# STRATEGIES OF DISASTER RISK REDUCTION ON THE BACKGROUND OF U.N. GGIM AND DIGITAL BELT AND ROAD EFFORTS

**M. Konečný, T. Bandrova, P. Kubíček, Z. Stachoň, R. Štampach, J. Shen, I. Rotanova, J. Brodský, P. Špulák**

**Affiliations:**

Prof. Dr. Milan Konečný, Ph.D.
Laboratory on Geoinformatics and Cartography, Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia
Kotlářská 2, 61137 Brno, Czechia
Tel.: +420 549495135
Email: konecny@geogr.muni.cz

Prof. Dr. Eng. Temenoujka Bandrova
University of Architecture, Civil Engineering and Geodesy / Bulgarian Cartographic Association
1, Chr. Smirnenski Blvd.
1046 Sofia, Bulgaria
Tel.: +359 887 832702
Email: tbandrova@abv.bg

Assoc. Prof. Dr. Petr Kubíček, Ph.D.
Laboratory on Geoinformatics and Cartography, Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia
Kotlářská 2, 61137 Brno, Czechia
Tel.: +420 549494498
Email: kubicek@geogr.muni.cz

Zdeněk Stachoň, Ph.D.
Laboratory on Geoinformatics and Cartography, Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia
Kotlářská 2, 61137 Brno, Czechia
Tel.: +420 549494925
Email: zstachon@geogr.muni.cz

Radim Štampach, Ph.D.
Laboratory on Geoinformatics and Cartography, Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia
Kotlářská 2, 61137 Brno, Czechia
Tel.: +420 549496640
Email: stampach@mail.muni.cz

Prof. Jie Shen
Key Laboratory of Virtual Geographic Environment (Nanjing Normal University), Ministry of Education, Nanjing, Jiangsu 210023, China,
Wenyuan Road 1, 210023 Nanjing, China
Tel.: +25 85891347

Assoc. Prof. Irina Rotanova, Ph.D.
Altai State University, Institute of Geography, Department of Physical Geography and GIS
Lenina 61, 656049, Barnaul, Russia,
Tel.:+7385 2291277
E-mail: rotanova@mail.asu.ru

Jan Brodský, M.Sc.
Laboratory on Geoinformatics and Cartography, Department of Geography, Faculty of Science, Masaryk University, Brno, Czechia
Kotlářská 2, 61137 Brno, Czechia
Email: broda@mail.muni.cz

Capt. Pavel Špulák
Ministry of the Interior – General Directorate of Fire and Rescue Service of the Czech Republic
Department of Information and Communication Technologies
Kloknerova 26, PO Box 69, 148 01 Prague 4, Czechia
Tel.: +420 950 819 851, Fax: +420 950 819 965
E-mail: pavel.spulak@grh.izscr.cz

***Abstract***
*The paper aims for the contemporary strategic development of the Disaster Risk Reduction (DRR) area defined by the U.N. DRR conference in Sendai, 2015, and other related conferences like the 2017 Global Platform in Cancun. There are also highlighted U.N. Sustainable Development Goals (SDGs) 2015-2030. DRR Sendai framework is inextricably linked with the main U.N. SDGs document. Paper investigates synergies between indicators of SGDs and Global indicators of Sendai Framework. The importance of geographical aspects and new data initiatives U.N. GGIM and DBAR, the essential parts in the building of the Global Data Ecosystem, are described. The cartography potentials for SDGs and the importance of using volunteers and Volunteer Geographic Information (VGI) for DRR and Crisis Management are commented on, and the examples of using VGI data and open-access platforms for the Humanitarian OpenStreetMap Team and Missing maps project are described.*

***Keywords****: disaster risk reduction, GGIM, digital belt and road, SDGs indicators, global Sendai Framework indicators, improvement of strategies, the role of cartography*

## 1. INTRODUCTION - DRM AND DRR

The Leaders' of the United Nations (U.N.) "2017 Global Platform for Disaster Risk Reduction" in Cancun, Mexico (Global Platform, 2017), recognise that globally, direct economic losses attributed to disasters are increasing significantly, having over the last decade reached close to US$1.4 trillion. Indirect economic losses magnify the figure further. Losses to countries' capital stock, including housing, infrastructure, productive assets and livelihoods, and impacts on health and education have had significant fiscal implications, hindering economic growth and development (Global Platform, 2017, https://www.unisdr.org/conferences/2017/globalplatform/en). In previous publications, it was shown how interest about the development of Disaster Risk Management (DRM) and Disaster Risk Reduction (DRR) changed, and the development of scientific and new technological solutions has increased (Konecny M. et al., 2011; Konecny et al., 2020)

