumbersome, that it is faster to implement a new model from scratch in the software of interest. In case of structural design, a separate model is typically implemented in an FE software, by manually importing the geometrical data. Even in case of simple buildings, where a sectional analysis is sufficient for designing the structural element, geometrical data and mechanical properties of each element must be found in the BIM model by the user and manually exported in the sectional analysis tool.

The export of the outcome in the BIM model is then a further step, which is not often completed, due to time limitation and the additional effort required by the task. As a result, the BIM model does not always include all information that could be stored, such as the mechanical properties of the materials or the precise details of the connections, reinforcing bars, and such. This issue is particularly limiting in case of steel elements that must be insulated against fire with board panels. Since board panel insulation modifies the shape of the profile and the encumbrance of the elements, it is important to update the BIM model with such changes.

The SEID-BIM code [15] has been developed with the aim of addressing such issue and providing a fast tool to export input data and import back the resulting insulation data between a BIM model and the software SteFi for fire design of structural elements. This tool is expected to be of use for students following a course on integrated design of tall buildings at DTU (course 11080 Advanced Building Design), which is based on the development of BIM models for a tall building.

2. INTEGRATED SOFTWARE TO SUPPORT TEACHING

In the following, the functioning of the two software is briefly presented. Both programs have been developed at DTU and are released as open software (Creative Common Attribution ShareAlike 4.0 International License), in order to be freely available to the students and any other person, who wants to use the software (under his/her own responsibility) or modify the code. The source code is freely downloadable on GitHub [16].

2.1. SteFi

SteFi is the abbreviation of Steel in Fire and is a calculation tool to verify or design the insulation of steel elements exposed to either parametric or standard fire. The software has a graphical user interface that is made of four windows illustrated in Figure 49.

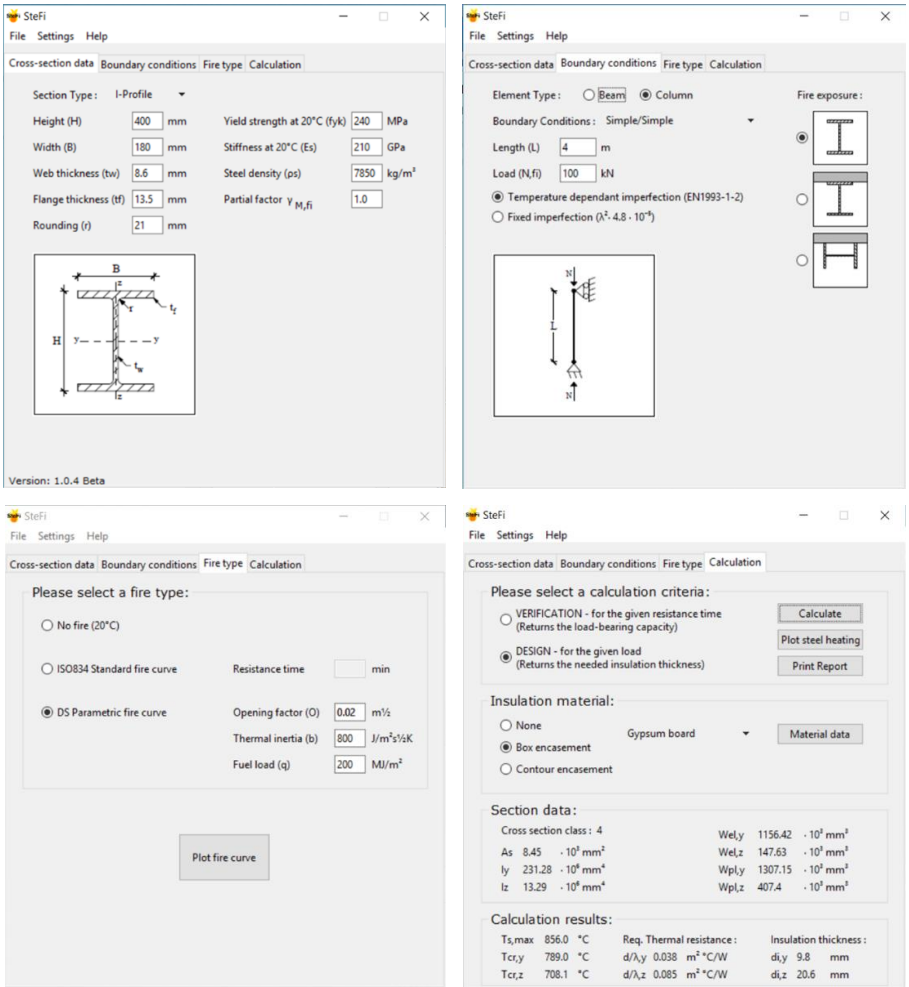

Figure 49 - The four windows constituting SteFi's GUI. From left to right and top to bottom: input of geometry, input of boundary conditions, input of fire solicitation, and results [17].

The first window collects the input data on the cross-section geometry of the element and on the mechanical properties of the steel. Such data can be either manually input or imported from the BIM software Revit [18] or IFC file by selecting the option File/Import Data in the

top menu and then selecting an excel file created by using the software SEID-BIM, as described in the following paragraph.

In the second window, information on the element must be input, such as the element type (beam or column), element length, mechanical load and thermal boundary conditions (exposed and adiabatic/insulated sides).

In the third window, information on the fire must be provided. In particular, one of the following three different cases can be selected:

i. no fire (this option corresponds to the common structural analysis of the element at ambient temperature);
ii. standard fire (in which case, the duration of the fire exposure must be indicated);
iii. parametric fire (in which case, the fuel load density, thermal inertia of the enclosure and opening factor must be input)

In the fourth and final window, the results of the calculations are shown. At the top of the page, it possible to choose between verification or design calculation. If a verification is made, the element can be calculated as unprotected or protected with an insulating material of given properties and thickness. The user must provide both pieces of information, while the program gives as output the load bearing capacity of the element ad compare it with the load specified in the second window. If a design calculation is of interest, the user must only choose the type of insulation, while the program gives as output the insulation thickness required for ensuring a load bearing capacity equal to the load specified in the second window. Such results can be printed on a report and also registered on an excel file, by selecting the option File/Export Data in SteFi's top menu. The data in such excel file can be read by SEID-BIM and imported back into the BIM model, as better explained below.

Further information on the functioning of the software and details on the calculations methods, used material models, libraries for profiles and insulating materials, etc., can be found on SteFi user guide [17]. An application showing the use of the software and differences between the available calculation methods is also presented in a DTU M.Sc. report [7].

2.2. SEID-BIM

As previously mentioned, SEID-BIM is a software capable of exporting and importing data from and into the BIM model. Thus, it allows using the information contained in the BIM model without having to manually find and input the data, which would be very time-consuming. Automation is the key factor to make fast verifications and to obtain an improved decision making process at the early design phase, which often leads to both reducing costs and improving the quality of the design.

The software is openable through the "Manage" menu of the Revit interface, clicking on "Dynamo Player" under the "Visual Programming" tab. Here it is possible to choose whether to export or to import data. As shown in Figure 50, SEID-BIM contains four processes, 2 for exporting and 2 for importing the data, as the import/export of the data can be made directly in Revit or by means of IFC files. IFC is a standardized format called Industry Foundation Classes that is compatible with several BIM software and can, therefore, be of interest for students or professionals, who do not have the Autodesk license for using REVIT. A user-friendly Graphical User Interface (GUI) guides the user in both cases.

On the left of Figure 51, a window is portrayed, which appears after choosing the "Export from REVIT" option listed in the window shown in Figure 50. In this case, the user is asked to select the element to calculate by clicking on it directly in the Revit environment. Then a directory to save the excel file with the exported data should be selected and a name to the file can be assigned. Since the program is optimized to be coupled with SteFi, the excel file with exported data is built according to the data and order of data required by SteFi. However, it contains information that is needed by most software for sectional verification of steel profiles and could therefore easily be adapted to serve as input file of other structural software as well. In particular, the following information is registered in the file:

i. geometrical parameters, such as the dimensions of the section and the length of the element;
ii. material properties, such as the density and the Young's modulus;
iii. boundary conditions (how the element is connected to neighboring elements.)

Figure 50 - The Visual Programing tab in the Revit environment and the main window of SEID-BIM

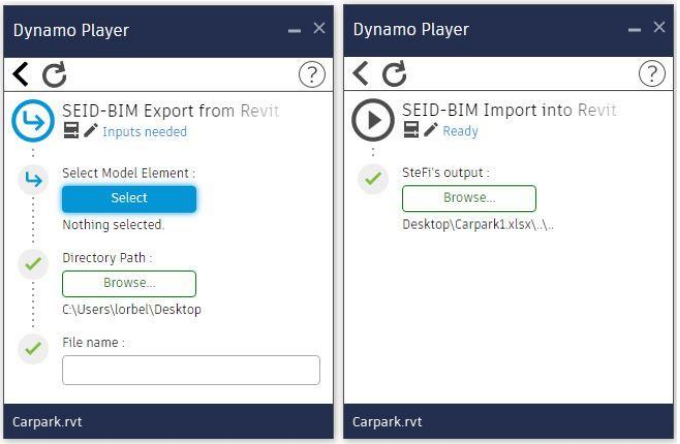

Figure 51 – Window of SEID-BIM for exporting (left) and importing (right) data from/into Revit

This information can be directly imported in SteFi, by choosing the option "File/Import Data" from the top menu in SteFi (Figure 48) and selecting the excel file created by SEID-BIM. Once the calculations are performed in SteFi, as described in the previous paragraph, the results can be exported by choosing in SteFi's top menu the option "File/Export Data" and selecting the same file used to import the data. The results are appended at the end of the file and are then read by SEID-BIM, when starting the import procedure. This is done by choosing the option "Import into Revit" (right side of Fig.4) and then selecting again the excel file that has been updated after using SteFi.

When the file is imported, not only the new information is stored in the appropriate sections as text, but the insulation is modelled as a physical element in the Revit model. This is relevant for the design, since it provides all actors involved in the design process with a better understanding of the space occupied by the insulation of the structural elements. Furthermore, the fast design process allowed by the combined use of SEID-BIM and STEFI allows to calculate the fire insulations of the elements at an earlier design stage and also repeat the verifications several times, in order to compare different design alternatives. This is a great advantage, as not only the encumbrance, but also the costs of the insulation can be compared and a more optimized design can be easily obtained.

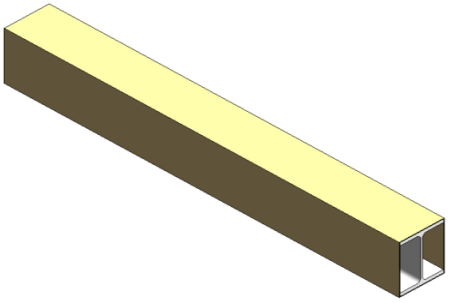

Figure 52 - A steel profile protected with boxed insulation in the Revit, after importing data from STEFI

3. CONCLUSIONS

An integrated software has been developed at DTU as support for teaching Structural Fire Safety. In particular, the students of the courses 11023 Structural Fire Safety and 11080 Advanced Building Design are expected to be the main users of the integrated software, which allows for quickly export, design, and re-import insulated steel element into a BIM model.

