Challenges of Disaster Risk Reduction Knowledge: The Case Study of Floods

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Abstract In the last 50 years of human development, water-related hazards have been dominating among the disasters, that have caused both human casualties and economic damage. Floods are among the top ten worst types of natural disasters, positioning on an unenviable third place, when taking in account, above all, the number of human lives that have been lost. Unfortunately, forecasts show that the negative trend of flood impact will continue to grow, mainly as a result of climate change, population growth and economic development. For these reasons, the need for implementing Disaster Risk Reduction has been recognized globally as a way to reduce the risk and impact of all natural disasters, including floods. On top of this, the need to include education in this area is also recognized, especially in the field of knowledge-based decision-making process. When it comes to Disaster Risk Reduction knowledge, it should be noted that despite the efforts related to the wider implementation of this type of education, practice shows that it is still been poorly represented at all necessary levels of formal and non-formal education, although in the Sendai Framework for Disaster Risk Reduction 2015–2030 precisely emphasizes the critical role of knowledge in Disaster Risk Reduction.

Keywords:: disaster risk, disaster risk reduction, disaster risk reduction knowledge, floods.

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1 Introduction

Global warming, climate change and natural disasters are significant and unfortunately growing threats to the further development of societies around the world as well as the very sustainability of the planet (Radaković, Makajić-Nikolić, & Petrović, 2021). The consequences of risks, crises and disasters require complex solutions to minimize their impacts. Managing and eliminating their consequences is recognized by the United Nations as an important skill, presented through its three frameworks - Sustainable Development Goals (2015-2030), Sendai Framework for Disaster Risk Reduction (2015-2030) and the Paris Protocol (2015-2020) (Radaković, Drašković, Makajić-Nikolić, & Petrović, 2021).

Unfortunately, disaster risks are a very current problem, both in the whole world and in the Republic of Serbia. There is more and more scientific research that deal with the problem of natural disasters, and their studies begin with data that show that the strength and frequency of disasters are growing, and that their effects on infrastructure, economy, environment and the number of human victims is worse. Despite the fact that scientists disagree about the causes of these changes, in hydrometeorological processes and the direction in which they take place, most of them agree that these changes are evident worldwide, primarily in the atmosphere and hydrosphere (Arnell, 2002; Gosling & Arnell, 2013; Hartmann et al., 2013; National Research Council, 2011; Shiklomanov & Rodda, 2006). On the other hand, firstly the human casualties and the damage caused to material goods, renames these natural processes into natural disasters. Population growth and increased population density, and logically the increased amount of supporting infrastructure for that population, leads to such cities becoming the ones most vulnerable to natural disasters and hazards (Cross, 2001; Gencer 2013; Sanderson, 2000).

Complex topics and phenomena such as natural disasters are the subject of study by many researchers in various scientific fields and numerous studies that deal with the origin and modes of natural disasters, their forecasts and elements exposed directly and indirectly to these hazards, population perceptions and others. Precisely because of this, various conferences on this topic have been held around the world – Yokohama (1994), Kobe (2005), and Sendai (2015), leaving behind many documents, frameworks, proposed measures, and strategies, which over time have become legal acts in minor or to a greater extent. Reducing the risk of natural

disasters is precisely the goal set at these conferences. Some of the important documents from the conferences are: Hyogo Framework 2005-2015 (United Nations Office for Disaster Risk Reduction [UNDRR]). 2005) and the Sendai Framework 2015-2030 (United Nations [UN], 2015). In the Sendai framework, there are following priorities: understanding disaster risk, strengthening disaster risk management systems (prevention, mitigation, preparedness, event preparedness, adequate response to events, post-event recovery, etc.), disaster risk reduction (DRR) investments.

It must be noted that the process of strengthening disaster resilience in the context of prevention and reducing exposure to hazards and vulnerability to disasters must include educational measures (United Nations Economic Commission for Europe [UNECE], 2022), as well as the fact that increasing knowledge of disaster risk "ultimately leads to better understanding, improved management, and finally to risk reduction and adaptation" (Spiekermann et al., 2015). In regard to these, the authors of the paper conducted research with the aim to analyze both students' knowledge and their attitudes related to disaster risk, disaster risk reduction, and especially floods. The floods are particularly singled out bearing in mind that in the Republic of Serbia, the most common natural disasters are torrential floods since 86.4 percent of the territory of Serbia is exposed to erosion processes (Ristić et al., 2012). We have chosen students for our research considering their future role in decision-making processes, with hope that they will recognize importance of supporting continuous improvement of disaster risk resilience which implies a significant role of public participation in DRR.