With the growing of disaster problems in last few years the line connected with global warming processes have been enhanced. Especially after tsunamis in SE Asia in 2004 and new approaches to the problems defined in the Hyogo Framework for Action (Hyogo Framework, 2005) were successfully developed. One of the important aspect have been ideas about creation of culture to be able to live with risks of disasters which should be also based on people-concentrated systems of Early Warning (EW) and gradual development of the new, wider concept of DRR which respect all knowledge gain from DRM but enriching it by more social oriented approaches.

## Definitions of DRM and DRR

According to updated “2009 UNISDR Terminology” (Terminology of UNISDR, 2016) and modified Terminology of U.N. DRR (2019) we respect these definitions.

**Disaster risk management** is the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses. **Disaster risk reduction** is aimed at preventing new and reducing existing disaster risk and managing residual risk, all of which contribute to strengthening resilience and therefore to the achievement of sustainable development. By other words, disaster risk reduction is the policy objective of disaster risk management, and its goals and objectives are defined in disaster risk reduction strategies and plans.

New concepts and strategies are developing and also improving by changing the scientific and data frameworks in which new approaches are applied. We are living and doing now everything in Big Data era (Bandrova et al., 2014; Filchev et al., 2018), and with efforts to create smart solutions (Kubicek et al., 2018; Stachon et al., 2016; Shen et al., 2020; Yang et al., 2018) , development of Data-driven Geography (Miller and Goodchild, 2015; Palma et al., 2016) and new approaches in various disciplines, like agriculture (Reznik et al., 2017) or soils (Feiden, 2011) all together created new knowledge and technological situation with new potentials for solving DRR problems. A very important fundamental aspects of the process are various data concepts and building of new quality data arsenals. Critical efforts for the contemporary world are Sustainable Development Goals defined by U.N. in 2015 as “2030 Agenda for Sustainable Development” defining 17 tasks and newly accompanied by sets of indicators and DRR Sendai goals and global indicators. It is not easy to combine them (Scott and Rajabifard, 2017; Metternicht et al., 2019; Metternicht et al., 2020) but all this effort is creating the real situation we can start to feel how is our planet breafing and developing.

## 2. SUSTAINABLE DEVELOPMENT GOALS (SDGS) AND INDICATORS

SGDs are defined in the document the U.N. Sustainable Development Goals 2015-2030. U.N. General Assembly on August 12, 2015, published document titled "Transforming our world: the 2030 Agenda for Sustainable Development” (United Nations General Assembly, 2015) there are defined 17 SGDs (see also Figure1 and part 7 of this paper). 1. End poverty in all its forms everywhere; 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture; 3. Ensure healthy lives and promote well-being for all at all ages; 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all; 5. Achieve gender equality and empower all women and girls; 6. Ensure availability and sustainable management of water and sanitation for all; 7. Ensure access to affordable, reliable, sustainable and modern energy for all; 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all; 9. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation; 10. Reduce inequality within and among countries; 11. Make cities and human settlements inclusive, safe, resilient and sustainable; 12. Ensure sustainable consumption and production patterns; 13. Take urgent action to combat climate change and its impacts; 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development; 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels; and 17. Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.


*Figure 1: U.N. Sustainable Development Goals 2015-2030. Source: United Nations Brussels Team (2018).*

The critical step ahead is a fact that 17th goals are accompanied by 169 targets, 232 global indicators to follow-up and review progress to know real state of the art of our planet according to measured characteristics. Implementation of these efforts is expected by implementation via national planning processes, policies, strategies and frameworks. Measuring and monitoring will be done by statistics, geospatial information, Earth observations and other Big Data.

The U.N. Statistical Commission, as a functional commission of Economic and Social Council (ECOSOC), was asked to develop the global indicator framework. The overarching principle of the 2030 Agenda for Sustainable Development is that no one should be left behind. Data which is high-quality, accessible, timely, reliable and disaggregated by income, sex, age, race, ethnicity, migration status, disability and geographic location and other characteristics relevant in national contexts should support implementation at all levels; the 2030 Agenda also included the need to exploit the contribution to be made by a wide range of data, including Earth observations and geospatial information.