The integrated software is made of two different programs: a stand-alone program called SteFi, aimed at designing steel beams and columns against fire, and a Dynamo routine called SEID-BIM, aimed at exporting input data from the BIM model to SteFi and importing back SteFi's results into the BIM model. Either REVIT environment or the more general IFC format can be used for the BIM model.

The software presents two main innovative aspects:

i. the inclusion of structural fire calculations into the BIM environment allows for a representation of the real encumbrance and final costs of the insulated elements and therefore a more effective optimization of the materials and saving of the project costs.

ii. the possibility of considering more realistic fire models, thus accounting for possible longer heating of elements in modern buildings, which could not be safely covered by the resistance class method.

It is important to point out that the software is at a first stage of development and many improvements should be yet done. Possible improvements of the software are related to both the algorithms (e.g. the inclusion of effects of hindered thermal expansion in SteFi or the export of arbitrary profiles in SEID-BIM) and the GUI's functions (e.g. corrections of minor bugs, inclusion of other libraries for the fire models, element profiles, and insulating materials). However, the open license the software has been released with allows users and future students to modify the source code and include of these and other aspects in the software.

4. AKNOWLEDGMENTS

The contribution of Thomas Dyhr and Mikkel Andersen, who wrote the code of SteFi in the framework of their M.Sc. project [7] is gratefully acknowledged.

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APPROACHES OF ENCLOSURE FIRE DEFINITION IN PROGRAMS FDS AND CFAST

Abstract: This paper focuses on the potential ways of representing design fires in two commonly used fire modeling software packages – CFAST and FDS. Three possibilities of design fire specification were investigated – fuel package burning simulation, prescription of heat release rate to a fixed area and radially spreading fires. The results indicate that the most common way of prescribing fires offers good accuracy in cases where the source fire test conditions do not differ too significantly from the modelled conditions, i.e. depend on the level of extrapolation. The radially spreading fire offers the possibility of controlling the both the heat output and the area of the design fire, however, lack advanced control in FDS. The direct simulation of fuel package burning is only possible in FDS at the moment. Although, most advanced, the underlying combustion sub-models are rather simple and may not necessarily result in a realistic output, especially where significant thermal feedback within the enclosure is expected.

Key words: computer modelling, fire definition, FDS, CFAST

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1. INTRODUCTION

Computer modelling is becoming a popular tool in fire engineering as it makes it possible to comprehend. the investigated problem of dynamics of fire in an enclosed space. However, the quality of outputs is fundamentally influenced by a large number of circumstances where the correct definition of input parameters plays a crucial role.

By enclosure fire modelling it is especially challenging to credibly interpret a model situation with different detail levels. This paper is focused on fire modelling of a case with a sofa in an enclosed space by using FDS and CFAST software packages.

2. APPROACHES TO FIRE DEFINITION

Different detail levels of enclosure fire modelling have already been an aim of research in multiple papers e.g. [1, 2] and generally there are two extremes that could occur. One is represented by a fully furnished room and the second one by an empty room with a prescribed time-dependent fire. Reduction in fire specification brings uncertainty into the process of fire modelling, which we should thoroughly point on.

This paper deals with a case study of different fire definition approaches in softwares FDS and CFAST. Particular ways of defining the modelled fire together with belonging model, which is possible to carry out, and the way of application are shown in Table 10.

Table 10- Methods of enclosure fire defining in computer models

Fire definition	Fire model	Aplication approach
Furniture fire in rectangular geometry	FDS	Enclosure space / free combustion
Fire with prescribed HRR per area	FDS, CFAST	Enclosure space (HRR values from ISO 9705) Enclosure space (HRR values from furniture calorimeter) Enclosure space (engineering approach – t^x fire)
Radially spreading fire	FDS, CFAST	Enclosure space / free combustion

Real furniture modelling is possible only in FDS. Since the program works with a rectangular calculation grid, the resulting objects only approximate their geometry with the real ones. This method of definition assumes a high similarity of outputs with real fires.

The most common way of defining a fire is to prescribe it using *HRR* (Heat Release Rate) values obtained during fire tests in fixed area. If the fire does not take place in a fixed area, it can be defined as a radially spreading fire. In the absence of fire test data to define the fire, the fire development model can be established based on the maximum *HRR* t^x values.

3. CREATED SCENARIOS USING DIFFERENT WAYS FOR DEFINING FIRE

For the purpose of comparing several ways of defining the fire, a closed space model was created in the FDS program. It has the dimensions of 2.4 x 3.6 x 2.4 m with an opening of 0.8 x 2.0 m to correspond with the "room corner test" according to ISO 9705.

3.1. Fire of furniture in rectangular geometry

On the chosen model, it is possible to verify not only the enclosed fire, but also the fire of free combustion (furniture calorimeter) of the sofa located under the intake duct of the combustion flue exhaust [3]. Figure 53 illustrates the selected model for the fire definition assessment study.

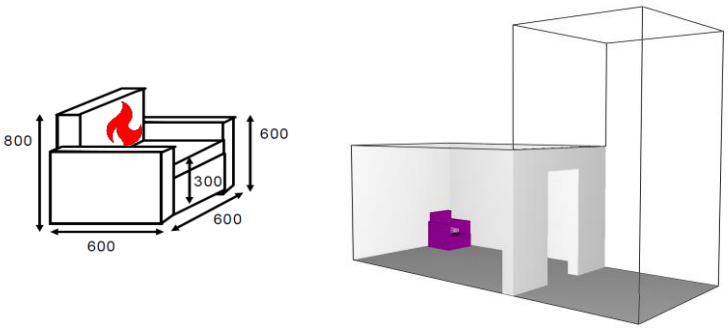

Figure 53 - Upholstered sofa dimensions together with fire initiator position (left) and FDS enclosure space model according to ISO 9705 (right)

The *HRR* data in time according to ISO 9705 as well as additional input information were obtained from an experimental study available at [4]. The 30 kW ignition source was located in the center of the sofa in the immediate vicinity of the backrest for the first 120 seconds.

During the fire in the furniture calorimeter (free burning), the sofa, together with a finer calculation grid, moved from the corner of the room in front of the door into the open space, ensuring free exhaust of flue gases without a thermal effect on the fire itself.

3.2. Fire with prescribed *HRR* per area

Another approach to defining a fire is to simplify it by prescribing *HRR* values on the specific area from which it will burn. This is one of the most common ways of defining fire using mathematical models.

Based on the *HRR* values, the fire of upholstered sofa can be rewritten into a simplified form of surface fire according to the following formula [5]:

$$HRRPUA = \frac{HRR}{S} \quad (1)$$

where:

HRRPUA - heat release rate per unit area [kW/m^2],
HRR - Heat release rate [kW],
S - fuel burning area [m^2].

In this case, the actual sofa surface was selected as area *S*. *HRR* values were taken from experimental measurements in enclosure space (as in the previous model case). Since real geometric objects are not used, there is no need to define material properties, which ultimately facilitates the process of modelling itself.

3.3. t^x fire with prescribed HRR per area

With a completely simplified engineering approach using a t^x fire, it is possible to start from the triangular model of upholstered furniture fire in the enclosed space. Figure 54 shows the principle of this simplified model [6].

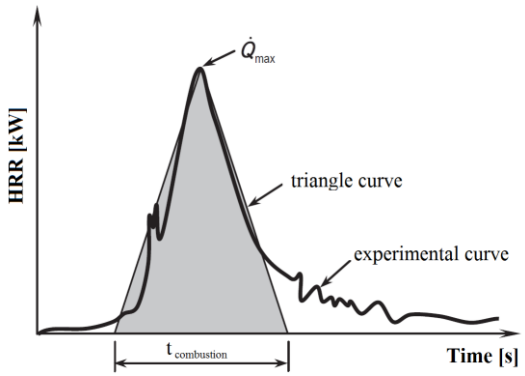

Figure 54 - Triangular fire model of upholstered furniture [6]

3.4. Radially spreading fire

The principle of the radially propagating fire in the enclosed space is shown in Figure 55.

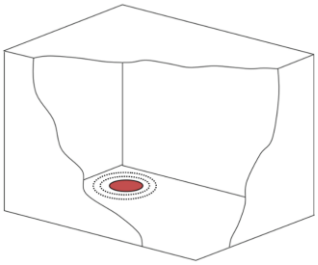

Figure 55 - Radially spreading fire in the enclosed space

This fire definition makes it possible to eliminate to a large extent the problems of fire with the prescribed *HRR* on a fixed area. By spreading the fire from a specific point at a specific velocity (FDS) in all directions or increasing its area (CFAST), a more natural representation of the development phase occurs.

4. OUTPUTS OF INDIVIDUAL FIRE DEFINITION APPROACHES

This section presents the outputs of the individual approaches to fire definition, which are graphically compared with the experimental outputs of fire in a closed space (from [4]).

4.1. Fire of furniture in rectangular geometry

The enclosure fire of the sofa reached a maximum *HRR* of 1.3 MW, both in the experimental test and in FDS modelling (Figure 56). However, FDS outputs lack a more gradual fire development, resulting in a power output of 0.6 MW approximately 50 seconds earlier than the real test.

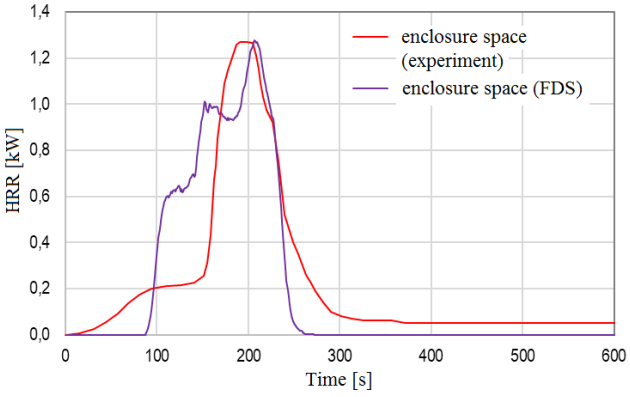

Figure 56 - Comparison of experimental and modeled outputs in the enclosed room according to ISO 9705 [4] (modified)

After integrating the two curves and comparing the total heat released (experiment = 136.62 MW; FDS = 124.21 MW; experiment difference -9%), it can be concluded that the FDS program represents the actual combustion with sufficient accuracy.

By free combustion, maximum *HRR* values up to 0.6 MW were achieved, which is almost half the output (-46%) compared to the enclosed space. This confirms the fact that even if the same fuel configuration was used in both cases, the fire performance is largely influenced by ventilation. The FDS outputs approximate to the experimental output data (Figure 57).

