# TOWARDS MAPPING MULTI-HAZARD VULNERABILITY OF NATURAL DISASTERS FOR THE BULGARIAN TERRITORY

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***Abstract***
*Multi-hazard, multi-sectoral and multi-level mapping of natural disasters contributing to the risk assessment is one of the high-priority areas for the international cartographic community. Natural disasters do not affect evenly the territory of Bulgaria and some of them have a trans-boundary impact. Different natural threats to the Bulgarian territory are separately mapped and various specialized thematic maps are available. In this paper an approach for mapping the multi-hazard vulnerability at national scale is outlined. This effort for vulnerability mapping is binded with freely available demographic and social information, industry, business and communications assets and building stock statistics. Vulnerability maps indicate the location of sites where people, the natural environment or property are at risk due to a potentially catastrophic event that could result in death, injury, pollution or other destruction. Being at early stage of development, this elaboration demonstrates a set of sequential methodological steps towards preparing vulnerability maps that can be used in all phases of disaster management.*

***Keywords****: natural disaster, vulnerability, mapping natural hazards, Bulgaria*

## INTRODUCTION

Natural hazards are inevitable natural phenomena. The degree of their negative consequences - human losses and social impact on society and/or different destructions, incl. infrastructure damages - might classify these threats as natural disasters. The impact of given natural disaster, which is valued by different degrees of natural and human vulnerability, is a function of the exposure to this natural phenomena and its magnitude.

Vulnerability, in general, describes the relationship, which people have with the environment, social forces and institutions, and cultural values. In 2015 a common effort towards Disaster Risk Reduction (DRR) has been the adoption of the Sendai Framework for DRR, UN Sustainable Development Goals, and UN Framework on Climate Change agreed at the Paris Climate Conference (UNISDR, 2015). The contemporary efficient and effective DRR practices need reliable basis of multi-hazard and multi-sectorial estimates, inclusive and accessible. Reducing disaster risk through proper risk assessment and management is a cost effective investment in preventing future losses. Risk assessment couples exposure with vulnerability estimation. Numerous activities are undertaken following various recommendations that are outlined on the base of risk and vulnerability assessments at the global, regional, national, and local level considering existing and future hazards. Mapping vulnerability allow us to analyze 'vulnerability' as a concept central to the way we understand disasters and their magnitude and impact (Bankoff et al., 2004; WEF, 2011) Vulnerability maps supply information on the location of the sites with particular resources - people, natural environment or property – which are exposed to a potentially catastrophic event that could result in death, injury, pollution or other destruction. These maps are made in conjunction with information about different types of risks. They can be used in full disaster management cycle: prevention, mitigation, preparedness, operations, relief, recovery and lessons-learned (Carpignano et al., 2009; Groeve et al., 2015). More specifically, the damaging effects of natural disasters can be reduced or minimized by proper measures, taken in advance by the responsible institusions and the public, despite the fact that they are sudden events, even in many cases, impossible to be forecasted. The governing bodies can carry out proper planning and performance of various actions to ensure gradual lowering of the natural disaster risk and to enhance the response capacity to natural disasters (Schmidt-Thome, 2006).

This paper deals with an approach for mapping the multi-hazard vulnerability. Demographic and social information, industry, business and communications information, building stock information are coupled in particular maps. The performed effort is focused on mapping of the vulnerability at national scale. Being at early stage of development, this elaboration demonstrates a set of sequential methodological steps towards preparing vulnerability maps that can be used in all phases of disaster management.

## VULNERABILITY TO NATURAL DISASTERS - CONCEPT, BENEFITS AND CHALLENGES

There are many different definitions of vulnerability. The word 'vulnerability' derives from the Latin word vulnerare (to be wounded). It describes the potential to be harmed, which means the sensitivity to a perturbation or stress (Downing et al., 2001). Vulnerability is understood in different dimensions that represent, in general, physical, social, economic, and environmental characteristics, which can be destabilized in case of a natural hazard (INSPIRE, 2013). A strong divergence in the definitions of the vulnerability exists, being a wider concept coupling assessment methods with the physical vulnerability issues (vulnerability finctions, fragility curves). There are general agreements reached for the use of the latter as element of the multi-risk analysis. It is still less clear how to integrate other kinds of vulnerability assesement (e.g. social, environmental, etc.) within a multi-risk analysis framework. Dealing with analysis of natural hazards, their impacts are often expressed in terms of vulnerability and exposure. Vulnerability models describe the uncertainty how the exposed human-environment system will react to different magnitudes of the hazardous event and this is strongly related to the hazard type and the characteristics of the concerned community, system or asset.
According to UNISDR (2009) the vulnerability describes characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. In probabilistic/quantitative risk assessments the term vulnerability expresses the part or percentage of exposure that is likely to be lost due to a certain hazard. Exposure is defined as the totality of people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. Vulnerability reduction is closely related to the concept of resilience - the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNEP/IE, 1998; EC, 2010; Groeve et al., 2015).