Although the development of the Global indicator framework has primarily been based on a statistical data input-output approach, the need for 'geographic location' in a new era of data needs is well recognised. Many national statistical offices now understand that geospatial information, Earth observations and other Big Data are able to provide new and consistent data sources and methodologies to integrate multiple 'location-based' variables to support and inform official statistics and the indicators for the SDGs. Geography and location provide an important link to enable a richer picture of our countries, and what is happening in and across them. It enables data from diverse sources to be brought together to unleash their combined power in analysis and decision making. To meet the ambitions and demands of the 2030 Agenda, it is necessary for the Global indicator framework to adequately and systematically address the issues of alternative data sources and methodologies, including geospatial information and Earth observations in the context of geographic location (IAEG-SDG, 2016).

On February 2020 with the intention to facilitate the implementation of the Global indicator framework, all indicators are classified by the Inter-Agency and Expert Group on SDG Indicators (IAEG-SDGs, 2020) into three tiers based on their level of methodological development and the availability of data at the global level, as follows:

- Tier I: Indicator is conceptually clear, has an internationally established methodology and standards are available, and data are regularly produced by countries for at least 50 per cent of countries and of the population in every region where the indicator is relevant.
- Tier II: Indicator is conceptually clear, has an internationally established methodology and standards are available, but data are not regularly produced by countries.
- Tier III: No internationally established methodology or standards are yet available for the indicator, but methodology/standards are being (or will be) developed or tested.

All indicators are equally important, and the establishment of the tier system is intended solely to assist in the development of global implementation strategies. For tier I and II indicators, the availability of data at the national level may not necessarily align with the global tier classification, and countries can create their tier classification for implementation. The tier I and II indicators' metadata are available in the metadata repository (https://unstats.un.org/sdgs/metadata/). Tier III indicators require work plans to be developed outlining the methodological development of the indicators for approval by the IAEG-SDGs. The current tier III work plans are available here (https://unstats.un.org/sdgs/tierIII-indicators/).

As of December 11 2019 the updated tier classification contains 116 tier I indicators, 92 tier II indicators and 20 tier III indicators were accepted. In addition to these, there are four indicators that have multiple tiers (different components of the indicator are classified into different tiers).

## 3. DISASTER RISK REDUCTION SENDAI GOALS AND GLOBAL INDICATORS

In the Third U.N. World Conference on DRR, March 14, 2015, in Sendai, Japan, The Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted (United Nations General Assembly, 2015b). The U.N. DRR conference is a culmination of contemporary state-of-the-art approaches to solving problems of risks and disasters on our planet. As never before the conference in its materials mentioned the role of ICTs, GIS, remote sensing, mapping, sensors, volunteer geographic information, etc.

In Sendai framework, four new priorities of action are defined:

- Priority 1: Understanding disaster risk;
- Priority 2: Strengthening disaster risk governance to manage disaster risk;
- Priority 3: Investing in disaster risk reduction for resilience;
- Priority 4: Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction (United Nations General Assembly, 2015b).

DRR Sendai framework is inextricably linked with the main U.N. SDGs document (explained above the text). The terminology of Open-Ended Intergovernmental Expert Working Group on Indicators and Terminology Relating to Disaster Risk Reduction (OEIEWG, 2017) was established by the U.N. General Assembly via resolution 69/284 and adopted on June 3 2015 for the development of a set of possible indicators to measure global progress in the implementation of the Sendai Framework. Report of the working group defining indicators and targets were endorsed by The U.N. General Assembly Resolution A/RES/71/276 on February 2 2017 (OEIEWG, 2017). The report is coherent with the work of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators (IAEG-SDGs), and the update of the publication entitled “2009 UNISDR Terminology on Disaster Risk Reduction” (Terminology of UNDRR, 2019).

Recommendations of the OEIEWG on Global indicators for the global targets of the Sendai Framework aim to operationalise seven indicators (A-G). They have been selected and as well as related and reflected to the SDGs items no. 1 - Poverty, 11 – Sustainable Cities and 13 – Climate Action (Figures 1 and 2).

On December 15, 2017, The U.N. Office for Disaster Risk Reduction (UNISDR) had launched a process for monitoring implementation of the Sendai Framework. The Sendai Framework Monitor started measuring of progress towards the mentioned SDGs items. It is a management tool to help countries develop disaster risk reduction strategies, make risk-informed policy decisions and allocate resources to prevent new disaster risks. The Sendai Framework Monitor can contribute to the Target E of the Sendai Framework related to the development of actionable national and local disaster risk reduction strategies by 2020.