Our research included 57 students enrolled at winter semester at University of Belgrade – Faculty of Organizational Sciences, the Republic of Serbia. For the purpose of our research, we used an on-line questionnaire that consisted of 21 questions in total. An analysis of the questionnaire was carried out using the SPSS 25 software package.

2 Disaster risk

On the 6th December 1917 a man-made explosion in Halifax, Canada, where two ships collided in a harbour injuring 9,000 people and causing the death of 2,000 more. After this event, there was a fist study of disasters by Prince (1920) where the socital response and change after disasters was researched and divided into phases (Coetzee & Van Niekerk, 2012):

1. Emergency period – confusion and general panic,
2. Transition period – organized groups respond to the disaster,
3. Rehabilitation period.

Prince's research served as a basis for disaster studies, one of the more recognized being Carr (1932). Carr identified four types of disasters based on the character of event and the scope of consequences (Carr, 1932; Makajić-Nikolić, 2020):

1. Instantaneous-diffused type that appears instantly and affects the entire community
2. Instantaneous-focalized type that affect a part of the community
3. Progressive-diffused type that last several hours or days and affects the whole community
4. Progressive-focalized type with a prolonged appearing that affects a part of the community.

Following the new found interest in disasters, these organizations were created - the Disaster Research Centre (DRC) in 1963 (Perry, 2018), the United Nations Office for Disaster Risk Reduction (UNISDR) in 1999, UN initiatives and resolutions and World Conferences on Disasters.

An imortant term interlinked with disasters is risk. Even though no general definition of risk is accepted, it comes down to two key elements such as likelihood or probability of some hazardous event happening, and the severity of the consequences. UNISDR (2009) defines disaster risk as "the potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time".

2.1 Disaster risk reduction

When it comes to DRR, it should be noted that there are several definitions of this term. So, it can be said that DRR represents prevention actions in relation to new disaster risks, as well as reduction of existing disaster risk. This should be added the management of residual risk with the aim to improve the resilience to disasters (Makajić-Nikolić, 2020).

DRR can also be defined as "the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment and improved preparedness for adverse events" (UNISDR, 2009).

Certainly, DRR is a complex issue that is directly related to the 2030 Agenda for Sustainable Development, as well as the Sendai Framework for Disaster Risk Reduction 2015-2030. This is because disasters directly affect a large number of the Sustainable Development Goals (SDGs), such as for example (United Nations Economic and Social Council [ECOSOC], 2017):

- SDG1. End poverty in all its forms everywhere,
- SDG2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture,
- SDG9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- SDG13. Take urgent action to combat climate change and its impacts.

It should be added that DRR also affects the following SDGs (see Figure 1): SDG3. Ensure healthy lives and promote well-being for all at all ages; SDG4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; SDG6. Ensure availability and sustainable management of water and sanitation for all; SDG11. Make cities and human settlements inclusive, safe, resilient and sustainable; SDG14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development; and SDG15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Figure 1: SDGs & Disaster Risk Reduction
Source: Stephens (2016)

2.2 Disaster risk reduction knowledge

DRR knowledge requires availability and access to comprehensive information in regards to all the known and vital dimensions of potential disaster risk, including hazards, risk propensity, risk exposure, risk severity, threatening to individuals, communities, organizations. This also includes having equally understandable information on national and regional level disaster threats. Additionally, comprehensive information is prerequisite by the cognitive ability to process the information related to the identified and observed risks, by those to whom specific information concerns the most.

The availability of information has to be provided by the appropriate risk level correlating authority. Usually by the municipal, regional or national government authority, or in specific cases by the non-governmental organizations, when such an information is not being provided by the designated bodies.

Furthermore, the time component influences tremendously the value of information when DRR knowledge is in question, regarding that the timely information is of enormous importance, especially when decision makers are concerned, regarding that the comprehensive information that feed into their knowledge bank has to be present when the choices that influence many have to be made.

In order for DRR to function properly, the DRR knowledge database has to be updated and checked regularly, in terms of the data that is being enclosed within the follow up information has corrected data that is collected on regular basis. The data here has to have appropriate qualitative and quantitative input on disaster risk stressors and pressures.

In order for general population to be able to respond better in case and provide much needed support for DRR, this knowledge has to be transparent, properly disseminated, as well as communicate in the manner that is easily digestible, understandable, informative on the actions that have to be undergone by the population that the specific disasters are concerning. These knowledge dissemination strategies have to address all the different parts of the society, so different strategies may be used when communicating the DRR knowledge information to adults or elderly citizens.

Furthermore, this is specifically important when children are in question, regarding that, they are specifically vulnerable group, that also has to possess the DRR knowledge, which dissemination is adjusted and designed to them specifically (Tuladhar, Yatabe, Dahal, & Bhandary, 2015).

