JOURNAL
OF THE BULGARIAN GEOGRAPHICAL SOCIETY

Communicating disasters to children through digital learning activities, geospatial data and platforms

Eugenia Sarafova

Sofia University "St. Kliment Ohridski", Sofia, Bulgaria
Corresponding author: evgenia@gea.uni-sofia.bg

Key words:
geography education, disaster risk, GIS, curriculum

ABSTRACT

Natural disasters can significantly impact children's well-being, making it essential to effectively communicate risks and potential hazards to them. This paper outlines a data-driven holistic approach to enhance resilience among children by leveraging geospatial data and maps used in the classroom. By providing easy-to-understand information about the location, extent, and intensity of potential hazards, geospatial data, and maps can help children better understand the risks and prepare for emergencies. Also, the integration of geospatial data and maps can facilitate improved comprehension of risks among children while concurrently fostering their preparedness for emergency situations. During the primary research phase, various mediums were explored for effective communication of disasters. Presentation templates were developed to present information about different types of disasters, their causes, and appropriate actions during and after such events. Various practical activities that students can engage in to learn about natural disasters and their impact were developed. These activities include exploring flooding in different areas using a virtual globe, visualizing wildfires using satellite data platforms, and studying plate tectonics using a virtual globe. Students can also work with KML datasets containing fault lines and point GIS layers of all the earthquakes in the country since the beginning of the XX century, as well as explore the country's landslide register using various maps and layers. These activities provide students with hands-on experience in using technology and data to understand natural disasters and their impact.

Article processing
Submitted: 23 May 2023
Accepted: 10 July 2023
Published: 21 July 2023
Academic editor: Stoyan Nedkov

1. Introduction

Natural disasters such as earthquakes, floods, and hurricanes can have a devastating impact on the well-being of children: according to The Sendai Framework (2015), more than 1.5 billion people have been affected by disasters in various ways, with women, children, and people in vulnerable situations disproportionately affected. In addition to the physical harm caused by disasters, children may also experience emotional trauma and long-term psychological effects (Selby and Kagawa 2014). Effective disaster risk communication is crucial to mitigate these impacts and enhance resilience among this specific age group (Bradley et al. 2014). The use of geospatial data and maps has been shown to be effective in enhancing disaster risk communication and improving decision-making among emergency responders and policymakers (Bednarz and Van der Schee 2006; Kalogiannidis et al. 2022; Jiali et al. 2022; Puertas-Aguilar and de Lázaro-Torres 2023). Climate Change has been introduced into various school systems across the globe (Leininger-Frézal et al. 2023). However, communicating disaster risks to children is challenging, given their limited understanding of complex concepts and their different cognitive and emotional needs.

In various regions worldwide, including Bulgaria, numerous normative documents have been established pertaining to disasters. The Disaster Protection Act serves as the primary legislation

outlining public relations regarding safeguarding the welfare of the population, and protecting the environment and property, in the face of disasters. Climate change is anticipated to have a detrimental impact on human health, biodiversity, and multiple economic sectors in the forthcoming decades (IPCC 2022). In accordance with climate models, temperatures are projected to continue rising in Bulgaria, with a higher frequency of extreme weather phenomena such as intense rain, heatwaves, droughts, and floods. Certain demographic groups, such as the elderly, ethnic minorities, and impoverished populations, are particularly susceptible to the effects of disasters.

It is crucial for individuals to possess knowledge of how to respond when a disaster occurs. This includes understanding the means and channels through which one can acquire credible information from relevant authorities. Additionally, one should be aware of locations that provide shelter, protection, and aid in the aftermath of such an event. Knowing how to help oneself and others in a disaster area is also imperative. It is therefore essential that the public is educated on these critical elements to ensure preparedness and resilience during disaster situations.

Geospatial data and maps have been extensively used in disaster management and emergency response. Geospatial data refers to any data with a geographic component, while maps are graphical representations of geospatial data. In disaster management, geospatial data and maps are used to visualize, analyze, and communicate various aspects of disaster risks, such as hazard intensity, vulnerability, and exposure. Geospatial data and maps have been shown to be effective in enhancing disaster risk communication and improving decision-making among emergency responders and policymakers In Bulgaria, various research activities were performed in recent years, using different geospatial data sources and modeling methods to showcase risks and scenarios (Dimitrov and Spasova 2019; Nikolova et al. 2021; Hristova et al. 2022; Nikolov et al. 2022; Todorov and Kirilov 2022; Todorova et al. 2023).

According to UNESCO and UNICEF (2012), a comprehensive approach to disaster risk reduction (DRR) requires the systematic inclusion of relevant topics throughout the entire curriculum, spanning all grade levels. This entails going beyond the fundamentals of hazard science and safety protocols, and encompassing prevention, mitigation, vulnerability, and the cultivation of resilience. In Bulgaria, traditional methods of disaster risk communication to children, such as brochures, pamphlets, and audio-visual aids, have been the primary approaches. However, these methods often fail to effectively convey the location, extent, and intensity of potential hazards in a manner that is easily comprehensible to children. It is evident that there is a need for the development and implementation of new, digital methods and interactive means of teaching to effectively communicate disaster risks in the classroom. These methods have the potential to convey information in a more engaging and comprehensible manner, thereby improving children's understanding of potential hazards and increasing their preparedness in the event of a disaster.