*Figure 2: Seven Global Targets of Sendai Framework for Disaster Risk Reduction. Source: Policy Area Secure (2018).*

A set of 38 indicators was identified to measure global progress in the implementation of the Sendai Framework.; the will measure progress in achieving the global targets of the Sendai Framework, and determine global trends in the reduction of risk and losses. The scope of monitoring has been categorised in a number of ways:

- Global and Custom targets and indicators:
  - The seven global targets (A - Mortality, B - Affected people, C - Economic loss, D – Damage, E – Countries, F – International cooperation, G - Availability) and thirty-eight global indicators will measure progress made by all countries on disaster risk reduction by the year 2030. These will contribute to the global analysis of the country-level information submitted by countries and documented in the biennial Global Assessment Reports.
  - Additionally, the custom targets and indicators are nationally defined instruments by the Member States to measure their progress against the four priorities of the Sendai Framework. They are based on the priorities of respective countries and will be reflected in the national DRR reports of the countries.

- Input, Output and Outcome level targets and indicators:
  - Input level: Nationally defined, appropriate public policy indicators to measure the implementation of the 4 Priorities and the Sendai Framework in general
  - Output level: Nationally defined targets and indicators to measure the reduction of risk and increase in resilience
  - Outcome level: Global targets and indicators as described above, which are objective and comparable

## 4. INTEGRATED MONITORING OF THE GLOBAL TARGETS OF THE SENDAI FRAMEWORK AND THE SUSTAINABLE DEVELOPMENT GOALS

The Sendai Framework targets and indicators contribute to measuring disaster-related goals and targets of the 2030 Agenda for Sustainable Development of above mentioned SDGs (PreventionWeb, 2020, https://www.preventionweb.net/sendai-framework/sendai-framework-monitor/common-indicators). Their desired outcomes are a product of complex and interconnected social and economic processes with overlap across the two agendas.

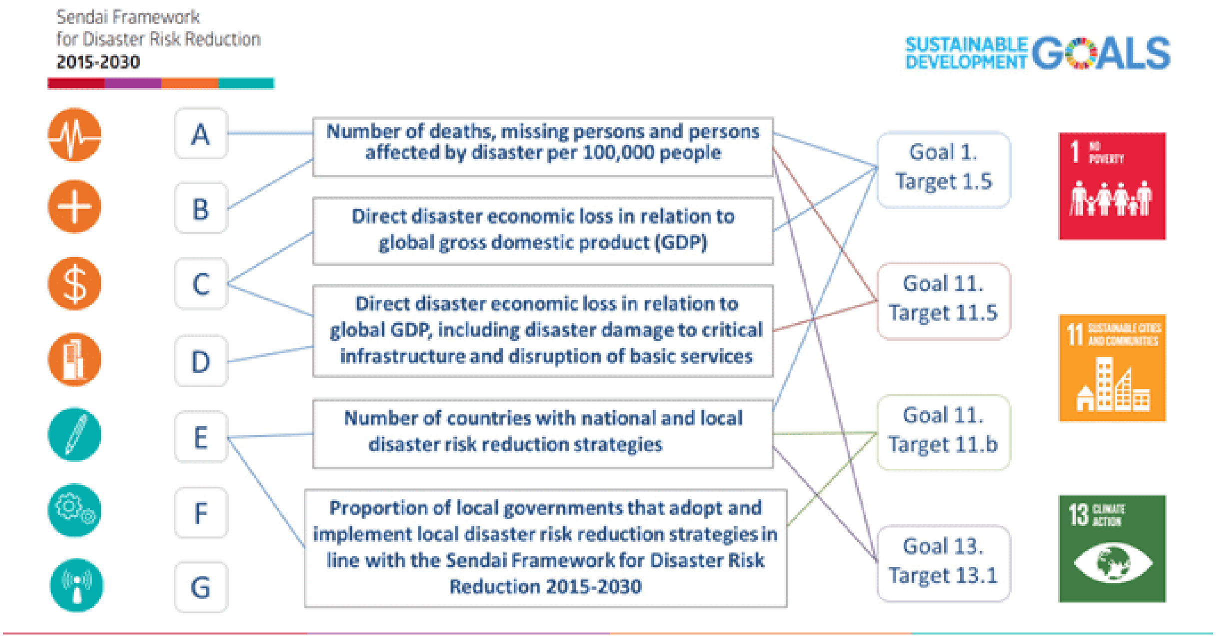


*Figure 3: Integrated Monitoring of the Gl obal Targets of the Sendai Framework and the Sustainable Development Goals. Source: PreventionWeb (2020).*

The realisation of all above-mentioned steps needs highest quality data coming from existing or just developing Spatial Data Infrastructures (SDI), monitoring of all kinds (ground-based or remote sensing) and their up-grading according to agreed rules (like in Copernicus or INSPIRE cases).

