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COMPARATIVE ANALYSIS OF METHODOLOGIES FOR LOSS ASSESSMENT AFTER ELEMENTARY DISASTERS OF COUNTRIES IN THE REGION AND THE INTERNATIONAL COMMUNITY

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COMPARATIVE ANALYSIS OF METHODOLOGIES FOR LOSS ASSESSMENT AFTER ELEMENTARY DISASTERS OF COUNTRIES IN THE REGION AND THE INTERNATIONAL COMMUNITY

Summary: *In the Republic of Serbia, the assessment of losses and damages after a natural disaster is based on a document adopted in 1987 during the Socialist Federal Republic of Yugoslavia. Although of exceptional quality in its structure and purpose, the Instruction on a Uniform Methodology for Assessing Damage from Natural Disasters has outlived its time and it is necessary to align the document with today's needs. The Government of the Republic of Serbia has formed a working group with the task of drafting a unique methodology for assessing damage from natural and other disasters, which is also in line with international standards and practice. In parallel with this activity, engineering associations and groups of experts are working on technical instructions for each of the natural hazards, which will be compatible with the unique methodology to be adopted by the Government of Serbia. The earthquake that hit the Republic of Croatia in 2020 pointed out a number of shortcomings in national documents, and then the international methodology "Post Disaster Need Assessment" was used to assess the damage. The paper presents the experiences of a team of experts from Serbia who paid an official visit to the Republic of Croatia after the earthquakes in Petrinja and Zagreb and gained significant experience from the field in damage assessment, as well as through cooperation with crisis headquarters formed after the earthquake.*
Keywords: *Damage Assessment Methodology, Earthquake Assessment Technical Manual, Earthquake Damage Categories, GIS database*

Introduction

Natural and other events are causing loss of lives and severe economic losses and damages all around the world. From 2007 until 2021 the number of disasters varies from 370 to 440 events per year (Statista, 2022). In 2020, worldwide, during one of the most challenging years in modern history, 430 notable natural disasters were documented in addition to pandemic-related events. 2021 recorded 432 disastrous events related to natural hazards worldwide. Overall, these accounted for 10,492 deaths,

affected 101.8 million people and caused approximately 252.1 billion US$ of economic losses (EM-DAT, 2022). Water-related hazards dominate the list of disasters in terms of both the human and economic toll over the past 50 years. Weather, climate and water-related hazards are increasing in frequency and intensity as a result of climate change (WMO, 2021). From 2007 till 2021 the wold had more than 4,7 trillion US$ damages from various natural events (Statista, 2022). Two years were the worsted ones, 2011 with 615 billion US$ and 2017 with 532 billion of damages US$.

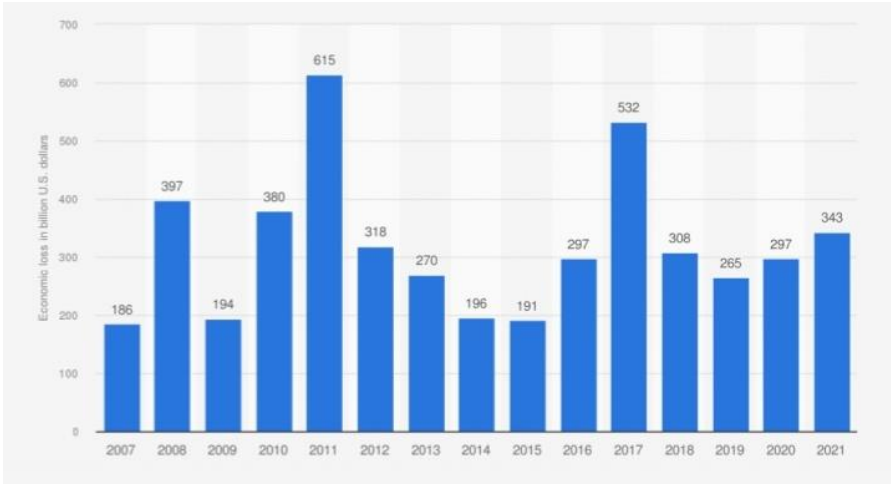

Figure 1. Economic loss from natural disasters from 2007–2021. (Statista 2022)

In 2021 most damages were caused by floods and tropical cyclones with around 200 billion US dollars. The earthquakes in 2021 exceeded 12 billion US$ damages globally. The year 2021 was a very active year for global seismicity and was even the most seismically active since 2007. Reported were 44 earthquakes with a magnitude above 6.5, which occurred throughout the whole year. Three of them had a magnitude above 8.0, with more than 2,000 fatalities (Reliefweb, 2021).