The Intergovernmental Panel on Climate Change and the European Environmental Agency define the vulnerability as the probability that a certain damage level would be exceeded at a certain magnitude of the event. According this definition, the vulnerability encompasses three components: exposure, sensitivity and adaptive capacity – distinguishing these components is quite useful for tracking the results of DRR strategies over time. DRR activities are often localized and address especially community-level vulnerabilities and institutional capacities (UNEP/IE, 1998; Groeve et al., 2015). EU recommendations include good-practice regularly updated, that can be used for the national risk assessment and should address the following subjects regarding vulnerability analysis:

- Identification of elements and people potentially at risk (exposure);
- Identification of vulnerability factors/impacts (physical/technical, economic, environmental, social/political);
- Assessment of likely impacts;
- Analysis of self-protection capabilities reducing exposure or vulnerability.

The main challenge of multi-risk assessments is to adequately take account of possible follow-on/knock-on, domino or cascading/effects among hazards. For example, an earthquake may provoke the landslide manifesations and/or flood (e.g. dam or pipelines damage), fires (e.g. gas pipe-line damage), etc. The multi-vulnerability concept refers to the variety of exposed sensitive targets (e.g. population, transport systems and infrastructure, buildings, cultural heritage, etc.). They show different types of vulnerability against the various natural hazards and require different types of capacities to prevent and cope with them.

Maps represent important information sources about hazards, vulnerabilities and risks in a particular area and thereby support the risk assessment process and overall the risk management strategy (WEF, 2011). They provide a useful information that might support a set of risk reduction strategies and relevant priorities. Maps also have important roles to play to ensure that all actors in the risk assessment have the same information about hazards and in the dissemination of the risk assessment results to stakeholders. Finally, the risk mapping could also be useful in the broader context of land use planning. Preparing risk maps is a complex process. They are normally part of the results of a risk analysis and estimation, coupling the results of the phases of mapping hazard and vulnerability over given territory. The vulnerability maps include information on the nature of the hazard (e.g. frequency and severity, topographical data, etc.), exposure inventory (e.g. population, buildings, transport network, etc.), and the vulnerability of exposures to hazards (dense population, poorly designed buildings, low grade settlements, inadequate emergency response capacity, etc.). More over, we need to take into account the target group of maps' end-users background, the specific tasks that they face, and their particular individual tastes and preferences (Konecny et al., 2011).

Decision making process during the full disaster management cycle - prevention, mitigation, preparedness, operations, relief, recovery, and lessons-learned - can be effectively driven with the vulnerability maps' aid, e.g. exposure can be reduced; capacity can be improved. Vulnerability mapping at local level as a part of the risk assessment cycle can improve the municipalities' ability to promote disaster reduction. These maps will allow them to decide on mitigating measures to prevent or reduce loss of life, injury and environmental consequences before a disaster occurs. Also, vulnerability maps are useful basis for the emergency planning during natural disaster event. When it is possible to provide an information about the potential multi-hazard scenarios (major event and triggered events), exposure and vulnerability analyses for each single event whithin the different scenarios branches and relevant risk estimates, these maps can be successfully used for setting multi-risk scenarios (Schmidt-Thome, 2006; Groeve et al., 2015). Risks and threatened objects are usually identified and classified using a set of tables. Two major scales are most oftenly used to estimate the consequences:

- Three grades scale: 1→ Low, 2 → Moderate and 3 → Severe;
- Five grades scale: 1→ Unimportant, 2 → Limited, 3 → Serious , 4 → Very serious and 5 → Catastrophic. Description of the different grades is published in UNEP/IE handbook (1998).

Vulnerability maps are usually created using the contemporary information technologies provided by GIS, but they can be prepared also "manually" using different available background maps. The use of GIS with remote sense technologies enables the visualisation of the spatial pattern of the physical/technical vulnerability and also individual, economic, environmental, social/political characteristics. Major challenges in vulnerability mapping are related to the data used – data quantity and quality, gaps and/or missing values, updating issues. Data availability and accessibility are common problem due to unclear legislative regulations and unwillingness to share an information, even from public institutions. For example, statistical data about the building stock in Bulgaria is not organized in relevant way to estimate the physical vulnerability and to associate it with social vulnerability. The information about infrastructure locations or land cover cadastres, especially for large regions, usually is too costly for the research institutions and universities. In Bulgaria, mostly raster maps are available as public data – they can be reached via Internet, as printed copies in different educational atlases and cartographic products. Within the data provided by National Statistical Institute (NSI, 2016) and available for registered fires, the household fires and other fire hazards are not distinguished. Other challenge in vulnerability mapping is to select a set of indicators that have to be minimal and applicable. Important feature of the vulnerability maps is their static character – these maps do not include temporal effects regarding the vulnerability for risk mitigation. Vulnerability maps usually are considered as starting point for continuous hazard risk monitoring and have to be regularly updated (Fekete, 2012).