Hawa et al. (2023) evaluate the presence of disaster risk reduction education in the geography curriculum at the secondary school level in Malaysia. The authors link geography curricula with DRR education and see this subject as the core of disaster-related content in schools. Similarly, Kamil (2021) discusses the development of disaster education in Indonesia, which began after the Aceh Tsunami disaster in 2004. The Indonesian government responded by revising the national curriculum to improve prevention efforts and preparedness in schools, recognizing the high risk faced by school students during disasters. After the tsunami, changes were made to the geography curriculum in secondary schools, following a revision in 2013. Maryani (2021) found that the discussion of disaster material in the curriculum in Indonesia was not optimal, and the teachers' understanding of the material was low. The study also found that teachers did not use various learning media to teach students about the importance of disaster preparedness. The authors suggest that improvements need to be made to the curriculum and teacher training in order to better educate students about disaster preparedness. Song et al. (2022) describe a survey of 180 students who were asked to compare the informativeness of web hazard maps and paper hazard maps. 77% of the students preferred web hazard maps, citing advantages such as the ability to obtain more information with one click, zoom in and out of layers, and overlay layers for optimal viewing. Only 10% of the students preferred paper hazard maps. The use of video games as an innovative teaching method to engage geography students was proposed by scholars, practitioners, and educators Gampell et al. (2020). A methodological framework based on constructivist learning theory was used to examine the potential of "serious" disaster video games to promote student participation in four New Zealand schools. The results show that the use of video games in the classroom needs further consideration of teaching and learning processes for both teachers and students. The alignment of video games to constructivism and the pedagogical mechanism of social science suggests that geography can enable deeper discussions and engagement of the curriculum by both students and teachers. Kalogiannidis et al. (2022) state that most countries' teacher education curriculum does not include disaster risk reduction material, but it is essential to incorporate it to help teachers spread knowledge to their students. Educational policies and processes should be reviewed to include disaster risk reduction and reorganize current educational concepts, regulations, and guidelines to achieve long-term educational goals. This would produce a workforce capable of contributing to the country's community disaster risk reduction initiatives. Incorporating disaster risk reduction in all kinds of schooling can aid in developing a cadre capable of addressing national issues and difficulties. There are many other examples of introduction to various problems, related to disasters, especially natural ones, in curricula across the globe (Bednarz and Van der Schee 2006; Kim and Bednarz 2013; Bearman et al. 2016; Siama et al. 2018).

The predominant approach to incorporating DRR into school curricula is through infusion or permeation, whereby DRR themes and topics are integrated into specific subject areas. This approach typically involves a review of the curriculum to assess its relevance and potential for DRR. The scope of this review ranges from a literal interpretation, such as identifying opportunities to discuss earthquakes in a Geography curriculum, to a more comprehensive approach that identifies opportunities for DRR that may not be explicitly related to disaster-related topics in a syllabus. For instance, reinforcing a culture of safety through subjects such as drama, music, etc (UNESCO and UNICEF 2012).

DRR is defined as the "concept and practice of reducing disaster risks through systematic efforts to analyze 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). The Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030, adopted at the Third United Nations World Conference on Disaster Risk Reduction, recognizes that disaster risk reduction is essential to achieving sustainable development (UNISDR 2015).

Geospatial data and maps have been extensively used in disaster management and emergency response. They have been shown to be effective in enhancing disaster risk communication and improving decision-making among emergency responders and policymakers.

In Bulgaria, the use of geospatial data and maps has been increasing in recent years, particularly in disaster management and risk reduction. The country has experienced various types of natural disasters, such as floods, landslides, and earthquakes.

The development and implementation of new methods for teaching disaster risks to children are crucial for improving their understanding and preparedness in the event of a disaster. By utilizing innovative approaches such as interactive digital media, GIS data, and maps, children could be provided with more engaging and effective means of learning about potential hazards. One promising approach is the use of GIS data and maps to provide a more interactive and engaging means of conveying this information. This approach has the potential to improve children's understanding of potential hazards and increase their preparedness in the event of a disaster. To address this challenge, we propose a holistic approach in using multiple types of digital resources that leverage geospatial data and maps to communicate disaster risks to children from the age of 7 to 18 years old. More specifically, we aim the creation of a digital library of resources, based on the systematic inclusion of relevant topics throughout the entire curriculum, spanning all grade levels and including geospatial data, maps, visualizations, and GIS layers, based on the UNESCO and UNICEF's framework.

2. Data and methods

2.1. Communication of disaster awareness among the general public

Comprehending the various perceptions of disasters is crucial in improving preparedness and response. Risk perception and the willingness to act in disaster situations may fluctuate based on cultural, social, and individual factors. Knowledge of such perceptions enables the development of effective communication and education strategies aimed at enhancing public awareness and preparedness. Communication of disaster awareness among the general public is crucial for the understanding of disasters in society, communities, and even in every single family.

Recently collected data from a nationally representative public awareness survey (MoI 2021b) on disaster risk management conducted in May 2021 revealed that awareness among the population regarding probable disasters in their respective settlements remains relatively low. The survey disclosed that one-third of respondents (33%) were completely uninformed of the likelihood of disasters in their area. Only a minimal proportion of respondents (2%) reported having complete knowledge regarding potential disasters.

Less than 50% of the survey participants displayed familiarity with measures that can mitigate the impacts and consequences of disasters, with 47% exhibiting a complete lack of awareness. The study revealed that the top risks as perceived by the respondents include infectious diseases, which is not surprising given the ongoing COVID-19 pandemic and the measures implemented in 2020 and 2021 in the country. Other perceived risks are floods, forest fires, earthquakes, severe thunderstorms, landslides, drought, infectious diseases affecting plants and animals, and man-made accidents.

The findings indicate that 60% of the survey respondents lacked awareness of any disasters or similar events in their area within the last decade. However, among those who reported being affected by a disaster during this timeframe, floods were the most prevalent at 30%, followed by earthquakes and severe thunderstorms, each reported by 29% of respondents. Notably, 48% of participants situated in the South-West region claimed to have been impacted by earthquakes, which can be attributed to the tremors experienced in the Pernik region in 2012.

The results show that there is relatively low awareness among the public in the country regarding the likelihood of disasters in their areas and the measures that can mitigate their impacts. This lack of awareness is concerning, as risk perception and the willingness to act in disaster situations can be influenced by social, cultural, and individual factors. This also emphasizes the need for effective communication and education strategies to enhance public awareness and preparedness. In particular, the findings suggest a need for better disaster education in schools to improve public knowledge and preparedness.

2.2. Availability of disasters data

Bulgaria is a country with diverse topography, which makes it susceptible to various types of natural disasters. Floods, together with earthquakes, landslides, and wildfires have caused significant damage to infrastructure, properties, and livelihoods in recent years. The collection of historical data on disasters is crucial for disaster prevention, analysis, and the provision of assistance after an event. The data collection and processing are done by analyzing archives from the past, such as photos, texts, and descriptions, and through digital sources, such as sensors, satellite data, and GIS analysis. In Bulgaria, there are several official data sources, including the National Statistical Institute, the Ministry of the Interior, and the Bulgarian Academy of Sciences. Additionally, there are various internet archives available, such as the State Agency "Archives" photo archive, and several crowdsourcing initiatives.