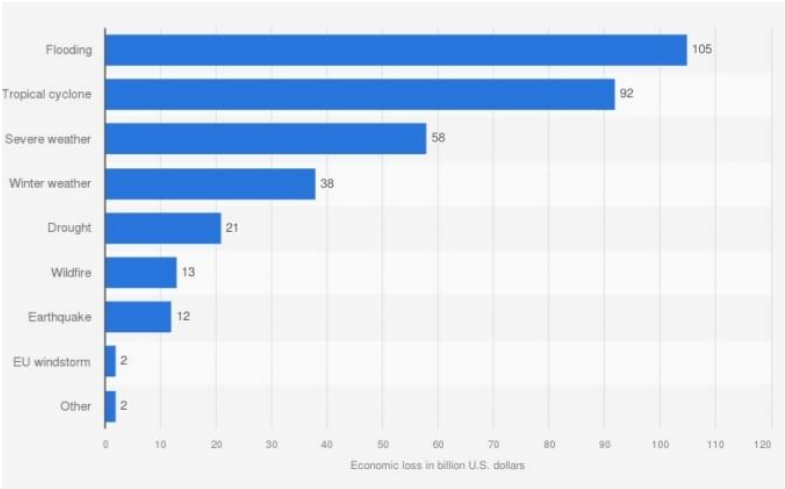

Figure 2. Economic loss in 2021 from natural events by hazard (Statista, 2022)

The strongest earthquake recorded in 140 years (Petrinja, 2020), killed at least seven people and left dozens more injured. There has been widespread damage to buildings and infrastructure, including the region's largest hospital and a variety of other healthcare-related facilities. Hundreds of thousands of people are without power, and travel and has been widely disrupted as officials assess damage to roads, bridges and local airports (Reliefweb, 2020).

Preparing Recovery Framework based on a community needs, damage, loss and need assessment is the first step in recovery and relief process. The quality of overall economic and societal loss assessment for any type of hazard depends strongly on quality and consistency of damage assessment (in terms of engineering loss on building structures).

It is important in this introduction part to distinguish damages and losses as different terms:

- Damages are identified as the value of destroyed physical durable assets, which is estimated as the cost to repair or rebuild the assets to the same characteristics they had prior to the disaster.
- Losses are the changes in the value of production of goods and services as well as changes in the costs of production of same, and usually include decline in production and higher-than-normal costs of production.

Current State in Damage Assesment Practice in Serbia

In spring 2014 the Republic of Serbia was affected by floods caused by heavy rainfall which did not occur over last 100 years (National Disaster Risk Management Program, 2014). In order to prepare for recovery and renewal after disaster, it is necessary to start assessment of damages, losses and needs. Methodology, which is effective in the Republic of Serbia, was adopted in 1987, at the time of Socialist Federal Republic of Yugoslavia, and, although being a good and comprehensive document, it was compiled at the time of existence of different social and political system and cannot respond to contemporary purposes. Serbia, due to lack of financial resources, asked for international financial support, and in June 2014, in Brussels, donor conference was held aimed to support for Serbian recovery. For the purposes of report on damage which will be presented at donor conference, as requested by the Serbian Government, process of assessment of damages and needs started, supported by UN, EU and WB under internationally recognized methodology Post Disaster Need Assessment (PDNA). Based on this report, Serbia had 1,3 billion EUR of direct damages and 1.7 billion EUR of losses. Report which was presented at the conference formed a basis for creation of comprehensive country recovery process (Nedeljkovic, Radonjanin, Laban, 2020).

The damages assessment in Republic of Serbia currently is being done by the Guidance on single methodology for assessment of damages from natural disasters (SFRY, 1987). Presented methodology is currently being applied in the Republic of Serbia, every time when the Serbian Government declares Natural Disaster and starts recovery process with own financial resources (Law on Recovery after Natural and Other Disasters, 2015). In 2019 the Serbian Government established inter-ministerial working group with the aim to prepare new methodology for damage assessment (Serbian Government, 2019). Having in mind that development of current methodology for assessment of damage from natural disasters was more than thirty years ago, that over this period there were significant social, economic, political and climate changes and conditions, it is necessary to start making new methodology for assessment of damage from natural and other disasters. The task for the Working Group is to incorporate international standards in new methodology and to inline it with Post Disaster Need Assessment (Nedeljkovic, Radonjanin, Laban, 2020). At this moment, based on old methodology, damage questionnaires are not

adopted in form of mobile phone application most suitable for quick data processing and georeferencing through the GIS platforms. The additional issue are internal procedures and specificities of several public companies (Public enterprise Roads of Serbia, Public enterprise Electric Power of Serbia, Serbia water authority...) that have its own technical manuals that need to be compatible with overall damage assessment methodology. The improvement of the existing methodology aims to have all standards based on PDNA incorporated and use of new technologies.

What is the Most Suitable Content of the Overall Damage Assesment Report?