## GOOD PRACTICES IN VULNERABILITY MAPPING

There are numerous examples of hazard, vulnerability and risk mapping methodologies being used by public authorities and private organisations in Europe and worldwide. Risk mapping practices in Europe have been recently reviewed by Carpignano et al. (2009) and major weaknesses and challenges have been identified. Most approaches address only natural hazards and less systematically the technological and industrial risks. The study argues that research on the comparability of man-made and natural risks is still a challenge. Furthermore qualitative aspects of vulnerability (e.g. values attributed to environmental or cultural assets) and risks perceptions are not taken on board. 'Debate on the definition of accurate parameters and indicators to express vulnerability and coping capacities are still ongoing'.

The EU projects like Armonia (2004-2007), DORIS (2010-2013), MATRIX (2010-2013), SENSUM (2013-2015), and others include a review of the state-of-the-art of existing single and multi-risk methodologies for mapping. These projects studied hazard and risk mapping techniques for different natural hazards: floods, earthquakes, landslides, forest fires, volcanoes plus meteorological extreme events, climate change, etc. Overall this review shows a range of different practices in hazard, vulnerability and risk mapping across the hazards. The review of multi-hazard and multi-risk mapping, for example, in the Armonia project comprises several systems including the US FEMA Hazus-MH and the French Délégation aux Risques Majeures (DDRM).

## BULGARIAN LEGISLATION AND NATIONAL STRATEGIES FOR DRR

The roles of the main actors in the Disaster Risk Reduction in Bulgaria are regulated by a number of normative documents: Law on Disaster Protection, Law on the Ministry of Interior (MoI), National Plan for Disaster Protection and National Action Plan, National Program for Protection in Disasters, Regulation on terms and conditions for the functioning of the National System for early warning and alert, Strategy to reduce the risk of disaster, etc. The systems for EW & CM have just started to be developed and the MoI is the responsible organization. Despite the general documents' title, the existing legal system in Bulgaria, related do natural disasters, is guided by the traditional principle of the single event (hazard type). Natural hazards are discussed without relevant interconnections and consequences.

Governing institutions have followed their obligations for DRR though formulating/reviewing/revising of operative disaster prevention plans; maintaining organizational infrastructure for disaster prevention; implementing disaster prevention and emergency measures; gathering/transmiting information related to disasters; reporting conditions of disasters; implementing rehabilitation work after disasters. On national to local level the disaster management plans addressed comprehensive and long-term DRR issues including risk management plans, disaster recovery and rehabilitation, scientific and technical support. Since September 30, 2008, the emergency telephone 112 has 100% national coverage and is accessible from anywhere in the country. According to the Act on Amendments and Supplements to the MoI Act, which has been in force since 24 November 2009, the Civil Protection Directorate-General (DG Fire Safety and Civil Protection) became part of the MoI of Bulgaria. The DG Fire Safety and Civil Protection is a national specialised structure responsible for performing tasks related to prevention and preparedness, management, reaction and recovery in case of natural and man-made disasters. The Situation Centre of the DG Fire Safety and Civil Protection at the MoI conducts the overall coordination in case of disasters. Operational Communication and Information Centres in all 28 districts (regions) of the country are also exist. Bulgarian Red Cross has developed and implements a Policy and a Strategy for actions in case of disasters until 2020.

Activities related to the protection of the population in case of threat or occurrences of disasters in Bulgaria are carried out by a various governmental and nongovernmental institutions, departments, offices and other operational structures. These units, offices and other operational structures are components of the Integrated Rescue System (IRS), while the institutional or organisational affiliation and their designated functions or objects are preserved. Civil protection expenditures are approximately 0.27% of the GDP (EC, 2015). In case of emergencies that disaster has large or transboundary impact, the activities related to the civil and property protection can be supported by international organisations and countries, based on specially signed agreements. In fact, these units are the target group, that should be interested in the information provided by the various vulnerability maps.