Geographic Information Systems (GIS) and geospatial data were first introduced in Bulgaria during the early 1990s. Despite being implemented and utilized for over 30 years, GIS is not yet well-integrated within certain state and municipal structures. The primary challenge for specialists is acquiring data from official sources responsible for them. However, the dissemination and sharing of open data from public institutions remain limited, and many areas in the country lack official publicly available data sources. As a result, crowdsourced data is often utilized in projects or national initiatives, as the authorities responsible for data collection and storage do not provide them for free usage.

Bulgaria's legislation on access to spatial data has been introduced in 2007 through the European Union (EU) Directive on the Creation of Infrastructure for Spatial Information in the EU (INSPIRE). However, in practice, the principles of INSPIRE have not yet been adopted in all organizations where it had to be established. The National Spatial Data Catalog was launched in December 2020 to provide some GIS data from official institutions in Bulgaria as required by INSPIRE. Although it provides a good opportunity to store and share institutional data, it requires further improvement and the introduction of additional datasets. The official government portal with open data is the Open Data Portal of the Republic of Bulgaria. However, one of the most significant challenges in accessing geospatial data in Bulgaria is that most municipalities do not have publicly available databases related to INSPIRE at the municipal level.

As of writing this paper, the search for disaster-related data on the Open Data Portal is constrained by the absence of a designated category for such data, thereby hindering efficient sorting. Utilizing keywords associated with the subject matter, like "fire", "flood" or similar, leads to limited outcomes from existing datasets, lacking in comprehensive coverage of the datasets available throughout the country.

Conversely, the National Spatial Data Catalog offers a "Natural Risk Zones" category, encompassing prospective areas of flood hazard.

According to the report on the Historical damage and loss data collection and the development of a concept for their collection in

the future (MoI 2021a) the project led to the creation of the most comprehensive database of damage and losses caused by disasters in Bulgaria to date. However, despite the efforts made to collect the most complete and accurate data possible, the resulting database is still limited by the available and collected data, project deadlines, and introduced anti-epidemic measures related to COVID-19. Therefore, the data collected during this project cannot be considered a statistically representative sample of the total number of events and losses in Bulgaria.

In total, the database identified 7 282 unique disasters that occurred in Bulgaria from 1881 to 2020 (Table 1). The majority of events (59%) were from the archive of the Directorate General Fire Safety and Civil Protection, followed by the database of the Forestry Executive Agency (32%) and the State Agency "Archives" (4%). It is important to note that although wildfires were the most frequently reported event type, they may not necessarily be the most significant or frequent hazard in the country. Data availability was a major factor in the high number of wildfires reported, as the Forestry Executive Agency's electronic database was readily accessible and well-maintained. Therefore, any comparisons made for event rates should consider the differences in data availability among the responsible institutions.

Based on data from the National Statistical Institute (NSI) for the year 2021, the total number of people that lost their lives from any kind of disasters amounted to 28 349 individuals. It should be noted that this number incorporates fatalities attributed to the "viral disease" hazard, which pertains exclusively to the COVID-19 pandemic and fatalities resulting from COVID-19 (U07). Additionally, the reported number of fatalities includes those arising from road traffic accidents, for 2021 amounting to 561 persons. Also, the NSI dataset shown on Table 2 comprises 16 cases of railway accidents or incidents.

GIS data for disasters from international sources and agencies like Copernicus and its services Climate Change, Emergency Management, and Land, together with data from various portals of NASA, are increasingly available and can provide valuable insights for disaster risk reduction efforts. These sources provide satellite imagery, data, and information on various types of natural disasters such as hurricanes, earthquakes, and wildfires, among others. Copernicus, for instance, provides satellite imagery, weather forecasts, and climate data, while NASA provides satellite data and information on wildfires, hurricanes, earthquakes, and other natural disasters. However, while the availability of data from these sources is significant, many teachers and educators are not familiar with it. Therefore, they may not know how to access these datasets or even that they exist. Training and educational resources on accessing and utilizing these datasets could greatly benefit teachers and improve their integration into the educational process.

2.3. DRR Framework

It has been demonstrated that the incorporation of DRR into formal education could be an effective way to reduce disaster risk. Therefore, it is crucial to promote the incorporation of disaster risk knowledge, including disaster prevention, mitigation, preparedness, response, recovery, and rehabilitation, in formal education at all levels to achieve priority 1 of SFDRR (UNISDR 2015). A framework containing categories and definitions was developed by UNESCO and UNICEF in 2014 (Selby and Kagawa 2014) and implemented into various school systems worldwide (Gong et al. 2021) as defined in Table 3.

Table 1. Historical damage and loss disasters data collection summary, according to the World Bank's report (2021).

Type of Disaster	Number of Events	% of the Total Number
Wildfire	2245	33.6
Flooding	1875	25.7
Storm	1526	21.0
Mass movement (dry)	966	13.3
Winter conditions	184	2.5
Other incidents (non-industrial)	79	1.1
Human infectious diseases	57	0.78
Earthquake	38	0.52
Drought	31	0.43
Industrial accident	28	0.38
Transport accident	16	0.22
Insects' invasion	11	0.15
Infectious and zoonotic diseases in animals	11	0.15
Waves	5	0.07
Mud flow	4	0.05
Avalanche	3	0.04
Extreme temperatures	3	0.04
Total: 7282		

Table 2. Number of events and loss of life in 2021 according to NSI data.