## 5. DIGITAL DATA CONCEPTS AND ARSENALS: U.N. GLOBAL GEOSPATIAL INFORMATION MANAGEMENT (U.N. GGIM) AND DIGITAL BELT AND ROAD INITIATIVE (DBAR)

All modern concepts of dealing digital data are based on the concept of SDI, which started by the formulation of National SDI by former president Clinton (2004) in USA. In fact, at the same time, crucial steps have been done in Australia and New Zealand, which are keeping and formulating fresh initiatives up to date. From important efforts and results should be mentioned: Global Map, Global Spatial Data Infrastructure Initiative and Association (GSDI and GSDIA), Global Earth Observation System of Systems (GEOSS), Digital Earth (D.E.), Copernicus and INSPIRE which authors mentioned in previous publications (Konecny et al., 2020), and newest breaking through initiatives are - U.N.Global Geospatial Information Management (U.N.GGIM) and Digital Belt and Road.

### U.N. GGIM

A newly established Global Data Ecosystem by the U.N. Global Geospatial Information Management (U.N. GGIM) will support the realisation of the SDGs, including all aspects linked with DRR. It helps to develop the global understanding of geospatial information (G.I.) and, in a second step, its coordination, coherence and implementation. The vision is to position G.I. to address global challenges and missions to ensure that G.I. and resources are coordinated maintained, accessible, and used effectively and efficiently by member states and society to address key global challenges in a timely manner. Gregg Scott defined the data needs for the 2030 Agenda as follows (Scott, 2018): "The scope of the2030 Agenda requires high-quality and disaggregated data that are timely, open, accessible, understandable and easy to use for a large range of users, including for decision making at all levels. There is a need for a reporting system on the SDGs that would have benefit from the subnational (local) to the national level; and allow for global reporting that builds directly on the data shared by countries. It is important to create an opportunity for countries to directly contribute to global reporting. While the challenges are immense, the digital technology that is available today allows the necessary transformation. An aspiration is to strengthen countries' national geospatial and statistical information systems to facilitate and enable a 'data ecosystem' that leverages an accessible, integrative and interoperable local to global system-of-systems."

The U.N. GGIM is the newest initiative to qualitatively improve the potential to solve the problems of the world, including DRR. Further efforts are needed to strengthen monitoring at the local level, develop the necessary metrics, and make risk information open, accessible, sharable across data platforms, and duly disaggregated to support efforts to leave no one behind. The implementation of the UN-GGIM Strategic Framework on G.I. and services was recognised as instrumental to the monitoring of the Sendai Framework and the SDGs also during 2017 Cancun Global Platform conference.

## DBAR

Both relatively new activities have been initiated by Silk Belt and Road Initiative (BAR). Digital Belt and Road Program (DBAR) is a pioneering international venture to share expertise, knowledge, technologies and data to demonstrate the significance of Earth Observation Science and Technology and Big Earth Data applications for large-scale sustainable development projects. The extensive geographical scope of the "BAR" initiative calls for smart uses and applications of Big Earth Data in the design, development and implementation of diverse projects related to infrastructure improvement, environmental protection, disaster risk reduction, water resource management, urban development, food security, coastal zone management, and the conservation and management of natural and cultural heritage sites. DBAR is committed to implementing projects and actions relevant to the 17 Sustainable Development Goals (SDGs) adopted by the United Nations in September 2015 (United Nations Brussels Team, 2018). It will also strive to integrate green, low-carbon and sustainable approaches to social and economic growth that are vital for the implementation of the Paris Agreement (UN FCC, 2016). See also Konecny et al. (2020).

## 6. STRATEGIES IMPROVEMENTS IN DRR REALISATION

The realisation of existing strategies in SDGs and Sendai DRR is monitored and gradually realised. The particular example are activities of the Global Platform for Disaster Risk Reduction (GPDRR).