While preparing reconnaissance report or detailed damage assessment report and applying field assessment, preliminary virtual assessment, and other techniques. The sectorial approach that includes sorting the losses and damages by sectors (housing, public, health, education) is generally more suitable than sorting the building object by type of structure (concrete, masonry, steel, etc). In joint reconnaissance report prepared by Operationalization of the Structural Extreme Events Reconnaissance (StEER) Network – CMMI-1841667, the following content structure has been used:

Damage to Buildings

- Low-Rise Residential Buildings
- Multi-Family Residential Buildings
- Commercial Buildings
- Healthcare Facilities
- Schools
- Government Facilities (Public Buildings)
- Historical Buildings
- Religious Buildings
- Industrial facilities

Nonstructural components and building content

- Performance of ceiling systems
- Anchorage of building contents
- Piping
- Elevators
- Façades, parapets and balconies

- Chimneys
- Roof tiles

Damage to infrastructure
- Electric Power Infrastructure
- Airport and Railway Infrastructure
- Bridges
- Roadways

Observed Geotechnical Failures
- Geological Setting – impact on hydrogeology
- Free-field Liquefaction
- Levee damages
- Building, Foundation, and Pavement Damages due to Liquefaction
- Sinkholes
- Landslides

Current Conditions and Access – indirect damage
- Power Outages
- Water Disruption
- Cellular Outage
- Post-earthquake Safety Structural Evaluations

Examples from the Petrinja 2020 Earthuake

The Republic Croatia faced severe earthquake 6.4 magnitude in December 2020 and few more in the beginning of 2021. These events happened during the global pandemic crisis due to corona virus. The earthquake struck central Croatia about 30 miles southeast of the capital, Zagreb, near the towns of Petrinja and Sisak.

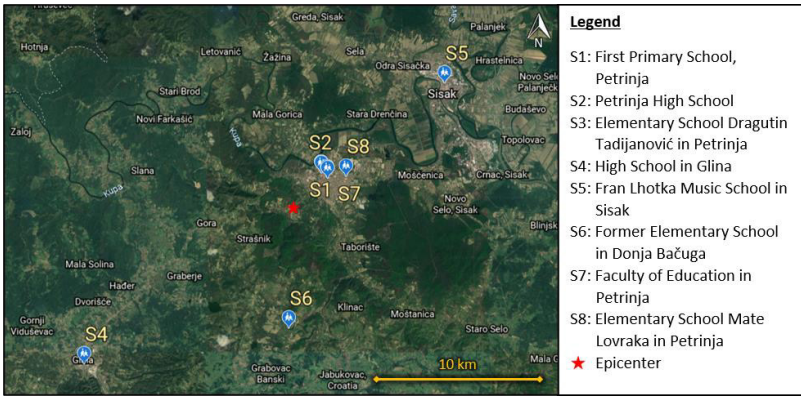

Figure 3. List of some of the damaged school buildings

Figure 4. Damages in schools in Petrinja (source: Nenad Bijelić)

Figure 5. Comparisons of (a) inadequate and (b) sufficient anchorage of building content in 1962 university building (Učiteljski fakultet Petrinja) (source: Marko Bartolac)

Figure 6. Embankment / levee failure by river Sava in Galdovo (source: Croatian Waters Archive)

Figure 7. (a) A wide transverse crack at the Brest Bridge approach road (source: Mate Baričević) and (b) a wide fissure in the road close to Brest Bridge (source: Index.hr)

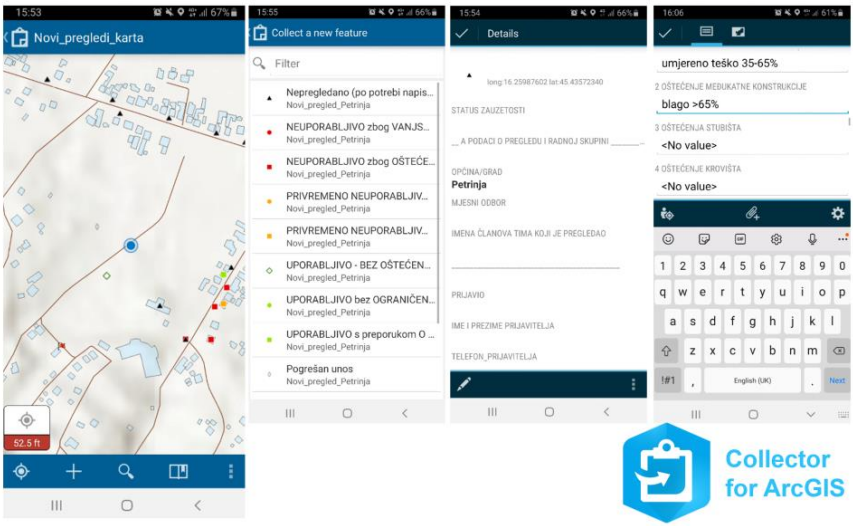

Figure 8. GIS usage in data collection during Petrinja 2020 Earthquake

Conclusion

After every significant natural hazard occurrence, there is discrepancy between the expectation of the society and real possibilities of (ad hoc formed) engineering teams to provide valuable information on damage assessment. The best way to avoid that is preparing the adequate technical questionnaires and "rules of the game" to be ready before the disaster occurrence. The GIS databases are excellent tool for collecting, processing and presenting collected damage assessment data, decision making during the crisis, and programing the recovery process.