Number of events and loss of life in 2021, according to NSI data				
Category	**Subcategory**	**Event/Hazard**	**Number of events/ hazards**	**Number of deaths**
		Total	**14 006**	**28 349**
Geophysical	Earthquakes	movement of earth's surface	1	0
	Mass movement (dry)	rock fall	22	0
		landslide	66	.
		subsidence	1	0
Meteorological	Storm	hail	3	0
		convective storm	10	0
		heavy rain	132	0
		tornado	3	0
		storm	17	0
		wind	6	0
	Winter conditions	snow/ice	5	0
		winter storm/blizzard	3	0
		Frost / freeze	1	0
	Fog	fog	2	0
Hydrological	Flood	rain flood	49	0
		flood caused by damaged infrastructure	7	0
		riverline flooding	22	0
	Mudflow	mud flow	2	0
Climatological	Drought	drought	2	0
	Wildfire	forest fire	164	.
		field fire	533	.
Technological	Industrial accident	fire (industrial)	425	.
		other (industrial)	3	0
	Other accidents (non-industrial)	fire (non-industrial)	6 362	.
		other (non-industrial)	4	0
	Transport accidents	road accident	6 080	561
		rail accident	37	16
		navigation accident	1	0
Biological	Infectious diseases in humans	virus diseases	1	27 588
Other hazardous events	Degradation of the environment	environmental degradation	1	0
	Others	others	41	0

2.4. Disasters in the Curriculum in Bulgaria

The Bulgarian school curriculum does include specific topics related to disaster risk reduction; however, teachers may not be adequately prepared to communicate such complex information to children.

DDR is a critical endeavor that necessitates the active participation of various stakeholders to foster resilience and sustainability. Building upon the research conducted by Kalogiannidis et al. (2022), we focused on the DDR approach implemented within the educational system in Bulgaria (Fig. 1), highlighting the pivotal role played by key data sources.

By using the specifics of the country and its educational system, we mapped the integration of disaster risk-related content available from different sources, into the school curriculum to promote awareness, the Ministry of Interior's efforts in knowledge dissemination, and through the contributions of the academic community. Our approach emphasizes the importance of

collaboration between different stakeholders, including government agencies, academic institutions, and society, in managing disaster risks and communicating this information to children. By utilizing spatial data and other resources, this approach aims to provide children with a comprehensive understanding of potential hazards and how to prepare for them.

According to the Ministry of Education and Science (2023), a total of 52 hours from 1st to 12th grade are dedicated to equipping students

Table 3. Five dimensions of DRR learning (Gong et al. 2021).

Category	Definition
Knowledge	This dimension concerns developing an understanding of the science and mechanisms of natural hazards such as cyclones, tsunamis, and volcanic eruptions.
Response	This dimension includes familiarization with hazard early warning signs and signals, instruction in evacuation or sheltering procedures, drills and exercises, familiarization with basic first aid and the contents of a first aid kit, health and safety measures, and guidance on how to stay safe after a hazard has subsided.
Action	This dimension seeks to encourage learners to act and be proactive in mitigating risk through a thorough examination of the elements at work in the fundamental disaster risk formula, which is Disaster Risk=Natural Hazard × Vulnerability Capacity of Societal System
Participation	This dimension engages learners in processes of resilience building in their own community through grassroots-level initiatives, identifying hazards, developing resilience action plans, and implementing those plans
Integration	This dimension places emphasis on blending the structural elements, such as school buildings and facilities, and non-structural elements, such as school disaster management and school policy development so that the school becomes a DRR learning community or organization oriented towards building a culture of safety and resilience

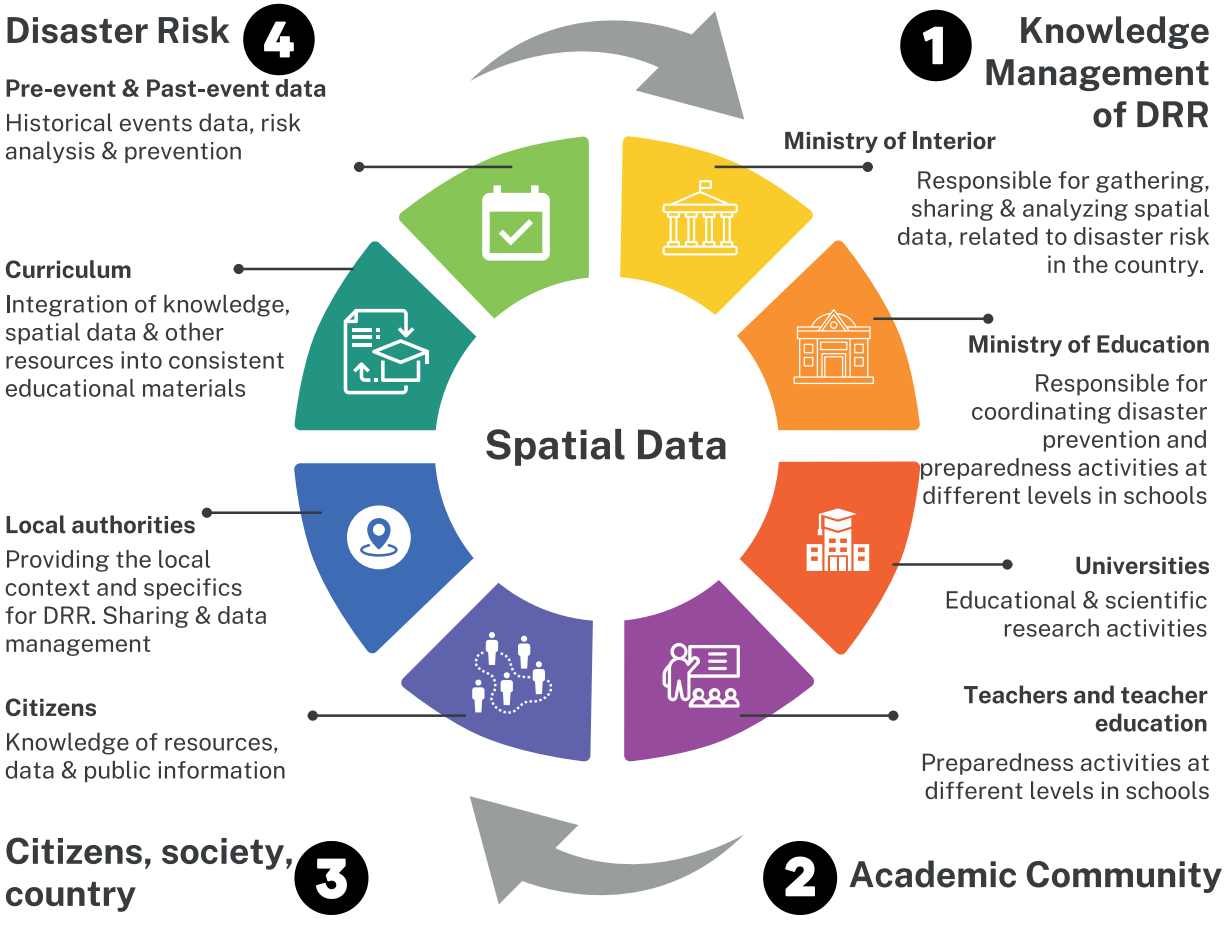

Figure 1. DRR approach through the school system (Kalogiannidis et al. 2022) and its relevant stakeholders in Bulgaria as organizations responsible for managing, sharing, and visualizing spatial data, related to DRR.