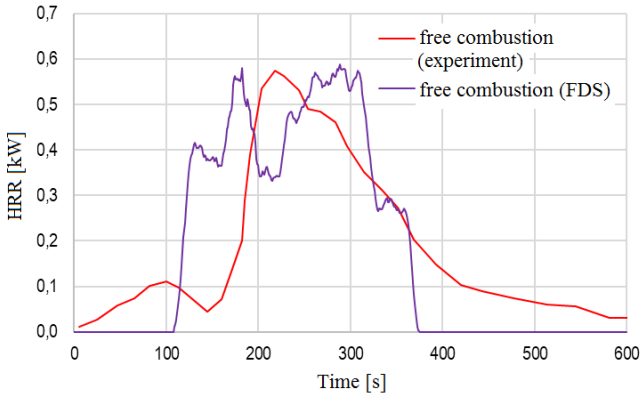

Figure 57 - Differences between experimental measurements and FDS modelling by free combustion [4] (modified)

Although the curves at first seem different, in both cases almost the same total amount of heat was released (experiment = 113.11 MW; FDS = 107.14 MW; experiment difference -5.3%).

4.2. Fire with prescribed *HRR* per area

Figure 58 shows the differences between the real sofa fire in the enclosed space and the fire with prescribed *HRR* value per area.

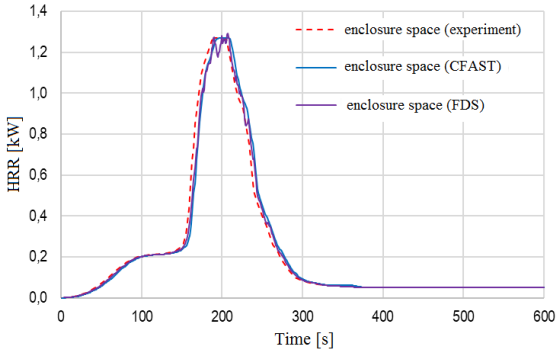

Figure 58 - Differences in fire performance between fire of furniture in rectangular geometry and fire with prescribed HRR per area [4] (modified)

The outputs of individual models, whether in enclosed space or by free burning (in FDS and CFAST), are expected to be almost identical to the course of the experiment. Deviations are caused only by the rounding of the power values, or more precisely by the reducing of the time interval in the case of the fire with the prescribed *HRR* per area.

4.3. t^x fire with prescribed HRR per area

Figure 59 shows the t^1, t^2 a t^3 increase model of the sofa fire in the enclosed space.

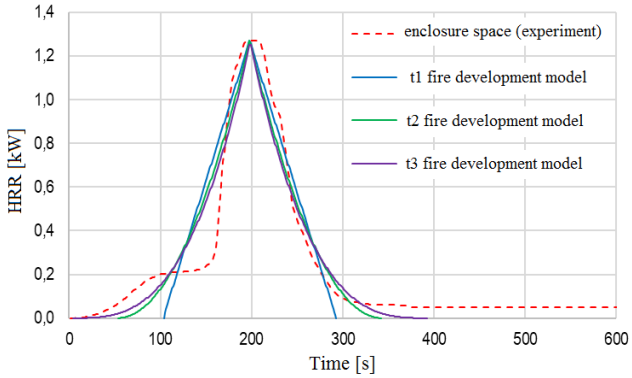

Figure 59 - Simplified t^x sofa fire model [4] (modified)

The differences in total released heat between the experiment and the selected fire-growth models are shown in Table 2.

Table 11 - Differences in total released heat between experiment and selected fire models

Fire model	Coefficient α [kWs^{-2}]	Total released heat [MW]	Difference comparing to experiment [MW]
t^1 model požiaru	13,3684	120,6	-9,0
t^2 model požiaru	0,0604	121,5	-0,3
t^3 model požiaru	0,0002	122,6	2,9

As can be seen in the table, the t^2 fire model approached the experiment outputs with its value of total heat released. Its negative value indicates a slight underestimation, but it is so low that it can be compared to a deviation.

4.4. Radially spreading fire

Comparison of the FDS and CFAST enclosed space combustion with the experiment of the radially spreading fires is shown in Figure 60.

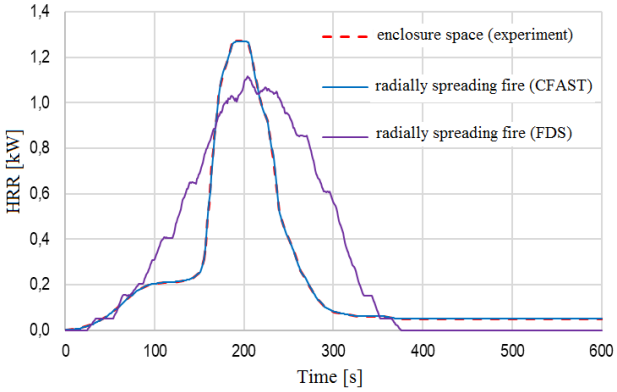

Figure 60 - Radially spreading fire of upholstered sofa in FDS and CFAST

In the figure above, a great similarity to the t^2 fire can be observed at the FDS development phase. However, this is purely random, because the fire spreads radially at a speed of 0.0029 $m.s^{-1}$. The total heat released for FDS was up to 186.45 MW, which is 49.83 MW (36.5%) more than in the enclosed space experiment.

5. CONCLUSIONS

In this paper, the available options of fire definition in fire modelling using FDS and CFAST in enclosed space were analyzed. The chosen case study was focused on the fire specification based on experimental values from burning of upholstered sofa in the enclosed space as well as in the open space.

The definition of fire is largely influenced not only by the variability of the different ways in which a fire can be prescribed, but also by the uncertainty associated with the input data itself.

If there is sufficient data amount of the materials, the actual development of the fire and the time to create the individual simulations, an adequate way is to define the fire of real objects in the rectangular geometry. Although the fire with the prescribed HRR on the fixed surface may appear to be more accurate from the study outputs of the HRR development, it is the influence of the smoke layer position in the enclosed space that indicates its shortcomings. Under simplification conditions, for a given fuel configuration, it is still the most accurate way to define the fire with a combination of the FDS and the CFAST programs.

In the absence of the fire data for upholstered furniture category it is appropriate to choose t^x fire with the prescribed HRR per area. The outputs pointed out that there were no significant changes compared to the fire with the prescribed HRR on the fixed area.

The application of natural development (radially spreading fire) is too complicated and inefficient for furniture fires due to the quality of the outputs in FDS. However, a similar approach in CFAST is relatively easy to apply and also provides relevant outputs.

The carried out case study showed the importance of defining fire in the modelling process. The high sensitivity to the available input data and the fact that it is not possible to isolate the individual fuel parameters and the development of combustion, which would generate randomly generated data, were confirmed.

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MANAGING THE FIRE RISIK IN THE OILSEEDS STORAGE

Abstract: Dangers of fire outbreak during processing and storing of oilseeds (sunflower, soy, oilseed rape) can be pronounced if proper protective measures aren't taken. There's a great risk of self-heating and spontaneous combustion of the oilseed mass during storage in silos due to inadequate and unprofessional management of the technological process. Since spontaneous combustion can result in smoldering fires which are exceptionally difficult to extinguish, understanding and preventing this process is of great importance. This article will explain the factors that influence the start and intensity of initial processes. Physicochemical parameters and minimal temperatures for seed ignition will be determined on an experimental example in the lab, with the purpose of finding key causes of fire outbreaks in oilseed industry, and presenting the solution for reducing the risk of fire outbreak.

Key words:fire outbreak, spontaneous combustion, silo, oilseeds.

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1. INTRODUCTION

Oilseed grain is used for getting oil, that is, it serves as a reproductive seed material.Oilseeds include sunflower, rapeseed, soybeans, castor, peanuts, sesame and poppy seeds (grain products).For quality oil, oilseeds are stored in a specific way and their storage is quite demanding, given its physical and chemical properties.Oilseed storage facilities are the most commonly reinforced concrete silo cells composed of the silo body, an overhead silo containing seed conveyors, and a sub-silo space consisting of a funnel for expelling the seed mass.Raw oilseeds are most commonly delivered in silos with different moisture content and impurities, which are very difficult to adapt technologically to the high degree of uniformity of basic technological and safety parameters.

During storage of oilseeds in silo cells, fire is most often caused by the process of self-oxidation of the seeds resulting from various oxidation processes and biological activity that can cause pyrolysis, i.e. smoldering fire.During the development of the process of self-oxidation, the seed loses quality and the resulting oil is darker in color.By increasing the temperature during self-heating, the dispersion of the seeds decreases and at the end of the process the mass is adhered by bonding with the decay products. The end result of seed decomposition is charredmass.If the process goes out of control, in addition to major damage to stored seed, significant damage is caused to the facilities and equipment.Extinguishing such fires is complex, associated with the constant risk of dust explosion and extremely dangerous for firefighters if proper precautionary measures are not followed.The fire departments must be aware of the potential fire risk indicators associated with the silo's structural characteristics.

2. SELF-HEATING PROCESS OF OIL SEEDS

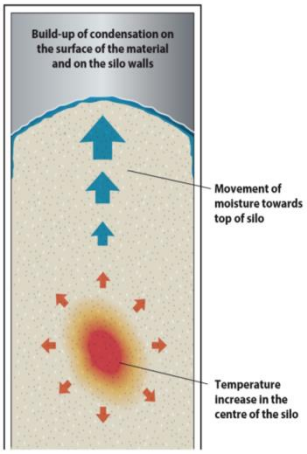
As mentioned in the introduction, the greatest danger to silos and other oil storage facilities is the possibility of self-heating, ie. spontaneous gradual accumulation of heat in stored mass. There are several possibilities for starting the process of self-oxidation of seed mass during storage and those are:

- Exothermic processes occur due to the creation of a suitable substrate for the development of microorganisms.The development of microorganisms is more intense with higher moisture content in the system.Due to the poor thermal conductivity of the oilseeds, the generated heat accumulates, and can reach a temperature of about 70˚C when the microorganisms die off, but the oxidation process continues;
- Due to the growth of the germ (germination) as in the previous case, if there is an increased moisture content, exothermic processes can occur and the temperature of about 70˚C can be reached when the germ dies off, but the oxidation process continues;
- By oxidizing unsaturated compounds contained in the seed with oxygen from the air. Oxidation processes can flow intensively especially on the double bonds of fatty acids that are activated by the presence of an acid group.Unlike the previous ones, these processes can also take place at high temperatures.

In accordance with the above, the self-heating process is characterized by two phases[6]:

- Initial phase, the seed is heated to 60-70˚C (this phase is initiated by micro-organisms, germination and oxidation process);
- Heating phase, in which both oxidation and non-oxygen processes participate.

The heating process takes place throughout the mass of stored seed, but the highest temperature is located in the center of the silo where the heat losses are lowest (Figure 1).If the temperature becomes high enough, spontaneous ignition of the stored mass will occur.A smoldering fire will use up oxygen from the air inside the mass of stored material, and heat and volatiles will move toward the top of the silo.The pyrolysis zone will move slightly downward, where it can still be supplied with oxygen.The rate of fire growth is affected by the flow of oxygen, which can significantly accelerate the growth of fire. If there an air inflow from the environment occurs through a mass discharge port or other opening, flames will be generated and the combustion will proceed with greater intensity.