Bulgarian legislation related to ensuring the protection of life and health, the environment and property in case of disaster (e.g., the Disater protection Act, the Law for the Ministry of Interior, the Law of water, etc.) have been recently updated in accordance with international and EU requirements and standards in this field (Bandrova et al., 2015; Boycheva, 2015). National and regional strategies are regularly updated, following the acquired information and the worldwide available experience and 'good practices'. In 2014 a national Strategy for Disaster Risk Reduction 2014-2020 was adopted based on Hyogo Framework for Action, followed by a Road Map, in which key activities are described along with deadlines and structures responsible for their implementation. National Program and National plan for Disaster Protection were also adopted in the same year. According to the Bulgarian progress report on the implementation of the Hyogo Framework for Action, a substantial achievement has been attained applying the effective modern methods for education on the disaster preparedness and protection (Boycheva, 2015). Responsible EW & CM institutions perform regular information campaigns for awareness of the population about the main rules for reaction and protection in case of disasters, and many initiatives are undertaken till now. These measures are clearly oriented to improving capacity of the community to cope with natural disasters.

## NATURAL DISASTERS THREATS AND MANIFESTATIONS IN BULGARIA

Natural disasters do not affect evenly the territory of our country. Bulgaria is more frequently affected by floods, extreme temperatures, earthquakes, storms, and wildfires. For example, during the last decade the total precipitation and extreme weather frequency have increased, with heavy rains causing severe floods, especially in 2006 and 2014. Statistics show that just for the period 2010 - 2015, 46,797 people were injured from natural disasters, of whom 67 have died and material damages are estimated over US$ 949K (NSI, 2016; Guha-Sapir et al., 2016). Collecting information for vulnerability mapping starts with identification of natural hazards that can cause disaster. Short description of the natural hazards, manifested within the Bulgarian territory is given in Table 1. For the period 2010-2014, NSI (2016) registered a total 30749 crisis events; among them natural disasters are 4593 (Fig.1a). Large financial losses for this period were caused by floods and landslides, which often can be provoked by the first. Substantial financial losses have been sustained because of landslides in 2010 and 2012, and from floods - in 2010 and 2013 as shown on Fig.1b. Data were obtained on the basis of the annual reports of 141 permanent municipal committees to protect the population during disasters, accidents and catastrophes.

*Table 1. List of natural disasters, manifested within the Bulgarian territory (updated Table 2;Pashova et al., 2010)*

| N | Disasters | Potenial affected area | Description | Consequences |
|---|---|---|---|---|
| GEOLOGICAL PROCESSES AND PHENOMENA | | | | |
| 1 | Earthquakes | regional*<br>local** | Intensity – up to 12 grades (MSK) | Soil displacements, cracks, land slides, fires, damage and collapse, human losses, ecological catastrophes |
| 2 | Slope failures (landslides, landslips, creep, falls, flows, subsidence) | local | Mass and velocity flow | Rock mass, material loss, human losses |
| 3 | Mud-rock flows | local | Mass, velocity flow | Mud- stone flow , material loss, human losses |
| 4 | Erosion and abrasion | local regional | Process intensity and speed | Dislocations, collapses, material loss, human losses |
| 5 | Storm surge | local regional | hurricane winds<br>Speed > 40km/h | Dislocations, collapses, material loss, human losses |
| 6 | Tsunami | local | sea floor displacement or triggering of slumps | Dislocations, collapses, material loss, human losses |
| HYDROLOGICAL AND METEOROLOGICAL PROCESSES AND PHENOMENA | | | | |
| 7 | Floods | regional, local | Racing the river level and/or dam destruction | Flooding of riparian zones, material loss, human losses |
| 8 | Snow flows and glaciations | regional, local | Quality of snow falls over 20 mm in 12 hours | Snowdrift - difficulties for road infrastructure |
| 9 | Drought | regional, local | High temperatures and low humidity | Damage in agriculture, reducing soil fertility, fire |
| 10 | Temperature extreme | regional, local | Temperature | material loss, human losses |
| 11 | Thunderstorm | local | intensity | material loss, human losses |
| 12 | Tornado phenomena | local | Speed > 30m/s | material loss |
| 13 | Dust storms | regional, local | High temperatures and low humidity, dusting | Damage in agriculture, reducing soil fertility, fire |
| 14 | Hailstorms | local | Icy grain size, intensity | Damage in agriculture |
| 15 | Wet snow | local | Quantity and moisture content of snow | Damage to forests, orchards, electricity supply network |
| 16 | Fog (coastal, evaporation, radiation, valley, upslope) | regional, local | Horizontal visibility at distances less than 500 м | Transport, clean air |
| 17 | Silver thaw | local | intensity | transport, agriculture |
| 18 | Wild land fire | regional, local | Temperature | Thermal effects, material losses, damage to the biosphere and soil |
| 19 | Strong wind | regional, local | Speed > 15m/s | material loss |