with the necessary skills and knowledge to effectively respond to emergencies such as disasters, accidents, and catastrophes. There are 4 hours per year from 1st to 4th grade; 5 hours per year from 5th to 10th grade and 3 hours per year in the last two years of high school. These hours are called "The hour of the class" and are separated from the geography classes that also include disaster-related information. This program allows for the inclusion of external experts to enrich the learning experience, for example, the Bulgarian Red Cross plays a pivotal role in the school curriculum by actively participating in disaster and accident prevention training. However, a significant number of teachers that have a leading role in these classes are not related in any way to the disaster topic. This leads to an even greater need to develop educational materials that can be used by teachers of various subjects.

3. Results and discussion

To provide effective disaster preparedness education for students, it is necessary to generate a comprehensive database that includes data, GIS layers, and methods that are specific to the country in question. The data used for these purposes must be presented in a simplified and generalized format that is easy to understand all the knowledge and skills needed. Also, it was noted that different schools use different software tools, so the educational materials and database were developed in various formats to accommodate different schools, age groups, and software or hardware equipment.

One of the key challenges in designing educational materials for disasters is ensuring that the data is accurate and up to date. This requires ongoing monitoring and updating of the data, as well as regular reviews of the database to ensure that it remains relevant and useful to educators and students. Also, it is important to develop effective teaching methods that can be used to educate students on disaster preparedness. These materials should be tailored to the specific needs of different age groups and should be designed to engage students and promote active learning.

The creation of a comprehensive database for disaster preparedness education is an essential component of disaster risk reduction efforts. By providing students with the knowledge and skills they need to prepare for and respond to disasters, we can help to build more resilient communities and reduce the impact of disasters on people's lives.

During the activities that took place at the beginning of 2023, the following principles guided the generation of data that can be used by teachers to teach their students about disasters:

- Safety
- Self-confidence and resilience
- Being a good citizen
- Interdisciplinary and STEM training
- Promoting peace of mind

In accordance with the principles of effective disaster communication mentioned above, the initial stage of educating students about disaster preparedness entails creating discussions with visual aids such as maps, images, videos, and Canva templates. As students progress to 5th grade and beyond, more advanced tools such as GIS layers, data, and maps can be introduced to provide a more in-depth understanding of disaster preparedness (Fig. 2).

The educational materials developed were tailored to the specific needs of the students, considering their age, the school's software and hardware equipment, and their ability to comprehend the information presented. All the materials were created based on the country's specific National Disaster Risk Profile (MoI 2021c), which provides a list and description of the possible disasters that could occur in the region. The structure of the educational materials is described in Table 4 below.

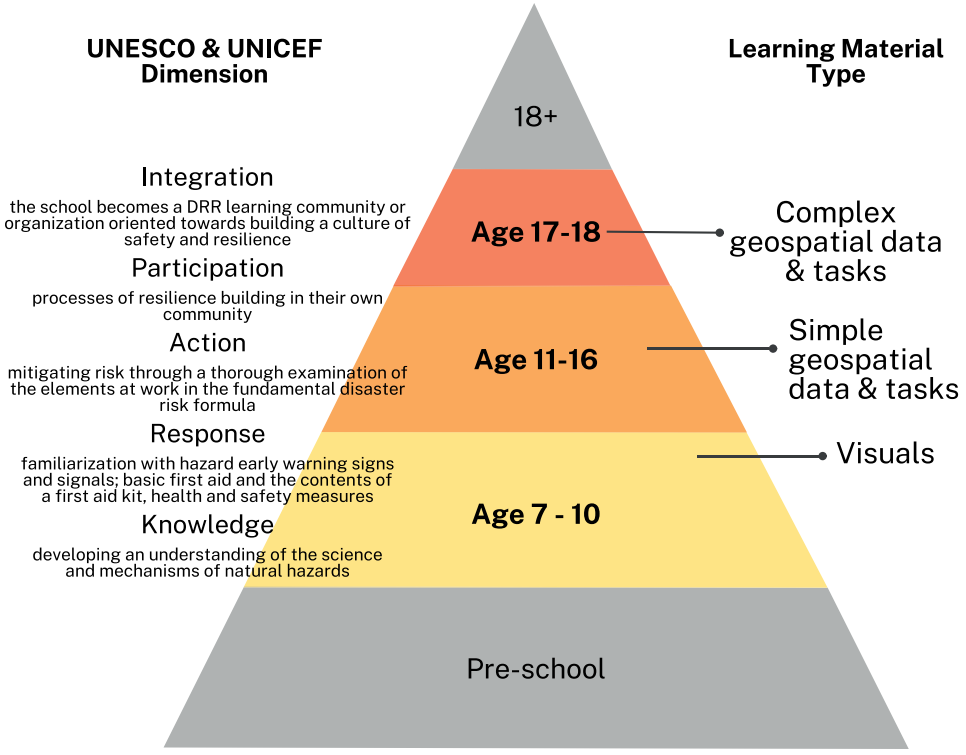

Figure 2. Levels of training materials developed according to the age of the students and the five dimensions, defined by UNESCO and UNICEF in 2014.

Table 4. Structure of the developed educational materials – by age, complexity and data source.