Slika 1- Prikaz razvoja požara u silosu[1]

Visualization of the measured temperatures inside the silo, artificial increase of the temperature in the silo 1m in diameter and 6 m height is shown in Figure 2. The resulting fire originated in the middle of the silo and was then left to unfold freely resulting in the fire spreading to the bottom of the silo. The combustion gases climbed to the top of the silo after about 20 hours. Immediately after 30 hours, inert gas was injected at the bottom of the silo, which quickly reduced the intensity of the fire [2].

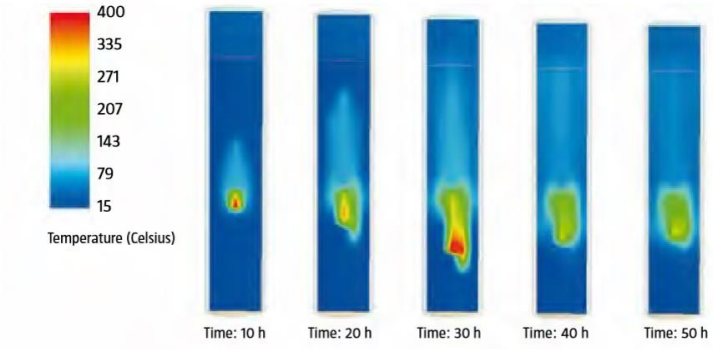


Figure 2- Illustration of the development of artificially induced silo fire [2]

This experiment found that the moisture and gases generated by combustion were moving at a rate of 0.1 m / h (2.5 m / day) toward the top of the silo, while the pyrolytic combustion process was moving toward the bottom of the silo at a rate of 0.04 m / h (1m / day).

During combustion, combustion products, CO2, CO, as well as unburned hydrocarbon residues are created in the space above the grain mass, which is the time when fire can be spotted. The concentration of volatile gases in the presence of air can create the condition for an explosion.

Thermal cameras as an early warning measure cannot be effective because of the large differences in surface temperature and in the center of mass. Thermal sensor cables are a better solution for early fire detection, but they can also sometimes be unreliable for the reason that they may be on the verge of pyrolytic combustion.

The conclusion that follows is that measuring and studying the concentration trends of certain gases (such as CO, CO2, hydrocarbons) in combination with temperature monitoring is a very important component of preventive action (early indications).

Study of the safety of stored soybeans in metal silo cells, made for this purpose, where soybean grain samples are stored: [1]

- Sample S, grain with a moisture content of 10.99% (recommended for commercial storage) and;
- • samples C1 and C2, grain with heightened moisture content of 16.99%, which enhances the processes that lead to spontaneous heating.

Silo cells are made of stainless steel. The cells are cylindrical in shape, 2 m high, 1 m in diameter, 1,695 m3 in volume. At the top of the cell there is a filling hole and at the bottom a discharge hole. The openings can be hermetically sealed.

The required amount of carbon dioxide for a grain of soybean moisture of 10.99% is 2.69 kg / cell, and for a grain of moisture of 16.96% is 2.81 kg / cell. The cells were filled with carbon dioxide through the ports at the bottom. The gas flow rate is set at 2.5 m3 / h.

Measurements showed that even in a hermetically sealed cell with sample C2, there was a change in the composition of the air. The oxygen concentration after 16 days of storage decreased to 10.7% and after 33 days to 8.6%. Based on this, it can be concluded that after 15 days of

storage conditions have been established when the processes which lead to spontaneous warming are slowed down.

The measured values of grain moisture in sample S were between 12 and 13%. In samples C1 and C2 the grain moisture varied between 18 and 19.5%. It is evident that there is no significant difference in the change in humidity of the grain stored in the atmosphere of the carbon dioxide and in the sealed cell. The moisture content of C2 samples (from a hermetically sealed cell) was on average about 4% lower than in C1 samples (carbon dioxide cell).

The values obtained show that the amount of oil in samples S (soybean with lower moisture content) ranged from 15.43 to 21.38%. In the samples with higher moisture content (C1 and C2) the oil content varied from 16.46 to 21.59%. Therefore, the amount of oil in the grain was not affected by the moisture content of the grain as well as by the storage conditions. There was no significant change in the amount of protein in the soybean under the test conditions.

Of all the changes that occur in the grain during storage, the most sensitive are the changes in oil quality. It is common for changes in oil quality to be monitored by determining the content of free fatty acids. Increased free fatty acid content is an indicator of lower oil quality.

During the experimental study, for 216 days, the recorded grain mass temperatures were relatively low (max. 25 ° C), and it was concluded that they had no effect on storage conditions that would lead to spontaneous heating. Measured values of oil and protein content showed that the high grain moisture content did not adversely affect the quality of the soybean. Also, the color of the soybean grain remained unchanged. Oil quality control from all samples was monitored by measuring the free fatty acid content and no significant change in quality was detected.

3. CHARACTERISTICS OF OILSEEDS

For quality oil, oilseeds are stored in a specific way and their storage is quite demanding, given the physical and chemical properties. Chemical properties have a far greater impact on the successful storage of oilseeds for a longer or shorter period. Self-heating is a process that should not be allowed, and is related to the humidity and temperature of the grain. During the storage of oilseeds, the amount of oil (fat) and the amount of water are the most important components that affect the course of biochemical processes.

The chemical composition of individual oilseeds is shown in Table 1. [4]

Table 1.- Chemical composition of certain oilseeds

Culture	Fats (oils)	Proteins	Nitrogen-free extractives	Mineral substances	Moisture
Sunflower	22,2–36%	10,5– 19,1%	10,5–19,1%	2,6–4,1%	6,4–12,9%
Soybean	12,0–21,0%	31,1– 40,3%	21,9–31,1%	3,4–14,0%	5,4–12,9%
Oilseed rape	35,5–45,0%	19,5–21,5%	15,7–18,0%	3,6–4,3%	7,3–12,0%

Oilseeds contain different amounts of oil (40-60% by weight of seeds or 80% by weight of kernels) and also protein (1.5-2 times more than in cereals). Most oilseeds have two saturated fatty acids (palmitic and stearic) and three unsaturated fatty acids (oleic, linoleic and α-linoleic).

At the same time, rapeseed oil has many unsaturated (Erucic) acids. Oil seeds have an average of 16-28% protein, with globulins accounting for the most.

Of all the types of material stored in silo cells, the most problems occur during the storage of sunflower seeds, since sunflower seeds have a high oil content, and that the outer shell, which is very thin and delicate, easily breaks, leading to rapid development microorganisms. Like all other seeds, sunflower seeds germinate if moisture increases above 11%. Therefore, intense self-heating of oilseeds can occur when the grain is stored with increased moisture and impurity content [2].

Even though they are properly dried and stored in clean and disinfected silo cells, the job is not done. During storage it is necessary that the grain temperature can be controlled. The temperature of the grain must not reach the temperature of the self-heating, since in this case the process of exothermic polymerization reactions, i.e. self-heating of the grain, begins. Self-igniting polymerization processes (anaerobic processes) can only be stopped by cooling the seed mass (which is done by huge fans at the bottom of the cell).

For oilseeds, according to Voskierushka (Trisvyatskiy, 1966), there is a formula by which moisture can be determined for optimal storage of oilseeds [3]. The formula reads:

$$V = \frac{14xZ}{100}$$

Where:

V – moisture amount limit, (%);

Z – 100 – oil amount (%);

14 – constant.

The upper limit of storage moisture is determined by the following formula [4].

$$W = \frac{16x(100 - U)}{100} - 2$$

Where:

W (%) – Upper limit of storage moisture;

U (%) – the amount of oil in an absolutely dry state.

4. THE EXPERIMENTAL PART

The physicochemical parameters and minimum ignition temperature of the ground samples of soybean, sunflower and rapeseed were tested on three samples taken from the technological process of oil production. The delivered seed samples were ground to a particle size below <250 μm before their analysis. The minimum ignition temperature of ground seed samples was determined using the standard test method EN 50281-2-1 [1].

Table 2 gives the parameters of the immediate analysis of the samples tested in accordance with the standard SRPS EN ISO 665: 2008 [5].

Tabel 2.- Parameters of the immediate analysis:

Parameter (% m/m)	Oilseed rape	Soybean	Sunflower
Moisture	5,82-6,40	8,62-9,30	5,73-5,80
Cinders	3,31-3,61	4,50-4,59	2,74-2,91
Volatiles	89,09-90,76	85,81-87,31	87,86-90,31
Flammable carbon	8,40-9,82	11,01-12,23	8,86-11,09

The parameters of the immediate analysis of the investigated samples of oilseeds from the technological process indicate that these are seeds of uniform quality. Moisture content is a very important parameter since increased content triggers negative biochemical processes in the seed. The percentage of non-combustible matter (moisture and cinder) in sunflower ranges from 8.54-8.64% w / w, in rape from 9.13-10.01% w / w soybean 13.21-13.8% w / w m. In terms of moisture content of the tested samples, it is evident that soybeans have the highest content of 8,62-9,30% w / w, followed by rapeseed with 5,82-6,40% w / w, and sunflower with 5,73-5 , 80% w / w. Also, the tendency of oilseeds to self-ignite is also explained by the high content of crude fibers, which increases the surface exposed to oxygen and thus the distribution of oil through the fibers.

Figure 3. shows a device that tested the minimum ignition temperature of seeds of shredded samples 5 mm thick.

Figure 3.-Self-ignition temperature measuring apparatus

During the experiment, the lowest ignition temperature within 30 min, the time to reach the auto-ignition temperature, and the firing mode were measured. For all the oilseeds tested, the

minimum ignition temperatures within 30 min were in the range of 240-270˚C, i.e. the following results were obtained:

- The ignition temperature of ground rapeseed ranged from 250-270˚C;
- The ignition temperature of ground soybean seeds was 250˚C for all three samples;
- The ignition temperature of ground sunflower seeds ranged from 240-250˚C.

The time to reach the minimum self-ignition temperature of the oilseeds tested is below 10 minutes and is shortest for the ground soybean seed.No difference was observed in the results for rapeseed and sunflower seeds. In case of the tested oilseeds, smoldering combustion occurs. The temperatures of the heated surface are insufficient for self-ignition and flame combustion.

5. CONCLUSION

When storing oilseeds in silos, self-heating can occur, viz. spontaneous gradual accumulation of heat within the stored mass. Experience says that human omissions are the most common cause of fire, irresponsible behavior, but also lack of knowledge of storage technology and the explosive characteristics of oilseeds in the silo.Modern silos offer many solutions for early detection of temperature rise within the stored mass, as well as monitoring of fire risk. The paper presents the most significant influencing factors on the occurrence of self-heating of stored mass of oilseeds and some of the preventive measures for safe storage. The optimal humidity for storing oilseeds ranges between 7 and 10%. Experimental investigation of ground oilseeds from technological process has determined minimum ignition temperatures in the range of 240-270 ºC. In order to manage fire risk in an oilseed storage facility, it is very important to assess the fire risk, identify the areas at risk, and to act preventively with all available technologies.