## ELEMENTS AT RISK & EXPOSURE. MAPPING VULNERABILITY FROM NATURAL THREATS IN BULGARIA

Each natural hazard event is characterized by its geographic location, area, size or magnitude, intensity, speed of onset, duration, and frequency. The event can occur alone or to be a trigger mechanism for the next disaster after the main event to happen, such as flood, landslide, fire, etc. Any event or hazard may trigger significant number of subsequent hazards, all of which could be individually considered. The likelihood of each of the events occurring is of course correlated to the likelihood of occurrence of the other event or the prior triggering event. The assessment of consequences then needs to consider the cumulative impact of all of the various impacts occurring at the same time or shortly following each other. Such multi-risk approaches are important in all geographic areas susceptible to several types of hazards, as is the case in many regions in the EU, as well as for Bulgaria. In this situation, exclusively focussing on the impact of only one specific hazard could even result in raising the vulnerability in respect of another type of hazard (Edwards et al., 2007; Groeve et al., 2015).

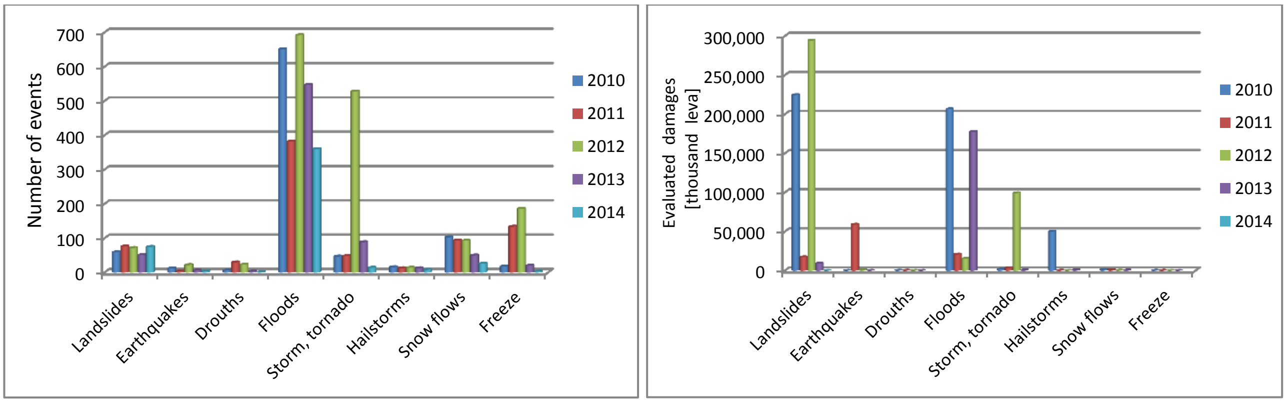


*Figure 1. Number of natural disasters (a) that occurred in Bulgaria and damage estimated (b) for the period 2010-2014*

In Bulgaria many hazard maps have been drafted by governmental, research organisations and local public bodies. Hazard mapping has been carried out for flooding, eartquakes and landslides. Hazard and risk maps are included in the DRR plans issued by governing institutions. Thus the public is kept informed regarding undertaking disaster countermeasures. The Ministry of Environment and Water (MEW), the Ministry of Ministry of Regional Development and Public Works (MRDPW) and other organisations have drawn up methodologies and guiding manuals on the subject. Usually, the threats to the national territory are separately mapped – e.g. maps of geological hazards, maps of seismic hazard, flood hazard and risk maps, etc. are available in different atlases, GIS governmental portals, legislation documents, and in other sources. Recently, variety of specialized thematic maps have been produced (e.g. Pashova et al., 2015; Marinova et al., 2015). Many of these maps have been made available to the general public on the Internet and elsewhere.

First flood hazard maps in Bulgaria have been prepared sporadically for decision support purposes in early 80s and have been not updates more then 30 years. For implementation of European Union Flood Directive 2007/60/EC, after first River Basin Management Plans developed in 2010, the MEW coordinates elaboration of second River Basin Management Plans and Flood Risk Management Plans for the period 2016 - 2021. The flood hazard and risk maps for all areas of potential significant flood risk (APSFR) in Bulgaria have been prepared according to the national methodology for the flood-scenarios with return periods 20, 100 and 1000 years. At present these plans are published on the four River Basin Directorates web sites for public consultation and written feedback, starting in December 30, 2015.

The main triggering factors of landslides are impact of surface and ground water, abrasion, erosion and earthquakes as in many cases landslides are provoked in combination of some of them. National Program for Prevention and mitigation of landslides on the territory of Bulgaria, erosion and abrasion of the Danube and the Black Sea coast for the period until 2020 is approved for implementation by the MRDPW. In 2015, based on the analysis and assessment of the current situation, officially registered are about 1,700 landslides in populated areas, depicted on a newly compiled map of the geological hazard at scale 1:500,000. They are not evenly distributed - a greater concentration of landslides settled along the Danube and Black Sea coast, in mountain areas and in some of the valleys.