Teaching resources for							
Floods	**Wildfires**	**Earthquakes**	**Landslides**	**Extreme climate – heatwaves, storms, drought**	**Infectious diseases**	**Accidents**	**Age-Appropriate Geospatial data source**
Age 7-10							
Pictures and presentation template Video Canva templates Printables	Pictures and presentation template Video Canva templates Printables	Pictures and presentation template Video Canva templates Printables	Pictures and presentation template	Pictures and presentation template Video Canva templates Printables	Pictures and presentation template	Pictures and presentation template	-
Age 11-16: (+ All of the above mentioned)							
Virtual globe activity Discussion questions	Satellite data platform activity Discussion questions	Virtual globe activity - plate tectonics Discussion questions	Discussion questions	Copernicus data simulation for heatwave days in the country Discussion questions	Discussion questions	Discussion questions	Digital elevation model (DEM), available at Google Earth Extracted and simplified data from MODIS USGS Plate Boundaries Copernicus Climate Change Service Data
Age 16-18: (+ All of the above mentioned)							
Activities featuring the official flood preparedness maps	GIS point layer activity, derived from hot spot observations	GIS activity – faults GIS activity using earthquake data in a virtual globe or desktop GIS	Web map activity - landslide data from the official landslide register	Activity with the European Drought Monitoring System			Flood Preparedness Maps of the Basin Directorates in the country MODIS Hotspots GIS point layer GEM Global Active Faults KML & .shp layers - earthquakes in Bulgaria and the neighboring territories, 1900 to 2023, magnitude above 2.5 (static & dynamic) Bulgarian Landslide Register Maps European Drought Monitoring System Web Platform

All mentioned disasters include general information that consists of texts about the needed preliminary preparation, what actions in case of danger should be done, and scenarios for different places where one could be located when the event happens - outdoors, at school, or at home. There are also audio and video files from the Ministry of Interior, providing examples of the sounds that will be played in case of a crisis event.

During the primary research phase, we explored various mediums for the proper communication of disasters to children aged 7-10 in Bulgaria, such as pictures and presentation templates, videos, Canva templates, and printables. This age group is still not used to exploring geographical maps, as they are first introduced in 3rd grade (age 9) and Geography classes start at age 11. For that reason, the focus was on other visual aids that could play a vital role in engaging children's attention and conveying information effectively. Presentation templates were created to present information about different types of disasters, their causes, and what to do during and after such events. Also, the design of the templates and printables included clear and simple text with visually appealing images to keep children interested and make the content easily understandable. Short, animated videos that explain various types of disasters, their impact, and safety measures were created to better engage children in this target group. The content is presented in a sensitive and reassuring manner (Fig. 3), focusing on how a flood or a wildfire looks like, empowering children with knowledge rather than creating unnecessary fear.

Canva is a user-friendly design platform that offers numerous templates suitable for creating educational materials. It is widely used in the country and many teachers search for different templates that can be used in the classroom. Templates that have age-appropriate visuals highlighting important safety tips and emergency contact information were created during the development of the materials. Bright colors and large fonts were used to enhance readability.

Printables, such as activity sheets and coloring pages, can be a valuable resource for educating children about disasters while keeping them engaged. Various printable worksheets and activities using geospatial data (Fig. 4), dedicated to different disasters, were created to enhance disaster preparedness in this age group. Two types of printables were created – colorful and black and white, as there might be different printer specifications in different schools across the country.

Geography plays a crucial role in broadening students' horizons and fostering their understanding of the world around them. In Bulgaria, the study of geography begins in the fifth grade (age 11). For a better understanding of disasters and their occurrence in the country were prepared more in-depth activities, suitable for students 11-18 years of age:

- A virtual globe practical where students explore flooding in different areas;
- Satellite data platforms visualizing wildfires;
- Plate tectonics virtual globe practical;
- Working with KML datasets containing fault lines and point GIS layers of all the earthquakes in the country since the beginning of the XX century;
- Exploring the landslide register of the country with various maps and layers.

GIS and virtual globes have revolutionized the way we communicate information, including disasters, to children. By utilizing dedicated geospatial data, we can engage children aged 7-18 in understanding and responding to various disasters. The usage of publicly available geospatial datasets, such as MODIS hot spot data, earthquake data from USGS and the European-Mediterranean Seismological Centre (EMSC), drought maps from the European Drought Observatory, and maps from the country's landslide register, were incorporated to effectively communicate and educate children about disasters.

Figure 3. Visuals representing presentation templates.