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MULTI CRITERIA DECISION ANALYSIS FOR WILDFIRE RISK FOR NOVI SAD, IN SERBIA

Abstract: The forested areas along Mediterranean region but mostly Serbia are ranked as first-degree fire sensitive zone. Nowadays forest fires result in important economic losses and even threaten human lives. Thus, it is important to determine the wildfire zones with high fire risks and minimize the damages on forest resources by taking preventive measures in these regions.

This article presents a method to collect, assay and estimate spatial information for wildfire risk assessment for Novi Sad city in Serbia. The framework consists of three phases; collection of spatial data, risk analysis, and risk assessment. At the final phase, the model will generate two different maps that categorize the forest surfaces by their Wildfire Ignition Probability Index and Wildfire Spread Capacity Index.

Key words: Wildfire,Risk, Ignition Probability, Spreading Capacity, Assessment

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1. INTRODUCTION

1.1. Background

Forest fires are a serious problem mostly in dry regions covered with vegetation as they affect the sustainability of forest resources [1]. Forest fires may cause huge detriment on forest ecosystems and affect forest resources sustainability negatively. Forest fires not only can decrease the economic value of the present vegetation but may cause massive loss of human lives and generate great amount of greenhouse gasses (CO2 and CH4). Another problem usually out of focus is that after fire incidents, fire-damaged trees become more sensitive to insects and fungus [2]. Forest fire risk mainly depends on various factors such as forest ecosystem, carbon-rich vegetation, topographic features, seasonally dry climates, atmospheric oxygen, widespread lightning, volcanic ignitions, and climatic parameters [3].The fire risk is relatively low at early stages of trees, while risk is very high at young generations [5]. Then, fire risk decreases from the mature to over mature stages, since accumulation of crown and surface fuels increases with stand age [4]. Topography is an important factor that affects the fire risk of the area. Fire potentially spreads slower down slopes and most faster in slopes. Besides, the fire risk increases as ground slope increases. In term of aspect, fire risk is higher in south-facing aspects due to high temperature and low humidity.

Worldwide studies and projects are continually done to increase the awareness of hazards from fire. An important area continually at risk is Balkan-Mediterranean area. Development of projects for this area promote transnational cooperation to improve and to implement systems for early detection of forest fires by controlling and protecting the environment [6].

Nowadays is a necessity to map areas with high fire risk capacity as with zone mapping can be done an accurate assessment of forest fire problems (Jaiswal et al., 2002). In order to generate forest fire risk maps based on spatial data layers that represent various fire risk factors we integrate Geographical Information System (GIS) techniques with Multi-Criteria Decision Analysis (MCDA) method. This alternation provides quick and effective solutions to complex spatial problems [3]. The MCDA method widely used in the field of forestry is Analytical Hierarchy Process (AHP) as multi-criteria decision-support method. In this study, GIS and AHP method was implemented to generate forest fire risk map for Novi Sad Region, in Serbia [7].

1.2. Overview

Forest fires are free-burning fires, and they cannot be controlled. The rate of spread, size, intensity, and life cycle of wildfires is a natural phenomenon in the forest and in the atmosphere above the forest. Physical, chemical, and atmospheric factors and their complex relationship influence forest fire behaviour, most important factors that have a greater impact in forest fire behaviour are: fuels, weather, and topography [8].

In Balkan Mediterranean area happened more than 800 wildfire events only during 2014. These fires have spread over 20 kha of which 25% have been Natura 2000. Wildfires are considered fatal events, that destroy infrastructures, world heritage sites, wildlife habitats and timber, and also produce CO2 in the atmosphere. The effects from the large and repeating fires alternated with wrong post-fire management practices are fatal for both natural environment and human communities. Early wildfire detection contributes greatly in the forest protection and reduces considerably the extent of burned forest land [9].

Forests occupy the area of about 4 milliard hectares, accounting for 30% of the total globe area. Forest area in Europe (without Russia) is 193 million hectares or 34%. In Serbia, forests occupy 2,252,400 ha (state forests 1,194,000 ha or 53.0%, and private forests 1,058,400 ha or 47.0%, according to the National Forest Inventory of the Republic of Serbia, 2009) or 29.1%. The percentage of forest

cover in Serbia accounts for 34.0%, including thickets, shrub and brush land. Forest fires are the most extreme aspect of forest devastation or complete destruction [10].

Figure 1 Novi Sad Location in Serbia, Balkan

Figure 2 Forest in Serbia

2. STUDY AREA

For study purposes in this paper it is taken into consideration the city of Novi Sad, which is located northern Serbia on the banks of the Danube River.

The main goal of this study is to unfold a risk assessment method, by alternating different methodologies, in order to use it as a decision support tool in disaster risk management and fire safety for forests in Novi Sad. In this study we aim to develop a method for indexing the forest surfaces by their wildfire ignition probability and wildfire spread capacity. It relies on three stages; (1) collection of spatial data, (2) data analysis, (3) and risk assessment by calculating and mapping Wildfire Ignition Probability Index (WIPI) and Wildfire Spread Capacity Index (WSCI) [11].
In the last 10 years the main causes of wildfire ignition in Serbia are: 66 % have been started by human activities, 3 % have had a natural origin, 31 % have been of unknown origin [11].

3. PURPOSE OF THE STUDY AND OBJECTIVES

As stated previously, wildfires are very common phenomenon in Serbia. This hazard may cause human tragedies, huge loss of lives, property damages, were the main reasons for choosing this topic. Novi Sad in Serbia is a city that is exposed to wildfire, therefore it is needed to generate GIS based maps categorized surfaces by their wildfire ignition probability index and spreading capacity index. Other reasons why this study was done are:

- The lack of studies about this issue in the Novi Sad region, Serbia.
- Providing some efficient methods to Multi-criteria analysis of zones affected by forest fires and analysing the factors that mostly affect the wildfire ignition and spreading
- Propose measurements to be taken into consideration in the Disaster Risk Management of Novi Sad region

The main objectives of this study can be listed as following:

- Generating a forest fire map by using GIS-based methods by considering risk factors in Novi Sad, Serbia;
- Generating maps with categorized surfaces by their wildfire ignition probability index and spreading capacity index in Novi Sad, Serbia; (Society for Photogrammetry and Remote Sensing [7];
- Multi-criteria analysis of areas affected by forest fires and analysing the factors that mostly affect the wildfire ignition and spreading.

Other objectives of the study may include:

- Evaluating a disaster database and making a disaster profile for the study case.
- Understand the concepts of hazard assessment, main importance elements at risk mapping, and risk assessment regarding wildfire events.
- Indicate the main factors that make up a wildfire risk assessment.
- Formulate the spatial data requirements for wildfire risk assessment [12].
- Develop the requirements of hazard data and methods.
- Prepare a fast, available and cost-free method of Wildfire risk mapping.
- Have a meticulous study case in how a risk assessment could be carried out[13].

4. METHODS

4.1. Research method

- The study explained through phases:
- Defining the study area that is Novi Sad in Serbia and the objective of the study.
- Preparing a review of Novi Sad, Serbia Hazard profile regarding Wild-fires.
- Spatial data collection from various repositories and data procession using QGIS 3.4.7 software.
- Weighting the criteria based on Analytical Hierarchy Process method.
- Classification of criteria values into 10 classes based on Jenks natural break.
- Preparing the maps through layout features for publication.

This study uses Quantum Geographical Information Systems as main software for the hazard risk assessment. A Geographic Information Systems is a computerized system that collects, stores, manage, combines, analyse and visualize spatial information and related non-spatial data. The ultimate purpose of GIS is to provide support for fast decision making based on spatial data, as in this case we are dealing with rapid phenomenon such as forest fires. Spatial data can be stored in various ways [12].

4.2. Input Data

Remote sensing data (satellite images) are always in raster format. Thematic data (e.g. contour lines, land use, geology) are digitized as vector data, but they can be converted to raster. The general purpose geographic information systems essentially perform six processor tasks[12]: Input, Manipulation, Management, Query, Analysis, Output and Visualization [13].

Input raw materials that were used in this study are summarized in the table as shown below:

Table 1 Materials

Criteria	Units	Index	Raw material	Source
Solar radiation	w/m²	E_1	Solar Gis	World Climate
Precipitation	mm	E_2	Copernicus	Copernicus
Maximal temperature	°C	E_3	Copernicus	Copernicus
Wind speed	m/s	E_4	Copernicus	Copernicus

Slope	°	P_1	DEM	Copernicus
Orientation	°	P_2	DEM	Copernicus
Altitude	°	P_3	DEM	Copernicus
Distance to Water Surfaces	m	P_4	Urban Atlas	Copernicus
Distance to Urban Centers	m	S_1	Urban Atlas	Copernicus
Distance to Settlements	m	S_2	OSM	Google
Distance to Any Road	m	S_3	OSM	Google
Distance to Main Roads	m	S_4	OSM	Google
Distance to Agricultural Land	m	S_5	Urban Atlas	Copernicus

First input will be boundary, urban atlas and DEM for Novi Sad, the information will be taken by Copernicus Webpage.

Figure 3 Novi Sad Boundary extracted from QGIS

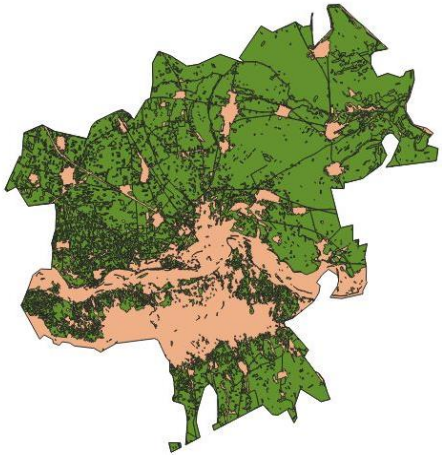


Figure 4 Novi Sad Forest Areas extracted from QGIS

Characteristics like P1.Slope, P2.Aspect, and P3.Altitude will be taken from DEM file, in Copernicus webpage and forest areas are extracted from this map as shown in the figure.

Since we should analyse only forests areas to determine the wildfire risk, we provide reference points with 500 m distance with each other. In total we will have 912 reference points for city of Novi Sad in Serbia. Then maps are overlapped for each characteristic with the reference points. Like this we generate 13 layers for each distance with the analysed characteristics we used in this study. Then we take a map generated by using point sampling tool, for 13 used layers.

4.3. Methodology

During QGIS operational work we insert plugins as NNjoin, Point Sampling Tool.

- The NNPlugin joins two vector layers (the input and the join layer) based on nearest neighbour relationships. The result of the join is a new vector layer with the same geometry type and coordinate reference system as the input layer.
- The Point Sampling Tool Plugin collects polygon attributes and raster values from multiple layers at specified sampling points. The plugin creates a new point layer with locations given by the sampling points and attributes taken from all the underlying polygons or/and raster cells.