A good contemporary example for vulnerability assessment and mapping climate hazards (thunderstorms, extreme temperature, heavy precipitation, snow dept, frost, drought, hail, and fogs) at local level for the municipality of Lom is published in (Nikolova and Gikov, 2013). The study is carried out on the base of a framework for vulnerability assessment including elements: hazard probability, exposure, sensitivity and coping capacity. Vulnerability Index for the municipality of Lom is estimated and maps of exposure to climate hazards and level of sensitivity to climate hazards are prepared. The results obtained are promising at local level of vulnerability assessment to ten climate hazards. Vulnerability maps indicate the location of sites where people, the natural environment or property are at risk due to a potentially catastrophic event that could result in death, injury, pollution or other destruction. Still, at national level there are not available assessments of the vulnerability and exposure to different natural hazards.

Different indicators are elaborated to describe the vulnerability model. For example, in accordance with the Disaster Risk Index, the vulnerability refers to the different variables that make people less able to absorb the impact and recover from a hazard event (Carpignano et al., 2009; EC, 2010; Balica, 2012). These may be technical (such as poorly constructed, unsafe housing); economic (such as lack of reserves or low asset levels); environmental (such as the fragility of ecosystems); and social (such as the absence of social support mechanisms or weak social organization). People's social/economic vulnerability has hazard specificity and it is not conceptually possible to arrive at a global multi-hazard indicator of vulnerability.

The vulnerability map describes susceptibility of a community to natural hazards. Census data are one of the main sources of information for generating vulnerability maps and have been widely used by experts in vulnerability assessment related to natural hazards. Based on the census data and data for the natural disastrous events /floods, fires, landslide and quakes/ in the period 2010-2014, obtained by the NSI (2016), a map is complied and presented in Fig. 2. Preveiling part of the disaster events over the whole territory of the country are the fires /probably they contain also household fires/, which are several times more than the other events. The majority of these events are registred in Burgas, Stara Zagora, Gabrovo and Varna districts with higer density of population - therefore the vulnerability of these areas is higher. A big number of flood events are registred in Sliven, Smolyan, Varna, Montana, Pleven and Buras districts. Some of these floods have several casulaties and many injured.