The DRR knowledge database is additionally if the information dissemination is done properly, as evidence show by study done by Reichel and Frömming (2014), become culturally embedded, especially at localities that are traditionally prone to risk disasters, and transfer of that knowledge from one generation to other becomes a tradition, almost folkloric.

Never the less, Weichselgartner and Pigeon (2015) note that regardless of knowledge being present, human kind is still witnessing the paradox of "knowing better and losing even more", firstly noted by White (2001), mainly as they concluded:

- knowledge is still imperfect in some areas and is holding specific stakeholders borderline ignorant;
- knowledge is there but not used properly;
- knowledge is used properly but the effects are time postponed from initial actions;
- general vulnerability is increased in comparison as a result of the rising inequalities.

3 Methodology - Research context

Previous studies have shown the importance of education about disasters and disaster literacy which provide a necessary community awareness about their role in dealing with disasters and disaster risk reduction (Agustinova & Syamsi, 2021). It must be noted that disaster literacy has three dimensions: knowledge, attitudes and behaviors regarding to disasters (Türker & Sözcü, 2021). "Also, many educators feel that they should not only teach the science, but also engage students and encourage positive responsiveness about the environment and sustainability" (i.e., Mason & Santi, 1998; Cross & Price, 1999; Lester, Ma, Lee, & Lambert, 2006; Petrovic, Jeremic, Petrovic, & Cirovic, 2014).

In order to get answers to our research questions, and having in mind the previous, the authors conceived a survey with aim to investigate not only students knowledge but also their attitudes especialy abour floods as an example of the most common disaster in the Republic of Serbia. When it comes to floods, it should be said that torrential floods are among the most common floods in the Republic of Serbia, and they are characterized by catastrophic consequences for both the population and the country's infrastructure. In the period of almost 100 years (between 1915 and 2013), there were 848 torrential floods that took 133 lives.

Research was performed based on the students attending the winter semester of the 2021/2022 academic year. Students voluntary took part in an online survey. The survey was conducted at the University of Belgrade - Faculty of Organizational Sciences. In the survey 57 students participated (36 females and 21 males). Students completed the survey and results for each student were calculated.

In order to evaluate results of the survey, we used the statistical software package SPSS 25. Kolmogorov-Smirnov test has been used to determine whether the variables were distributed normally. Comparing two groups has been done by non-parametric Mann-Whitney test. Relationship between two categorical variables has been explored by chi-square test. Correlation between two ordinal variables was evaluated with non-parametric Spearman's rho correlation. A p value is used to indicate if the differences between two particular groups are statistically significant, or if there is relationship between two categorical variables, or if there is significant correlation between two ordinal variables (where $p<0.05$ is considered statistically significant at the 95% confidence level).

4 Results and discussion

When it comes to the students who took the survey - 36 of them (63.2 percent) were female, and 21 of them (36.8 percent) were male.

The first set of questions aimed to identify students' knowledge about floods in the Republic of Serbia. When asked to determine the most frequent type of floods in our country, only 36.8 percent of students answered correctly – torrential floods. That number is slightly greater in response to the correct cause of torrential floods with 45.6 percent of students answering heavy rainfall, and 56.1 percent correctly naming the consequences of this type of floods. Still these numbers are somber, showing how little we are actually informed on the number one natural disaster in our country that devastes our lands and causes the loss of lives every few years.

The seventh question of the survey was "Name the year and city where a flood you know happened in the Republic of Serbia", 55 of the 57 students answered Obrenovac in 2014, with some descrepancies in them stating the correct dates, and with only two students answering "I do not know any" and "The floods of 2019" respectively. It should be noted that the floods of Obrenovac were eight years ago, and many of these students were only in elementary or high school living in areas not as affected as Obrenovac was, but without a fault, all of them remember this stresfull and devastating time.

On the 14th of May 2014, Obrenovac was hit with heavy rainfall resulting in strong torrential floods killing 33 people, endangering 1.6 milion more, causing the evacuation of 32,000 and resulting in 1.7 billion euros in damage and 280 bridges completely destroyed or severly damaged. The story of Obrenovac is in no way in our past, with torrential floods happening again in 2016 and 2019, hitting the city of Kraljevo especially hard.

The next 14 questions of the survey aimed to research the students' opinions and attitudes when it came to floods in the Republic of Serbia, all measured with a Likhert scale of 1 to 5. In Q8 and Q9 they were asked to approximate the probability of floods happening in Serbia in Q8 - a year; or Q9 - in five years. Their opinion was measured by a Likhert scale with a measurment of 1 being a very small probability and a measurment of 5 being a very large probability. When it came to their predictions of floods happening in the next year the mean value is 3.35, with the students being slightly more pesimistic of the next five years - the mean value being 3.89.