In this study is used AHP to generate the impact factor each criteria would have in reference with their relevancy to either ignition or spreading of a forest fire.

The Analytic Hierarchy Process (AHP), introduced by Thomas Saaty (1980), is an useful tool that help with complex decision making, since analyses by comparing the impact of two factors at the same time for one index, and may aid the decision maker to set priorities and make the best decision easily. By reducing complex decisions to a series of pairwise comparisons, and then synthesizing the results, the AHP method helps to obtain both subjective and objective aspects of a decision. In addition, the AHP incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus reducing the doubts in the decision-making process [14]. The AHP method looks at the problem in three parts. The first part is problem that needs solution, the second part is production of several solutions that may solve the problem and the third and the most important part as far as the AHP method is concerned is the criteria used to evaluate the alternative solutions.

The AHP method explains that even there are several criteria, the magnitude of each criterion may not be equal. For ignition and spread of fire we consider prioritizing one factor over another within 10 values. Hence, while evaluating alternative solutions, weights need to be added to the criteria in order to achieve a correct and liable conclusion. This may seem simple, however, until very late management scientists have been facing problems on how to assign weights. As the number of criteria (factors) multiplies, the assignments become more and more arbitrary [15]. The procedure: 1) Define alternatives, 2)Define the problem and criteria, 3) Establish priority amongst criteria using pairwise comparison, 4) Check consistency, 5) Get the relative weights [15].

In this study, will be calculated the coefficients for each criteria and their importance is weighted in overall criteria capacity via AHP based on their relevancy to either the ignition probability or spreading capacity of wildfire.

Natural breaks classes are based on natural groupings inherent in the data. Class breaks are identified firstly as groups with similar values and then differences between classes are maximized. (Jenks, 1967) QGIS identifies break points by picking the class breaks itself and than groups best similar values and after that maximizes the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.

- Good for: Mapping values that are not evenly distributed on histogram
- Disadvantages: Class ranges are tailored to one data set, so difficult to compare maps for different data sets; Can be difficult to choose optimum number of classes, especially if data are evenly distributed [16].

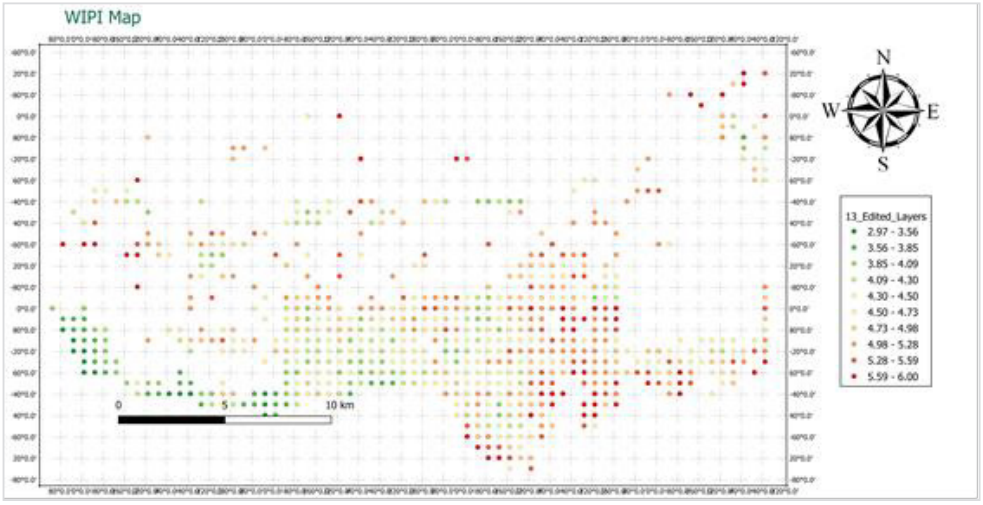
Jenks natural break are used in this study to do a reclassification of all 13 criteria. After entering the layer that includes all 13 criteria, we will operate in attribute table by firstly removing null values. Then we will generate breaking values by 10, after that we will reclassify according to breaking values for all 13 criteria, in the end will be shown the final maps with categorized point values.

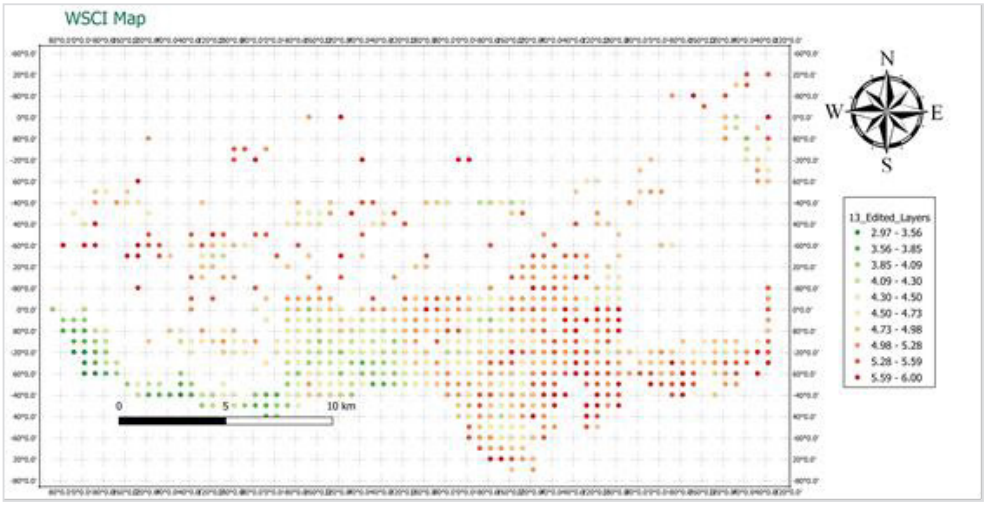
5. CONCLUSIONS

This study shows a method for indexing forest surfaces in Novi Sad by their wildfire ignition probability and wildfire spreading capacity. The study follows a multi-criteria approach in assessing the wildfire ignition probability or wildfire spreading capacities, considering simultaneously social, environmental, and physical properties of the context where the study area is located.

This method can be of used in different disaster risk management and fire safety (DRMFS) for decision making and mitigation of risks in the future. The model that is generated in QGIS 3.4.6-Madeira software, is a step to understand the involved factors in wildfire, to be able to evaluate spatial risk information impact on risk governance, to help in determined decisions and management processes of Disaster Risk Management and Fire Safety (DRMFS) agendas for wildfires in a short time.

In the end all above criteria maps are attached to one another with the appropriate factor producing two indicative maps.The first map presents the WIPI indexes and the second map shows WICI indexes for Novi Sad region in Serbia.





6. RECOMMENDATIONS

This study has generated maps that identify the hotspots that have the greatest probability for fire ignition and spreading in the city of Novi Sad. This material could be used as basic data by the public institutions that are responsible for Fire Management and Protection in Serbia.

In order to prevent wildfire ignition and spreading, these Institutions should prepare a fire protection plan that foresees the following measures:

- Warning and detection of fire ignition in an early stage;
- Monitoring the climate conditions in order to estimate the existing fire hazard;
- Organization of specialized teams for first response;

- Construction of fire breaks and water tanks;
- Implementation of silvicultural measures for reducing the risk of fire spreading;
- Maintenance of picnic sites;
- Placing and distributing information materials;
- Raising awareness among the locals.

This study could be a useful tool to understand the involved factors in wildfire, to be able to evaluate spatial risk information impact on risk governance, to assist in decision making and management processes of Disaster Risk Management and Fire Safety (DRMFS) agendas for wildfires.

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SEISMIC PROFILE OF SHKODRA REGION

Abstract: The main purpose of this paper is to evaluate the expected economic loss that results from the building damages due to the earthquakes in the region of Shkodra. Shkodra is the largest city in the northern Albania and it is very affected by the seismic activity. Although the data regarding seismic activity in Albania, and particularly in Shkodra region, are very scarce, the paper is focused on a specific region, as Albania is characterized by several types of seismic activity in its territory, due to the diversified geomorphology and geologic structure. The aim of our paper is to construct a modest seismic profile for Shkodra region, with respect to the expected of loss value and the number of fatalities.

Key words: earthquake, Shkodra, seismic activity, magnitude, economic losses

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1. INTRODUCTION

Shkodra is a city which lies in Northwestern Albania. It represents the largest city in northern Albania. The municipality which extends from the Albanian Alps to the Adriatic Sea, was established after the territorial reform in 2015 by merging the former units of Ana Mali, Bërdica, Dajçi, Black Stone, Postriba, Pulti, Shala, Shoshi and Velipoja. It has an area of about 872.71 km^2; there is the lake of the same name to the west, the rivers Kir to the east, Drin to the south and Buna to the west. It extends in a "protected" lowland from the Albanian Alps and it is only 45 km far away he Adriatic Sea.

The layout between a flat, hilly, paramaloric and mountainous terrain, the proximity to the Adriatic Sea and Lake Shkodra have also defined its climate, a Mediterranean climate with mild and humid winters and hot and dry summers.

Shkodra is exposed to two natural hazards: floods and earthquakes.

The hydrographic system consisting of the Lake of Shkodra and the Buna River has also brought about severe floods of the 1960s, 1970s, 1976, 1980s, and subsequently those in 1996, 1997, 2002, 2003, 2004 and 2010.

In January 2010, in the regions of Shkodra and Lezha, about 14,000 hectares and 1,200 buildings were flooded, and 12,000 people had to be evacuated from their homes. Shkodra at that time resembled Venice, so long as the inhabitants started using rubber instead of cars.

Climate experts forecast significant changes in the region's climate. Although rainfall is expected to decrease, they are becoming more concentrated in the months of November and December. In addition, increased temperatures have caused the snow to melt earlier and faster during the year (Erol & Randhir, 2012). These effects further increase the river flow and flood risk, respectively, during the fall and late winter. Moreover, the increasing of sea levels (as expected for the Adriatic Sea), will extend the duration of floods by slowing the rate of water flow from land. On the other hand, erosion increases the severity of floods from the Buna River.

Albania is located in the area included in the Aegean Sea, which is the most seismologically active areas throughout the European part of the Mediterranean alpine seismic descent. Albania is characterized by intense seismic micro activity, with small earthquakes and medium-sized earthquakes and rarely any major earthquakes.

Seismicity of Shkodra on the seismic map of Albania is scaled 1:500,000. According to Sulstarova (1980) Shkodra is included in the area where earthquakes have Io = VIII Degree Richter MSK-64 are expected within the next 100 years for average land conditions. The geological construction of Shkodra region is complex. This area is characterized by the collision of tectonic zones associated with a series of tidal and detachable tectonic movements in horizontal and vertical directions of old tectonics and the subsequent complication of this area by neotectonic movements. Many fractures and active fracture zones are identified in this area: 1- Zone of depressive fractures of Shkodra; 2- Zone of coastal fractures of Ulqin, and 3- Zone of transverse fractures of Ulqin-Shkoder (part of Shkodra-Peja cross-section).