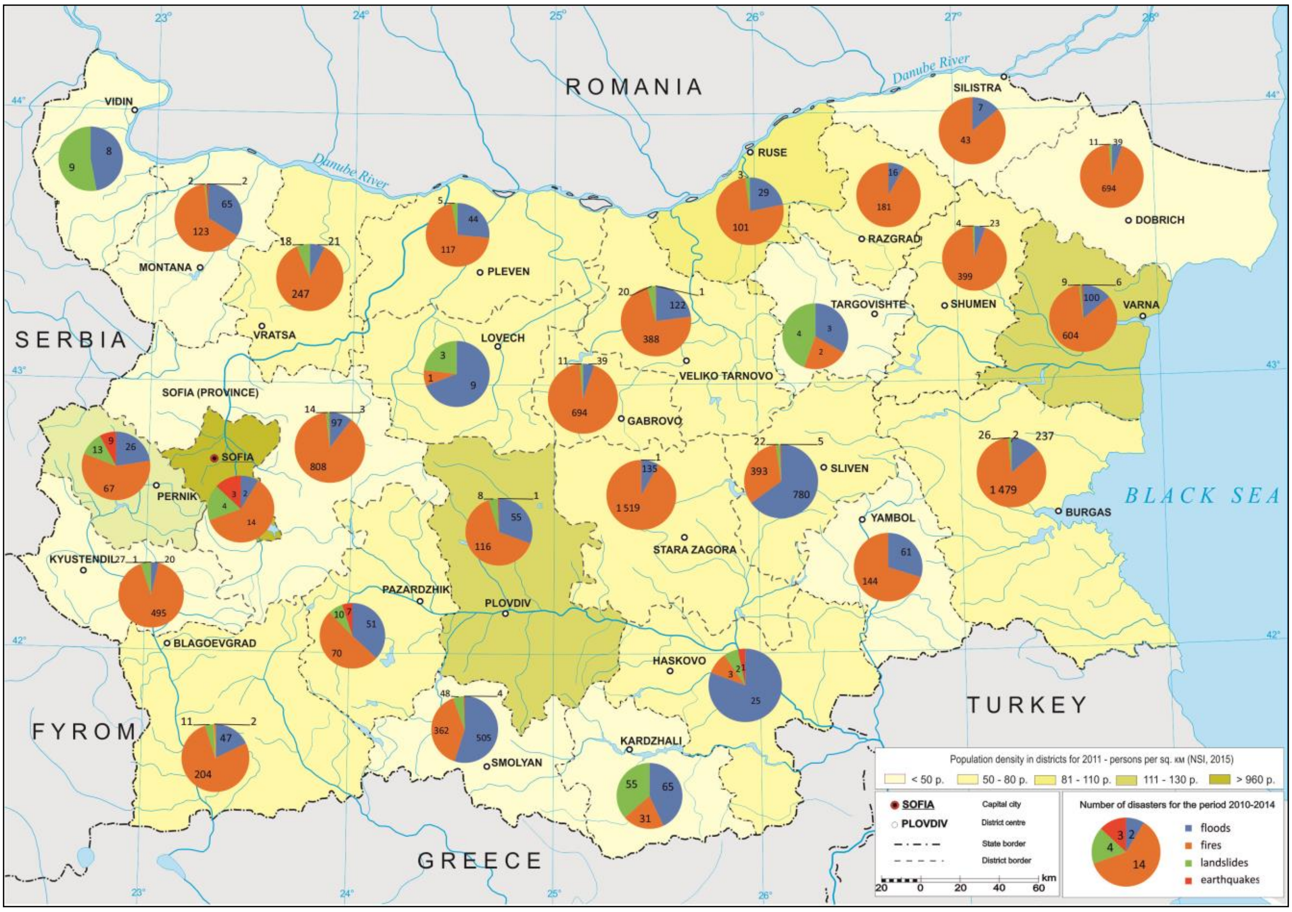


*Figure 2. Different natural hazard events that happened in the Bulgarian districts /oblast/ for the period 2010-2014 (NSI, 2016)*

Floods that happened in the Bulgarian districts for the same period, presented by years, are shown in Fig.3. It is evident that most of the floods have been happened in 2010 in Smolyan, Yambol, Dobrich, Burgas, Sofia /province/ and Montana districts. It should be noted 2014, when 10 major floods in Varna, Dobrich and Mizia (Montana district) and other locations happened with 18 casualties and many infrastructural losses, evaluated on hundreds of millions BGN.

The exposure concerns natural disaster casualties that are limited by the number of people present in stricken areas and losse, which are constrained by the quantity and value of the buildings, infrastructure and other property in those areas. The risk of natural disasters increases in more densely populated and urbanized territorries. Levels of preparedness and disaster resilience determine how vulnerable the people are to the natural hazards. Individuals, organizations and communities that have invested in assessing their natural hasard risks, and in formulating and implementing responsible preparedness and mitigation measures, are likely to experience fewer casualties, less damage and less disruption from natural disasters.