The good damage assessment questionnaire needs to be complete in terms of technical data, as well as easy to fill in the field (the mobile phone application if possible). In that case, this can really narrow a gap between engineers on the field, decision makers and other stakeholders (donors, international financial institutions...). Also, while asking for international financial support, Government needs to have methodology that is in line with international one, Post Disaster Need Assessment. The Reports base on this methodology is eligible for disbursement of international aid. Serbia and Croatia, neighboring countries, experienced the need of incorporating international standards and processes in their own documents.

REFERENCES

Group of authors, PRJ-2959 | StEER-EERI: PETRINJA, CROATIA DECEMBER 29, 2020, Mw 6.4 EARTHQUAKE; https://doi.org/10.17603/ds2-1w0y-5080

Nedeljkovic S., Zugic Z., Dragojevic D. (2021) Post disaster recovery practice in Serbia 2010–202 Proceedings of the 1st Croatian Conference on Earthquake Engineering, Zagreb, Croatia, 22–24 March 2021, pp. 813–820.

Technical Manual for Economic Evaluation of Flood Control Investment in Japan; http://www.mlit.go.jp/river/mizubousaivision/toushin_e/1805_manual_e.pdf

Geotechnical Reconnaissance and Engineering Effects of the December 29, 2020, M6.4 Petrinja, Croatia Earthquake, and Associated Seismic Sequence; https://geerassociation.org/administrator/components/com_geer_reports/geerfiles/2020%20Croatia%20Report%20-%20GEER.pdf

Nedeljkovic S, Radonjanin V, Laban M, Post Disaster Damage, Loss and Need Assessment for Recovery of Affected Area, "SAFETY FOR FUTURE 2020": Proceedings/6th International Scientific and Professional Conference "Security and Crises Management– Theory and Practice SeCMan 2020", p. 12.

Guidance on single methodology for assessment of damages from natural disasters („SFRY Official Gazette", number 27 of 10 April 1987).

Law on Recovery after Natural and Other Disasters (Serbian Official Gazette, No.112/2015).

National Disaster Risk Management Program (Determination of Serbian Government 05 Number 217-16233/2014-1 of 19 December 2014), Serbian Government.

https://www.statista.com/statistics/510959/number-of-natural-disasters-events-globally/

https://public.wmo.int/en/media/press-release/water-related-hazards-dominate-disasters-past-50-years

КОМПАРАТИВНА АНАЛИЗА МЕТОДОЛОГИЈА ЗА ПРОЦЕНУ ШТЕТЕ НАКОН ЕЛЕМЕНТАРНЕ НЕПОГОДЕ ЗЕМАЉА У РЕГИОНУ И МЕЂУНАРОДНЕ ЗАЈЕДНИЦЕ

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Влада Републике Србије, Канцеларија за управљање јавним улагањима

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Сажетак

У Републици Србији процена штете након елементарне непогоде врши се на основу документа који је усвојен 1987. године за време Социјалистичке Федеративне Републике Југославије. Иако изузетно квалитетан по својој структури и намени, Упутство о јединственој методологији за процену штета од елементарних непогода је превазишло време и потребно је да се документ уподоби са данашњим потребама. Влада Републике Србије је формирала радну групу са задатком да изради предлог јединствене методологије за процену штета од елементарних и других непогода, који је уједно усаглашен са међународним стандардима и праксом. Паралелно са овом активношћу, инжењерска удружења и групе експерата за сваки од природних хазарда раде на техничким упутствима која ће бити компатибилна са јединственом методологијом коју ће усвојити Влада Србије. Земљотрес који је погодио Републику Хрватску 2020. године указао је на низ недостатака домаћих докумената и тада се за процену штете користила међународна методологија Post Disaster Need Assessment. У раду су приказана искуства тима експерата из Србије који су били у званичној посети Републици Хрватској након земљотреса у Петињи и Загребу и стекли значајна искуства са терена у процени штета, као и кроз сарадњу са кризним штабовима који су формирани након земљотреса.

Кључне речи: *Методологија за процену штете, Техничко упутство за процену после земљотреса, Категорије оштећења услед земљотреса, ГИС базе података.*