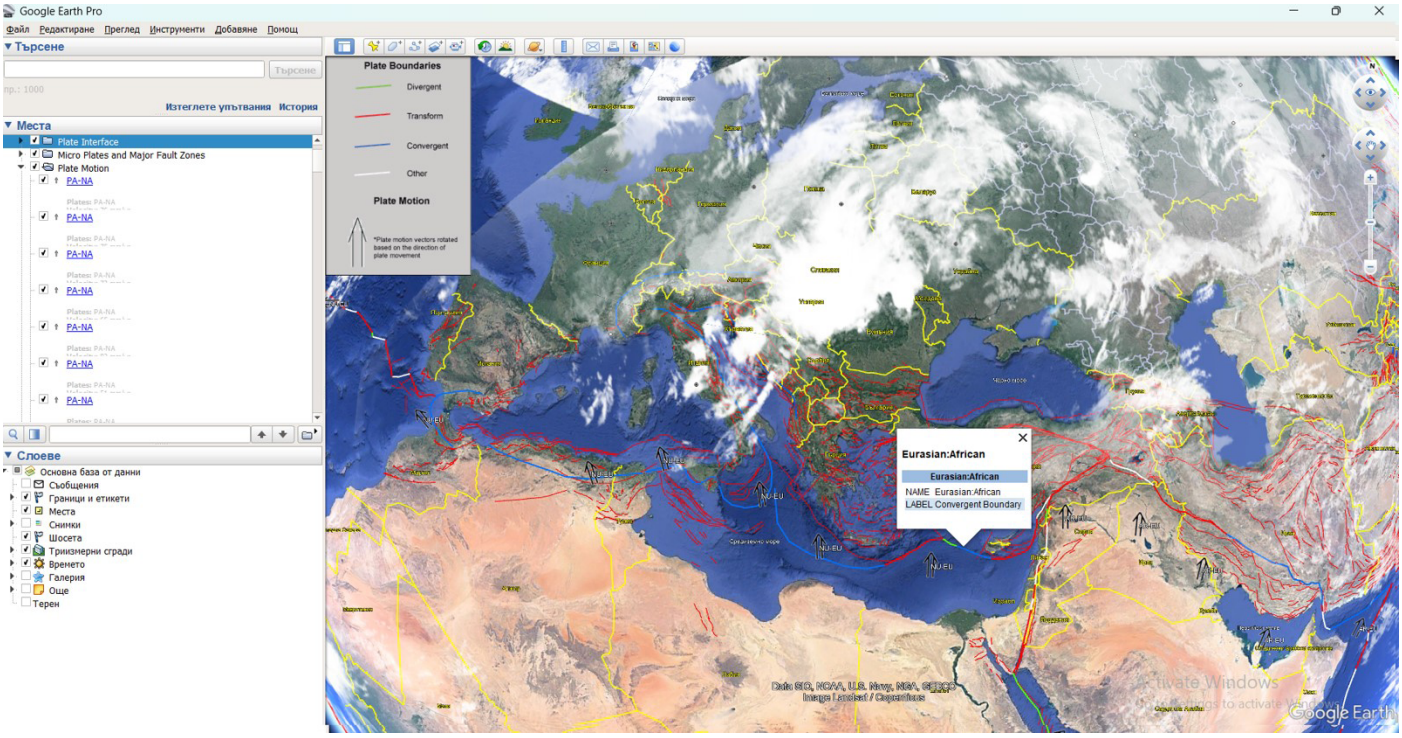

Figure. 4. Activity for understanding earthquakes, using Google Earth and USGS faults and plate layers. Map data 2019 (C) Google.

4. Conclusion

Educating children about the causes, prevention, response, and nature of disasters is important for several reasons, including helping them understand the risks associated with different types of disasters, developing coping skills to manage stress and anxiety, and fostering the value of community participation and cooperation. The content developed as a preliminary database was provided to teachers as a ready-to-use digital resource, suitable for different ages. It was privately funded and is not available for free access to the open public, however, it could be used as a basis for future development activities in this field of study.

The use of age-appropriate language and visual aids such as photos, diagrams, videos, virtual globes, maps, or data is highly recommended to facilitate understanding of the mechanisms of disasters. In addition, reassuring children of their safety, practicing emergency scenarios, encouraging emotional expression, and seeking support are important steps in preparing them for disasters. The development of a database with geospatial data for disaster risk communication represents a new way of presenting this information in the curricula. This methodology has the potential to improve children's understanding of potential hazards and increase their preparedness in the event of a disaster. To popularize it, several steps can be taken in future activities – a collaboration with schools, universities, and other educational institutions to facilitate the integration of this methodology into their curricula; partnerships with government agencies and non-profit organizations can promote the use of the methodology in disaster risk communication and education. Further research is needed to explore the effectiveness of these approaches and to develop best practices for their implementation.

It is important to note that the successful implementation and popularization of this approach requires public funding. It can be used to support the development and dissemination of educational materials, the training of educators, and the integration of this methodology into curricula. It can also support ongoing research to evaluate the effectiveness of this approach and to refine it based on feedback from educators and students. By providing the necessary resources, we can ensure that this methodology achieves its full potential in improving disaster risk communication to children.

References

Bearman N, Jones N, André I, Cachinho HA, DeMers M (2016) The future role of GIS education in creating critical spatial thinkers. Journal of Geography in Higher education 40(3): 394-408. http://dx.doi.org/10.1080/03098265.2016.1144729

Bradley DT, McFarland M, Clarke M (2014) The Effectiveness of Disaster Risk Communication: A Systematic Review of Intervention Studies. PLoS Currents 6. https://doi.org/10.1371/currents.dis.349062e0db1048bb9fc3a3fa67d8a4f8

Bednarz, S, Van der Schee, J (2006) Europe and the United States: the implementation of geographic information systems in secondary edu-cation in two contexts. Journal of Technology, Pedagogy and Education 15(2): 191-205. https://doi.org/10.1080/14759390600769573

Dimitrov Ts, Spasova Z (2019) Hot waves in Sofia and their impact on cases of stroke and heart attack in the summer. In: Electronic reports from the 12th EFSA Scientific Conference for Bulgaria - Risk Assessment Center on Food Chain at the Ministry of Agriculture of Bulgaria, "Climate change - a global threat to the food chain", Sofia (Bulgaria) 40-60 http://online.fliphtml5.com/bkgx/cjzs/#p=1

European Drought Observatory (EDO): official website https://edo.jrc.ec.europa.eu/

European-Mediterranean Seismological Centre (EMSC): Earthquake Data, https://www.emsc-csem.org/Earthquake_data/

Gampell A, Gaillard JC, Parsons M, Loïc Le Dé (2020) 'Serious' Disaster Video Games: An Innovative Approach to Teaching

and Learning about Disasters and Disaster Risk Reduction. Journal of Geography 119:5, 159-170. https://doi.org/10.1080/00221341.2020.1795225

Gong Q, Duan Y, Guo F (2021) Disaster Risk Reduction Education in School Geography Curriculum: Review and Outlook from a Perspective of China. Sustainability 13: 3963. https://doi.org/10.3390/su13073963

GEM Global Active Faults project (GEM-GAF): Official website https://blogs.openquake.org/hazard/global-active-fault-viewer/

Hawa NN, Zakaria SZ, Razman MR, Majid NA, Taib AM (2023) Element of Disaster Risk Reduction in Geography Education in Malaysia. Sustainability 15(2): 1326. https://doi.org/10.3390/su15021326

Hristova D, Stoycheva V, Nedkov S (2022) Review on the state of the art of the modeling of flood regulation ecosystem service and publication on ecosystem accounting. Deliverable D2.1.1. INES project, 16 p.