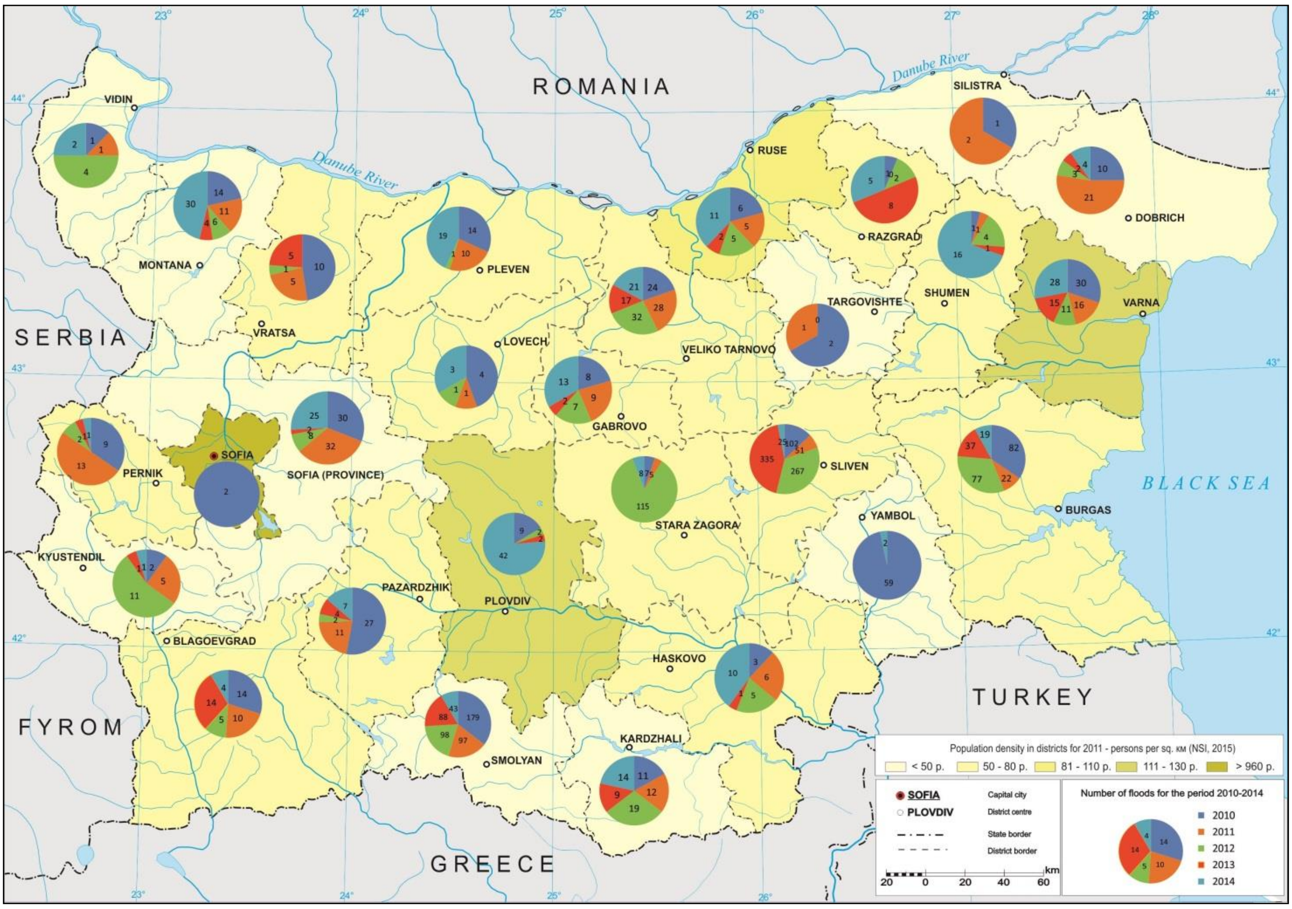


*Figure 3. Flood events for the period 2010-2014 by year on the Bulgarian territory (NSI, 2016)*

## CONCLUDING REMARKS

Disaster damages can be reduced with the advances of society capabilities to address natural disasters and the mitigation of vulnerability by establishing early-warning disaster systems, promoting nationwide land conservation, improving weather forecast, improving risk assessment process and risk management, increasing public awareness, and promoting education and scientific research in this field. Institutional partnership should be a guiding principle for successful DRR strategy. While the events of natural disasters can not be prevented, the efforts can focus on precautions to avoid loss of life and reduce economic losses caused by natural disasters. The cross cutting nature of DRR work puts additional demands on the need for good governance practices. For DRR work at local levels, the holistic approach is especially important. Decision-making, counseling and representation of all stakeholders and society in DRR process will contribute to the development of good governance.

Considering the available information, digital data and raster maps, an approach for mapping the multi-hazard vulnerability is outlined. Demographic and social information (population density), floods, fires, landslides and earthquake hazard are particularly considered for the purpose of this study. The performed effort is focused on mapping vulnerability at national scale. Being at early stage of development, this elaboration demonstrates a set of sequential methodological steps towards preparing vulnerability maps that can be used in all phases of disaster management. Authors' ambitions to include in this study also information about the industry, business and communications, building stock were discomfited due to the available data - the raster maps have not best quality and the lack of relevant digital data. The data for natural disastrous events and exposure in Bulgaria are still scattered, limited, difficult to be accessed and compared; the data on social-economic impacts of disasters are only indicative. There is insufficient public awareness on the principles, objectives and activities to reduce the natural disaster risk and to response on the activities before, during and after disasters. The measures implemented in this direction are inconsistent and limited in scope, as underestimated problem and resource provision. There are gaps in the arrangements for the activities on disaster recovery between governing bodies and stakeholders. The financial issues are also not clarified and the responsibilities of stakeholders to assume the cost of disaster recovery. It is very important to invest in the risk management and not to underestimated, which in the long run has a high rate of return and limited follow-government aid, while contributing to sustainable economic development.

The most valuable lesson learnt is the major challenge of the present day – the natural disasters cannot be efficiently solved in isolation. Vulnerability mapping should go beyond the single analysis of exposure to hazard. To mitigate the negative hazard consequences is required planners to shift their strategy to cope with the complex factors that contribute to disasters in today's environment. Reliable vulnerability maps need of reliable data and proper data processing techniques. The good vulnerability maps are suitable tool for communicate different risks to the public. The constructed hybrid maps indicate that reliable vulnerability and risk management need to shift the focus of adjustment of physical structures towards improvement of planning and organization processes. Working to improve education, legislation and increase the resilience of physical structures are proper tools for improving capacity and reducing exposure.

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