The GPDRR was established in 2006 (U.N. General Assembly resolution 61/198) is the world's foremost gathering of stakeholders committed to reducing risk and building the resilience of communities and nations to disasters. The Global Platform is recognised as the leading forum at the global level for strategic advice, coordination, partnership development and the review of progress in the implementation of international instruments on disaster risk reduction, in particular the Sendai Framework for DRR (2015-2030). Launched in 2007 and convened every two years, the Global Platform is characterised by a format that facilitates dialogue and exchanges among all stakeholders, both governmental and non-governmental. Furthermore, the Global Platform outcomes contribute to the deliberations of U.N. governance bodies and mechanisms, such as the General Assembly, the ECOSOC and the High-Level Political Forum on Sustainable Development, and especially for the follow-up processes to U.N. conferences and summits, in particular the 2030 Agenda and its Sustainable Development Goals (Global Platform, 2017). In the Chair Summary (2017) "From Commitment to Action" (https://www.preventionweb.net/files/53989_chairssummaryofthe2017globalplatfor.pdf) were examined and assessed the results of realisation of four priorities of the Sendai Framework.

For this paper, it is important that in Priority 1: Understanding disaster risk is in point 8 said: Methodologies and guidelines for the collection of data to build and maintain national disaster loss databases and conduct risk assessments need to be strengthened and developed into global standards for use by the public and private sectors in the efforts to implement the Sendai Framework. In point 9 is the request of practical examples regarding the use of open data platforms that present geo-referenced risk information across hazards and exposure data in open source and interoperable formats which need to be documented and shared. This includes documenting the cost-effectiveness and the multiple sustainable development benefits of such open risk data platforms for the public and private sector. In point 10, there are countries encouraged to incentivise the collection of risk information by local authorities, which can enable higher levels of data disaggregation. When consolidating the data nationally, it is recommended to preserve similar levels of disaggregation. In point 11 is requested that risk assessments should include data on displacement as well as data disaggregated by sex, age, income and persons with disabilities. Further improvement is required to achieve this. Identified good practices include the connection and active engagement of stakeholder groups who are already compiling such data through the household survey or other means. In point 12 is statutes that risk information is the foundation for awareness-raising and the development of educational material on disaster risk. Risk assessment and its guidance can be strengthened through the systematic integration of indigenous and traditional knowledge and practices. Point 13 highlights that there is inconsistent availability of risk information to drive effective multi-hazard early warnings. The number of countries compiling data on casualty risk and developing scenarios to establish thresholds for impacts-based warnings needs to increase. Point 14 says that risk information of the exposed population, including aspects of vulnerability and the identification of people with special needs, is required to target warnings and identify suitable communication channels. Progress in this area will need to be measured against Target (G) of the Sendai Framework. Point 19 highlights that Volunteerism continues to be a fundamental resource which needs to be leveraged and supported. The critical role in this regard of the Red Cross and Red Crescent movement was repeatedly emphasised.

But as cartographic and geoinformation specialists, we have the potential to develop so-called volunteer geographic information (VGI) which can progressively better improved practical acts in catastrophic situations.

## 7. THE ROLE OF GI SCIENCES AND CARTOGRAPHY

There are two world operating organisations United Nations, the International Strategy for Disaster Reduction (U.N. ISDR) and the Integrated Research on Disaster Risk (IRDR). There are also activities of prominent World research organisations, members of the International Science Council (ICSU). The working group and later Commission on Cartography for Early Warning and Disaster Risk Management were founded inside International Cartographic Association - ICA (in 2004 resp. in 2007 arranged by M. Konecny). Very fruitful were also The International Society for Photogrammetry and Remote Sensing (ISPRS) which started organisation of GI4DM conferences (Sisi Zlatanova); last one was organized in Prague (Lena Halounova, Orhan Altan); and The International Federation of Surveyors (FIG) which organised at the time of Working Week 2016 in Christchurch, New Zealand the conference Recovery from Disaster (Chryssy Potsiou).

The mentioned activities are essential components in disaster prevention, prediction, response and management, as well as in planning and monitoring for sustainable development. New technologies and institutional arrangements are now playing a prominent role during decision-making. International cooperation and partnerships are key to achieving integral, comprehensive and inclusive approaches to effective DRR, resilience-building and sustainable development. They also highlighted that the data needed for DRR must integrate different sources of information, including: household surveys, government censuses, geospatial and Earth observations data, administrative registers, quality of services surveys, volunteered geographic information (VGI), Big Data, etc. This also includes listening of the people affected or potentially affected by disasters and integrating them in a systematic manner in the planning and decision-making process.