The city of Shkodra and the surrounding area is affected by powerful earthquakes with M≤ 6.6 of Io to VIII-IX. This city is included in the strong seismic longitudinal Ionian-Adriatic coastal zone with an expected maximum magnitude of 6.0-7.0. Earthquakes that hit the city of Shkodra and the surrounding area have a long history and significant damage. Problems of this natural phenomenon need special attention in the process of the territory planning and especially for the urban development. Powerful earthquakes with severe consequences for the city of Shkodra are those of the year: 1855, 1905, 1948, 1979.

During the 20th century, these powerful earthquakes were recorded:

- Shkodra region in 1855, which caused a lot of damage in the surrounding villages;
- Shkodra on June 1st, 1905, which destroyed 1500 houses, killed 200 people, and injured 500 persons.
- Shkodra region, on 27th August 1948. One person was dead and 27 persons injured. It caused a lot of material damage.
- Shkodra-Librazhdi on November 3rd, 1968
- Shkodra-Lezha on April 15th, 1979, killing 40 people and damaging 17,118 houses and social-cultural objects.

One of the consequences of these large earthquakes was the disappearance of small islands and creation of totally new islands. After the short introduction regarding the characteristic of Shkodra region and its seismic history, the second section describes the literature review relating to the calculation of losses resulted from the earthquake. Methodology, data set and the limitations of the paper are presented in the section 3. Section 4 presents the estimations performed by the authors and the respective results. Conclusions are displayed in the last section.

2. LITERATURE REVIEW

EERI[17] Committee on Seismic Risk in 1984, has defined the seismic risk as "the probability that social and economic consequences of earthquakes will equal or exceed specified values at a site, at various sites or in an area during a specified exposure time". Earthquakes are usually classified into the following categories: 1. Physical impacts 2. Social impacts (the impact on people) 3. Economic impacts (the impact on the wealth of an area) 4. Environmental impacts (the impact on the landscape). (Soa at al. 2014).

As described above, the paper is focused on the economic impact of the earthquake. The economic impact of an earthquake or any natural disaster can be classified as: (i) losses to immovable assets, (ii) losses to movable assets (iii) economic losses due to business interruption, (iv) public sector economic costs, and (v) household income losses due to death, injury, and job disruption (Sinha at. Al 2007). The economic loss may by either direct or indirect. A direct loss is defined as an economic loss that results from the people injuries and deaths, physical damage or destructions of property, etc. An indirect loss is an economic loss that results indirectly from the occurrence of a direct loss. Indirect or consequential losses include the loss of normal profit, business interruption, extra operating expenses, higher cost of funds and foregone investments ect. The recent studies on earthquakes have shown that economic losses and social losses are primarily a function of damage to buildings because (1) buildings are the predominant kind facility in the built environment, and (2) buildings are vulnerable to earthquake damage (Kirchet at al. 1997). As a result,the authors of the paper aim to calculate the economic loss caused by the damage of buildings in a specific territory of Albania – Shkodra.

There are various models in the literature for rapid assessment of earthquake losses based on economic and human predictors, such as gross domestic product (GDP) and population size and density. Regarding the number of human losses, many authors have designed models that define a

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relation between the number of killed or injured persons in case of earthquakes and factors such as the growth of population, temporal variation of earthquake disasters in various countries, earthquake magnitudes etc. Heatwole and Rose (2013) proposed a specific reduced-form model based on U.S. earthquakes. They built a linear regression model of predictor variables to predict losses and examined the population of the affected area, the magnitude of the earthquake, and the total economic losses adjusted to 2011 values using the Consumer Price Index. Samardijeva and Badal (2002) have constructed a quantitative model that combines the earthquake magnitude (M) and the population density (D) in order to compute the number of human losses (N). They have used the following regression equation:

$$logN_K(D) = a(D) + b(D)M(3) \quad (1)$$

where the coefficients a and b are regression parameters depending on the average population density of the affected area and they can be retrieved from the Table II.

Table 3- Regression coefficients (a, b) in Equation (1) for different density in the world [4]

Population density	a	b	r	σ
D < 25	-3.11	0.67	0.84	0.343
D = 25-50	-3.32	0.75	0.85	0.342
D = 50-100	-3.12	0.84	0.82	0.345
D = 100-200	-3.22	0.92	0.70	0.397
D > 200	-3.15	0.97	0.75	0.348

A damage pattern of building strongly depends on the type of building structure: masonry, wood frame, and reinforced concrete with moment-resisting concrete frame. Several organizations and authors propose different categories of damage patterns. The European Macro-seismic Scale (EMS-98) has 12 divisions for masonry buildings, which can be grouped into five categories as displayed in Table 1:

Table 2- Classification of earthquake damages according to the earthquake magnitude

Moment magnitude	Earthquake effects
Grade 1	No-felt to slight damage
Grade 2	Moderate damage
Grade 3	Substantial to heavy damage
Grade 4	Very heavy damage
Grade 5	Destruction

Andrews (2016) presents a classification of earthquake damages according to the earthquake magnitude (Table 1).

Table 3- Classification of earthquake damages according to the earthquake magnitude [5]

Moment magnitude	Earthquake effects
2.0 to 2.9	Usually not felt

3.0 to 3.9	Often felt
4.0 to 4.9	Minor damage
5.0 to 5.9	Moderate damage
6.0 to 6.9	Substantial widespread damage
7.0 to 7.9	Total destruction near epicenter
Over 8	……

Consequently, the literature lists many factors that affect the earthquake damages, such as population density, GDP, earthquake characteristics (for example, magnitude, intensity), construction quality and the structure type of the specific buildings.

3. METHODOLOGY AND DATA SET

Shkodra is one of the cities in Albania that is exposed to the earthquake hazard. In order to calculate the loss value caused by an earthquake in the Shkodra region we need several data. Unfortunately, all these data are lacking for Albania and in particular for Shkodra region. This is one of the limitation of our paper. To perform the calculations, we have used some of the models presented in the literature review and the data collected from the Institute of Statistics in Albania and other studies on evaluation of earthquake damages in Shkodra, Albania and world.

4. ESTIMATIONS AND RESULTS

4.1. Estimations

In order to compute the value of expected losses, we firstly have to compute the value of the property at risk. The Council of Ministers of Albania through the Decision No. 132, dated 07.03.2018, set the reference price of the buildings at 58,000 ALL (Albanian Lek) per meter square. Since the price is per meter square, we have to find the total dwelling surface of Shkodra district. Based on the Household Budget Survey of INSAT, we have extracted the information shown in Table 1.

Table 4- Classification of dwelling buildings, according to their surface [6]

Dwelling area	2017
Less than 50m2	7.5%
51-90 m2	50.6%
91-130 m2	34.8%
Over 130 m2	7.1%

Taking in consideration the above data, we have constructed the following table:

Table 5- Calculation of average value of dwelling building. Authors' calculations

Category	The average (1) (Min+Max)/2	Percentage of each category % (2)	Buildings per Category (3) (2)*(Total Buildings)	Average surface per category (4) (1)*(3)	Average value per category in ALL (4)*58000ALL/m2	Average value per category in EUR
0 - 50m2	25	7.5%	3,647.48	91,186.88	5,288,838,750.00	43,009,179.07
51-90m2	70.5	50.6%	24,608.30	1,734,885.01	100,623,330,522.00	818,275,437.28
91-130m2	110.5	34.8%	16,924.28	1,870,133.38	108,467,736,156.00	882,066,651.67
Over 130 m2	150	7.1%	3,452.94	517,941.45	30,040,604,100.00	244,292,137.11
	Total	**100.0%**	**48,633.00**			**€ 1,987,643,405.12**

Retaking in consideration the model proposed by Samardijeva and Badal for human fatalities we have estimated the fatalities for each magnitude measured on degree Richter which are as follows:

Table 6- Classification of accumulative expected value of fatalities. Authors' calculations

Magnitude Richter scale	Expected value of fatalities	Accumulative expected value of fatalities
1	0.007	0.007
2	0.062	0.068
3	0.575	0.644
4	5.370	6.014
5	50.119	56.133
6	467.735	523.868
7	4,365.158	4,889.026
Over 8	40,738.028	45,627.054

Concerning the probability of occurrence of earthquakes Kociou provides the following information for the Albania calculated over a time period of 475 years (Kociu 2005):

Table 7- Probability of earthquake occurrence. Authors' calculations

Magnitude Richter scale	**Times of occurrence**	**Probability**
≥8	4	0.80%
4.2-7.9	15	3.20%
0-4.1	1037	100%

4.2. Results

Based on the estimations made above, we can now compute the expected losses and fatalities for each scenario.

Table 8- Calculation of expected loss in Eur. Authors' calculations

Magnitude Richter scale	Probability	% of proper Value Loss	Expected loss in EUR
≥8	0.80%	84.60%	13,452,370.57
4.2-7.9	3.20%	15.40%	9,795,106.70
0-4.1	100%	0%	-

Table 9- Calculation of expected value of fatalities. Authors' calculations

Magnitude Richter scale	Theoretical value of fatalities	Probability	Expected value of fatalities
1	0.007	100.00%	6.01
2	0.062		
3	0.575		
4	5.370		
5	50.119	3.20%	156.45
6	467.735		
7	4,365.158		
Over 8	40,738.028	0.80%	325.90

5. CONCLUSIONS

Shkodra is one of the cities in Albania that is exposed to the earthquake hazard. The aim of this paper is to calculate the expected value of damages in Eur and in fatalities, caused by potential earthquakes. But due to the lack of information and historical data regarding this specific region in Albania, it is very difficult to duly calculate these values. As indicated by the results of our scenarios, the expected losses are very high, particularly in comparison to the funds allocated in budget for emergency events. Therefore, the government, either central or local, should pay more attention to such disasters which cannot be prevented, but their consequences may be reduced.

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FIRE DYNAMICS AND FIRE CHEMISTRY EXPERIMENTS AT DTU FIRELAB

Abstract: The Fire Group at DTU Civil Engineering teaches the topics fire dynamics and fire chemistry on a master level and as life-long learning (LLL) courses, through our part time master education program "Master in Fire Safety". The theoretical classroom lectures are aligned with practical fire lab exercises, to deepen the understanding of the basic fire phenomena. DTU FireLab developed several experiments to determine some material key parameters important for fire safety engineering and fire risk assessment. These experiments include, but are not limited to, oxygen depletion calorimetry, mass loss cone calorimetry, oxygen bomb calorimetry, time to ignition measurements and flame spread experiments. The students will understand the practical side of the fire dynamics and fire chemistry, and will be better to relate theoretical material properties to real fire behaviour.