Question 12 aimed to find out when the flood did ocurr, in which institution did the students have the most faith in. The institutions ranks and mean values are as follow:

- Most faith in - firefighters 3.65
- Ambulance 3.11
- Hydrometeorological Institute 2.74
- Local self-government 2.60
- Police 2.39
- Least faith in - government 2.12

Questions 16 to 18 asked the students to give a mark to floods in corelation to their severity compared to other natural disasters (earthquake, hurricane, volcano erruption, tornado, wildfires, draught), when it came to consequences to Q15 - environment, Q16 - infrastructure and Q17 - human lives. The students' answers were mean values of 3.88, 4.23 and 3.88 respectively, showing that they feel that the floods are especially dangerous when it came to our countries infrastructure.

Questions 19 to 21 where regarding prepardness to act in a case of flood of Q19 - students, Q20 - local self-government, Q21 - the country, with the mean ranks as follow respectively - 2.96, 2.58 and 2.60. It is interesting to note that when using the Mann-Whitney test, it showed that male students felt like they were more prepared to act in case of flood with the mean value of 3.43 as opposed to the mean value of 2.69 in case of female students. This is especially important since studies say that women, boys and girls are 14 times more likely to die in a natural disaster than men (Peterson, 2007). On the other hand, men tend to be more exposed to risky situations and even die for the belief of being a part of the "stronger sex" (Bradshaw, 2004). A study conducted on thuderstorm related deaths in the United States, from 1994 to 2000, concluded that men were twice more likely to die than women (Riplay, 2008).

Another interesting fact is that the survey also showed that the students that gave a complete answer to the question "what are the consequences of torrential floods" showed less faith in police handling flood situations and thought that the local self-governance institutions and the country itself were less prepared for floods. They also believed that there was more chance for floods to happen in the next five years. It can be concluded that the students that know the whole story of the potential consequences of floods have less faith in the country knowing them as well.

Table 1: The correlation of students' knowledge of flood consequences and their opinions on flood occurrence and faith in institutions

What are the potential consequences of floods?	**The chances of a flood happening in the Republic of Serbia in the next 5 years**	**Faith in police**	**Faith in preparedness of local self-governance**	**Faith in preparedness of the country**
Complete answer mean value	4.22	2.13	2.31	2.22
Incomplete answer mean value	3.48	2.72	2.92	3.08

Using Spearman's rank correlation coefficient, it showed the following:

- The more students believed that a flood will happen in the following year, the more they believed it will also happen in the next five years and that their birth city is more exposed.
- The more students believed that a flood will happen in the next five years, the less faith they had in the preparedness of the local self-governance and the country.
- The more faith students placed in police, the more faith they placed in all other institutions mentioned - ambulances, firefighters, government, hydrometeorological institute, local self-government.
- The higher they placed the danger of floods to the environment, the higher they placed it to the infrastructure and human lives.
- The more the students felt they were prepared for floods, the more they believed the local self-governance and the country were prepared.

5 Conclusion

At first glance, the causes of floods seem simple - melting snow, frequent and heavy rains and storms, but these obvious causes make up only a small part of the real causes of floods in practice. This, perhaps the most terrible natural disaster known to mankind, took 173,170 lives between 1947 and 1967. At the same time, the death toll of all other types of natural disasters - hurricanes, tornadoes, earthquakes, and volcanic eruptions, was 269,635 (Davis, 2008).

Defense against "running water" is almost impossible - one cubic meter of released water weighs almost one ton. The speed of the river is largely determined by gravity. The greater the amount of water and the steeper the descent, the faster the water moves - within certain limits. Friction caused by a combination of the Earth's surface under water, air above, and even friction inside the water itself, usually keeps it at a speed of about 30km/h. However, given all these factors, the potential for disaster is staggering. Still, the lack of knowledge regarding this type of disaster is sobering.

Year after year, floods happen all around the world. They cause human casualties - immediate and "secondhand" from spread of polluted water and disease; loss of farm land and livestock resulting in famine; loss of infrastructure and massive econimic costs; etc. And yet, we still find missinformation, lack of information and knowledge, lack of preparation., lack of timely warnings.

When asked how prepared they were in case a flood happened - the mean value of students' answers was 2.92. Optimisticly on the other hand, when asked whether or not they felt there was a need for education and training in this field - 96.5 percent of students said yes. Moreover, 94.7 percent of them said that they would participate in education classes and trainings themselves. This, along with the obvious absence of knowledge on floods - their types, causes and consequences, leaves room and neccesity for more education in this area country wide. And that is maybe the most important conclusion this paper aimed to achieve.

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