### The Sustainable Development Goals and Cartography

The mentioned ongoing cooperation between international political, research and other bodies (e.g. U.N., ICA, etc.) can be extended and intensified. Such cooperation can be documented on the cooperation between U.N. and most important international cartographic umbrella organisation – ICA (see Figure 4). Activities of the most active Commission on Cartography in Early Warning and Crises Management (founded by prof. Konečný) provided general concept to:

- Provide leadership in the development of concepts, ontologisation and standardisation for early warning, hazard, risk and vulnerability mapping.
- Promote the cartographic use of remotely sensed and other geospatial data for early warning and crisis management through scientic conferences, seminars and workshops.
- Investigate the psychological condition of end-user given by their personal character and situation and psychological condition of rescued persons (with support of ubiquitous and adaptive mapping).
- Foster quality mapping and cartographic modelling, including state-of-the-art visualisation technologies, geospatial processing and publishing tools, for early warning and crisis management through topic related publication activities.
- Participate and contribute to global initiatives in early warning and crisis management through the maintenance of a website, newsletters and social network channels.
- Promote the development of dynamic and real-time cartographic visualisation concepts and techniques for enhanced operational early warning activities through active collaboration with governmental authorities.
- Establish and cultivate professional networks for the exchange of information among stakeholders in the domains of crisis management and early warning.
- Develop mechanisms of command and control systems integration as well as improve real-time data-centric intelligence based on sensors for purposes of Crisis Management.
- Develop mapping methodologies and technologies for EW&CM in children perspectives. Promote the process of teaching, understanding and using maps for EW&CM in children aspects.

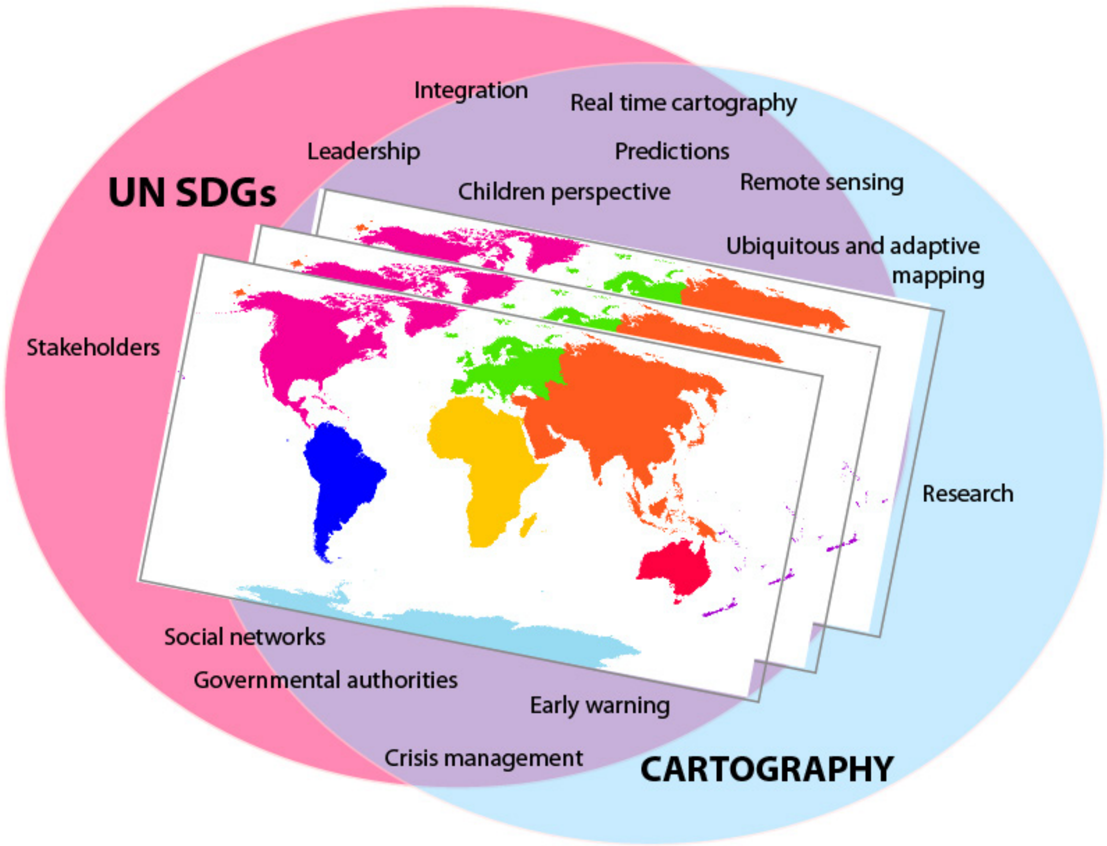


*Figure 4. Concept of cooperation and overlaps of Agenda – example of U.N. and ICA. Source: own work.*