Keywords: Education, fire dynamics, fire chemistry, materials, reaction to heat, fire spread, time to ignition

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1. INTRODUCTION

1.1. Importance of LLL in fire education

Life Long Learning (LLL) is a way to support, that candidates keep their skills up to date through entire career. LLL is normally associated with relatively short courses, and often without ECTS-points. Therefore, LLL activities are most intended for brushup learning objectives, and a smooth way to introduce new techniques, methods, building materials, trends etc. in a fast and effective way. At DTU, a new Learn for Life center is recently established, and the center is intended to be responsible for all LLL at DTU.

1.2. Student eduction in performance-based fire engineering methods

Nowadays, the application of performance-based fire engineering methods are permitted in many European countries. It is possible to use prescriptive and performance-based methods for traditional smaller buildings and advanced complex buildings, respectively. In some cases, a combination of prescriptive and performance-based methods are used to assess the overall fire safety of larger buildings to facilitate the process.

The performance-based fire engineering methods are based on scientific knowledge, while the prescriptive methods are seen as experience-based solutions, based on historical fire incidents. For this reason, prescriptive rules may be inappropriate for application of new technological solutions. Therefor, it is essential that fire engineering students get a sound education on the scientific principles of fires in general and the fire engineering models that are developed using these principles. These principles are embedded in the courses of Fire Dynamics and Fire Chemistry, taught at DTU civil engineering. Our students have typically a background in building construction and building materials. They have a basic training in physics, mechanics and to some degree in chemistry.

Fire Dynamics and Fire Chemistry are complex phenomena and their effects are mutual dependent on each other. It is not just a linear process, but highly unlinear due to feedback loops. As a result, small deviation in the system of a fire, may provide completely different fire consequences. A fire system is defined by the material (fuel, construction material), the room, temperature, ventilation in relation to the amount of ignited material, and other conditions. Thus, the understanding of the behaviour of a fire system, needs knowledge on the material chemistry including the specific reaction mechanisms that lead to evaporation of the combustible gases. These gases finally lead to the flaming combustion, which produces the heat, the plume gases and particles. Fire safety engineers must be able to assess all this and evaluate for the various acceptance criteria and compare with the safe egress time for the evacuating persons.

The fire is started by the heat transfer processes, could be in a fire compartment. The evaporation of the combustible gases may be physical processes, but for many solid materials this is a combination of physical and chemical processes. Hereunder the pyrolysis of the solid material as e.g. plywood yields into smaller gases compounds and in parallel char generation on the materials surface.

The heat release rate (HRR) is regarded the most important parameter in fire safety engineering. Smoke and toxic fire effluents will spread in the building or infrastructure, and impact people far away from the original fire. The construction materials are impacted by the heat flow. Such phenomena are addressed by the following student experiments.

2. LECTURES IN FIRE DYNAMICS AND FIRE CHEMISTRY

2.1. Lectures topics

The students will learn about the basic principles. The main theoretical books are (Karlsson, 2000; Drysdale, 2011; Sørensen, 2014) and the lectures are supplemented with scientific articles, short film documentaries and YouTube available lectures on e.g. relevant basic chemistry topics. The courses deal with the following main topics and 2 hours of lecturing are followed by the same time of exercises

2.1.1. Fire dynamics

- Mass loss rate versus burning rate. Introduction of basic terms
- Flame height – including theory on mean flame heigt, laminar and turbulent flame characteristics etc.
- Heat transfer processes in fires – conduction, convection and thermal radiation
- Design fires. Fuel controlled and ventilation controled principles
- Plume theory, including axisymmetric buyant plume characteristic, line plumes etc. Calculating of plume mass flow, plume temerature and other parameters
- Jet flames, impinging on ceiling, temperature and radius estimates etc.
- Pressure and ventilation for pre- and post-flashover situations.
- Tempearatures in a fire room – gas temperature in the smoke layer etc.
- 2-zone modles, CFD theory and introduction to conservation equations.

2.1.2. Fire chemistry

- Introduction to combustion
  - heat of combustion, fire triangle, free radical reactions, solid phase reactions, premixed and non-premixed flames, flammability limits
- Wrap up of basic chemistry

- definition of terms : Avogadro number, mass versus mole, balancing chemical equations

- Reaction mechanisms and kinetics
  - chemical reaction rate, temperature dependence on reaction rate (Arrhenius equation),

3. EXERCISES IN DTU FIRELAB

The lectures are supplemented with practical experiments in the DTU FireLab. A number of experimental stations are build up to be used by groups of 3-4 stuents, depending on the size of the courses (between 25 and 35 students). One of the lectures is preparing the students for the lab exercises by presenting the different experiments and the theory of relevance.

Each student has prior to the FireLab excersies to pass an obligatory on-line general safety test and the lecture further gives specific safety instruction for the work in the fire lab and the different fire experiments.

The experimental stations could be chosen as:

1. Liquid pool fire measurements – HRR and effective heat of combustion
2. Bomb calorimeter – Total heat of combustion measurements
3. Flame spread scenarious – flame spread rate
4. Cone calorimter: Time to ignition of solid materials – critical heat flux, thermal thin and thick materials

Each experiment takes no more than 30 min and the student groups go from station to station. The pool fire (Figure 4) and the bomb calorimeter (Figure 5) are complementary and provide the effective and total heat of combustion, respectively. These are described in more detail in the following. Other important knowledge is the flame spread rate and the time to ignition measured in the other two setups shown in Figures 7 and 8.

In the pool fire experiments, successively, three different size pans are filled with a combustable liquid (e.g. Heptane, Acetone, Ethanol, Butanol). For each test 3 different approaches to measure the HRR are used.

1. HRR correlation using the average flame hight
2. HRR calculation using the mass loss measured during an experiemnt
3. HRR measurement using oxygen depletion measurements

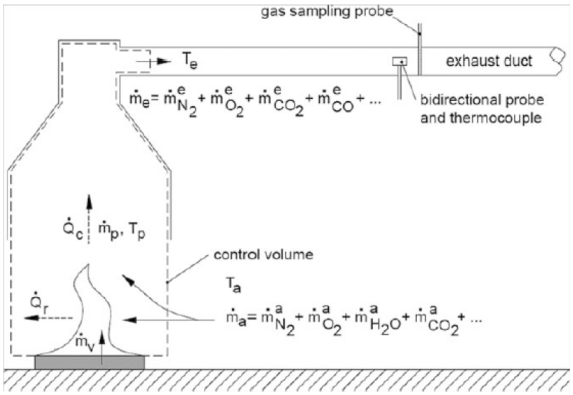

Figure 1 – Drawing of the heat and mass balance, to detrmine the amount of oxygen combusted in the pool fire (Janssen's method)

$$\dot{Q} = E\left(\dot{m}_a\, Y^a_{O_2} - \dot{m}_e\, Y^e_{O_2}\right)$$

$$\dot{m}_e = C\sqrt{\frac{\Delta p}{T_e}} = \frac{A\,k_c}{f(\mathrm{Re})}\sqrt{2\,\rho_e \Delta p}$$

$$\Delta p = \frac{1}{2}\rho_e[f(\mathrm{Re})v_c]^2$$

With Q = heat flow rate; E = 13100 kJ/kg O_2 m = mass flow rates; Y = mass fractions; C=constant; p= pressure; T= temperature ρ= density; Re = Reynolds number; v=velocity; f(Re)= function term

Figure 2 – Equation describing the depletion of oxygen during a combustion process

The latter uses Janssens method. The experimental data are automatically recorded by a computer system and the students are provided the raw data form the data logger and an Excel sheet setup to perform the calculation of the HRR and the effective heat of combustion.

The oxygen depletion is calculated using the following equation (Figure 3). The Janssen method is applied to transform the general equation to the experimenal setup and the gas flow measurements in the hood. Three differnt experimental situations are expalined: 1) only oxygen measurement, 2) combined meaurement of oxygen, carbon dioxide and carbon monooxide, where in one case the amount of carbon monoxide is negligible.

Table 1 – material to measure the total heat of combustion in the Bomb calorimeter

Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Sugar	PE-Plast	Ethanol	Heptane	Sugar	Ethanol	Flour	Heptane
Flour	Plexiglas	Butanol	Toluene	Butanol	Plexiglas	Toluene	PE-Plast

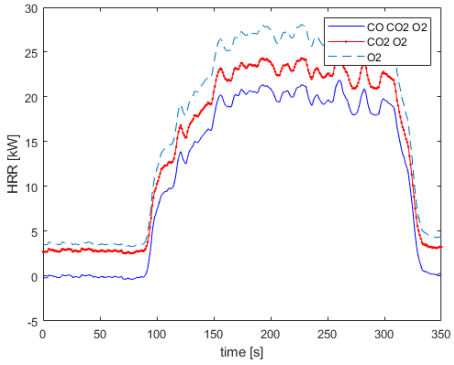

Figure 3 – HRR curves according to serveral measurement conditions a) only by oxygen depletion, b) and c) recognizing differnet amounts of carbon monoxide (CO) and carbon dioxide (CO_2)

Table 2 – Directions and materials used for the flame spread experiments

Direction	Group 1	Group 2	Group 3	Group 4
90 down	Coated paper	Paper	Plexiglas	PE plast
90 up	Plexiglas	Coated paper	PE plast	Paper
45 up	Paper	PE plast	Coated paper	Plexiglass

Figure 4 - Liquid pool fire setup.

Figure 5 – bomb calorimeter parts

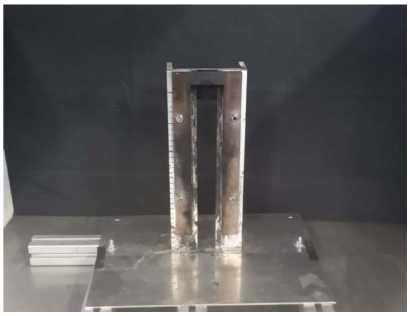

Figure 6 – Setup for the flame spread experiments

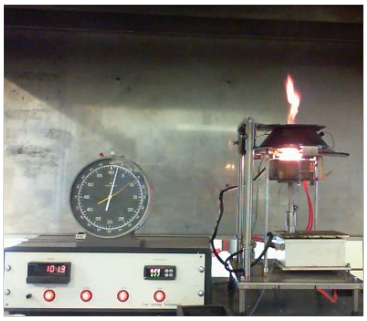

Figure 7 - Cone calorimter setup – time to ignition

4. CONCLUSION

The topics fire dynamics and fire chemistry are important for fire safety engineers to getfamiliar with. The two subjects are very much interrelated. The theoretical lecturing is combined with experiments to better understand the nature of the theories. The student will understand that a number of different tests have to be performed to understand the behaviour of materials in fire and to enable excellent predictions of the fire safety in buildings.

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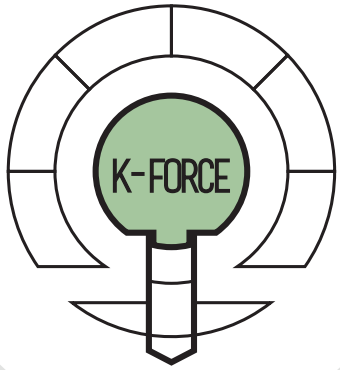

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