Intergovernmental Panel on Climate Change (IPCC) (2022) Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp. https://doi.org/10.1017/9781009325844

Jiali S, Hiroyuki Y, Takashi O, Takuro O (2022) Application of web hazard maps to high school education for disaster risk reduction, International Journal of Disaster Risk Reduction 72: 102866. https://doi.org/10.1016/j.ijdrr.2022.102866

Kamil P (2021) IOP Conference Series: Earth Environment. Sci. 630 012018

Kim M, Bednarz R (2013) Development of critical spatial thinking through GIS learning. Journal of Geography in Higher Education 37: 350–366. http://dx.doi.org/10.1080/03098265.2013.769091

Kalogiannidis S, Toska E, Chatzitheodoridis F, Kalfas D (2022) Using School Systems as a Hub for Risk and Disaster Management: A Case Study of Greece. Risks 10(5): 89. https://doi.org/10.3390/risks10050089

Leininger-Frézal C, Sprenger S, de Lázaro Torres M, Ángeles M, Heidari N, Pigaki M, Naudet C, Lecomte A, Gallardo M (2023) Global Change Challenge in the Higher Education Curriculum on the Approach of Blended Learning. European Journal of Geography 14 (2): 1-14. https://doi.org/10.48088/ejg.c.lei.14.2.001.014

Maryani E (2021) IOP Conference Series: Earth and Environmental Science, Volume 683, International Geography Seminar 2019, Indonesia

Ministry of Education and Science – official website: 52 Hours of Disaster Preparedness Activities https://www.mon.bg/bg/news/5209

Ministry of Environment and Water (MoE): Flood Risk Management Plans 2022-2027 https://www.moew.government.bg/bg/vodi/planove-za-upravlenie/planove-za-upravlenie-na-riska-ot-navodneniya-purn/planove-za-upravlenie-na-riska-ot-navodneniya-2022-2027/

Ministry of Interior (MoI) (2021a) Agreement for the provision of consulting services strengthening resilience to disaster risks, Component 2: Historical damage and loss data collection and development of a concept for their collection in the future. Collection of historical disaster damage and loss data, Technical Annex - Data Analysis. TECHNICAL ANNEX TO PART I OF THE FINAL REPORT, 4 Mar. 2021, edited on 28 Jul. 2021.

Ministry of Interior (MoI) (2021b) Reports from the Agreement for the provision of consulting services between the Ministry of Interior and the International Bank for Reconstruction and Development.2021. Component 4 – Public Awareness Study Regarding Disaster Risks: A National Representative Study For The Level Of Disaster Awareness, Level Of Preparedness and Need for Information of The Bulgarian Population

Ministry of Interior (MoI) (2021c) Agreement to provide consultancy services enhancing sustainability to disaster risks (P170629). Component 3: A proposal for National disaster risk profile in Bulgaria, 2021

Ministry of Regional Development and Public Works (MRDPW): National Landslide Register of Bulgaria https://www.mrrb.bg/

MODIS Collection 6 NRT Hotspot / Active Fire Detections MCD14DL: https://earthdata.nasa.gov/firms. doi:10.5067/FIRMS/MODIS/MCD14DL.NRT.006

National Statistical Institute: Number of events and loss of life in 2021 https://infostat.nsi.bg

National Spatial Data Catalogue https://inspire.egov.bg/

Nikolov P, Hristova D, Stoycheva V (2022) Modeling of flood regulation for ecosystem accounting: a case study of Ogosta river basin. Journal of the Bulgarian Geographical Society 46: 3-10. https://doi.org/10.3897/jbgs.e86288

Nikolova N, Zlateva P, Todorov L (2021) Fuzzy Logic Approach to Complex Assessment of Drought Vulnerability. In: Murayama Y, Velev D, Zlateva P (Eds) Information Technology in Disaster Risk Reduction. ITDRR 2020. IFIP Advances in Information and Communication Technology, vol 622. Springer, Cham. https://doi.org/10.1007/978-3-030-81469-4_24

Open Data Portal in the Republic of Bulgaria https://data.egov.bg/

Puertas-Aguilar, M, Ana E. García S, de Lázaro-Torres (2023) Web GIS to Learn Geopolitics in Secondary Education: A Case Study from Spain European Journal of Geography 14 (2):15-31. https://doi.org/10.48088/ejg.m.pue.14.2.015.031.

Puertas-Aguilar M-Á, García Sipols AE, de Lázaro-Torres ML (2023) Web GIS to Learn Geopolitics in Secondary Education: A Case Study from Spain. European Journal of Geography 14 (2):15-31. https://doi.org/10.48088/ejg.m.pue.14.2.015.031.

Siama I, Theano S, Klonari A (2018) Building a Landscape Educational Program for the Needs of Greek Preschool and Primary-School Children: A Methodological Approach European Journal of Geography 9 (1). https://eurogeojournal.eu/index.php/egj/article/view/95

State Agency "Archives": official website https://www.archives.government.bg/

Todorova E, Zhiyanski MK, Todorov L (2023) Using high precision climate data for wildfire risk assessment. Silva Balcanica 24(1): 5-16. https://doi.org/10.3897/silvabalcanica.24.e101192

Todorov L, Kirilov K (2022) Land use change and monitoring of endangered wetlands using geospatial technologies: A case study of Boyana marsh. Journal of the Bulgarian Geographical Society 47: 3-14. https://doi.org/10.3897/jbgs.e94102

United Nations Office for Disaster Risk Reduction (UNISDR) (2009) Terminology on Disaster Risk Reduction, UNISDR: Geneva (Switzerland) pp. 10–11.

United Nations Office for Disaster Risk Reduction (UNISDR) (2015) Sendai Framework for Disaster Risk Reduction 2015–2030; Geneva (Switzerland) pp. 13–15.

UNESCO, UNICEF (2012) Disaster Risk Reduction in School Curricula: Case Studies from Thirty Countries. Published by the United Nations Children Fund, ISBN 978-92-3-001087-4

USGS, Earthquake Hazards Program: Google Earth™ / KML Files, available at https://www.usgs.gov/programs/earthquake-hazards/google-earthtmkml-files

Selby D, Kagawa, F (2014) Towards a Learning Culture of Safety and Resilience: Technical Guidance for Integrating Disaster Risk Reduction in the School Curriculum; UNESCO: Paris, France; UNICEF: New York, NY, USA pp. 24–27,61.

Song J, Yamauchi M, Oguchi, Ogura T (2022) Application of web hazard maps to high school education for disaster risk reduction. International Journal of Disaster Risk Reduction 72: 102866. https://doi.org/10.1016/j.ijdrr.2022.102866

Conflict of interest

The author have declared that no competing interests exist.

ORCID

https://orcid.org/0000-0002-1164-1204 - E. Sarafova