The cartography and cartographers are able to provide the support for DRR on several levels. At first, there are methods and activities providing the spatial data. Secondly, the tools for spatial analysis and last but not least, the cartographic visualisation. Following text, bring examples of the possible contribution of cartography to the U.N. Sustainable Development Goals (see part 2) on mentioned levels.

Goal 1: End poverty in all its forms everywhere
- Provide data about the spatial distribution of poverty, social protection, etc.
- Visualise the most vulnerable areas.

Goal 2: Zero Hunger
- Provide the data about the spatial distribution of hunger, soil quality, arable land and agriculture production temporal development and fluctuations.
- Visualise the areas vulnerable to soil erosion, areas with a decrease of production.

Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Provide data about the health status of the population. Provide near real-time data on possible pandemic development.
- Visualise the regions with the decreasing average age. Visualise the trajectories of pandemic spreading.

Goal 4: Quality Education
- Provide data about the availability of different levels of education in different regions.
- Visualise the development of education rate.

Goal 5: Achieve gender equality and empower all women and girls
- Visualise the spatial differences in gender equality regarding the access to education, equal salaries etc.

Goal 6: Ensure access to water and sanitation for all
- Provide the data about the water resources, actual or possible water contamination.
- Identify the most vulnerable inhabited areas.
- Visualise the areas with water shortage.

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy
- Identify the promising areas for clean energy (solar, wind, etc.) production.
- Visualise the spatial distribution of renewable energy sources and share on energy consumption.

Goal 8: Promote inclusive and sustainable economic growth, employment and decent work for all

- Visualise the areas with economic regression and possible vulnerable areas.

Goal 9: Build resilient infrastructure, promote sustainable industrialisation and foster innovation
- Collect the data about spatial infrastructure development.
- Identify the areas without sufficient infrastructure.
- Visualise the areas vulnerable to damages on infrastructures caused by natural or human disasters.

Goal 10: Reduce inequality within and among countries
- Identify the areas with inequalities within and among countries.
- Visualise the temporal development of outlier countries.

Goal 11: Make cities inclusive, safe, resilient and sustainable
- Identify the unsafe zones in the cities.
- Visualise the spatiotemporal patterns of inhabitants.

Goal 12: Ensure sustainable consumption and production patterns
- Visualise the spatiotemporal changes of consumption and production patterns

Goal 13: Take urgent action to combat climate change and its impacts
- Provide the data about the spatial distribution of the air and water temparatures, moisture and other characterictics.
- Identify the most vulnerable areas to the climate changes.
- Visualise the spatiotemporal changes of temperature of air, water bodies, etc.

Goal 14: Conserve and sustainably use the oceans, seas and marine resources
- Provide the data about the water pollution, changes of the water level, etc.
- Visualise the most polluted and threatened water bodies.

Goal 15: Sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss
- Provide the data about the spatiotemporal changes of forests, deserts, etc.
- Identify the most vulnerable ares.
- Visualise the historic data and possible development.

Goal 16: Promote justice, peaceful and inclusive societies
- Visualise the most conflict threathened regions.

Goal 17: Revitalise the global partnership for sustainable development
- Provide one of the universal communication channel between the nations.

Spatial data and visualisations activities connected with the SDGs 3, 10 and 16 are presented on example VGI for DRR and Crisis Management (see next part).

## Using volunteers and VGI for DRR and Crisis Management

The main role of G.I. Science in DRR is creation, providing and sharing of spatial data and providing analyses of data. The development of electronics, networks, databases, data sharing brings new possibilities for data collection, management and providing. However, there is a big gap between technological and financial possibilities of developed and developing countries. The third world faces to the big number of disasters, both natural and man-caused. Infrastructure and number of experts for DRR available in these countries are very inappropriate to solve such amount of critical situations. The possible way how to bridge this problem is using of volunteers – both for disaster risk reduction and crisis management (see Figure 5).

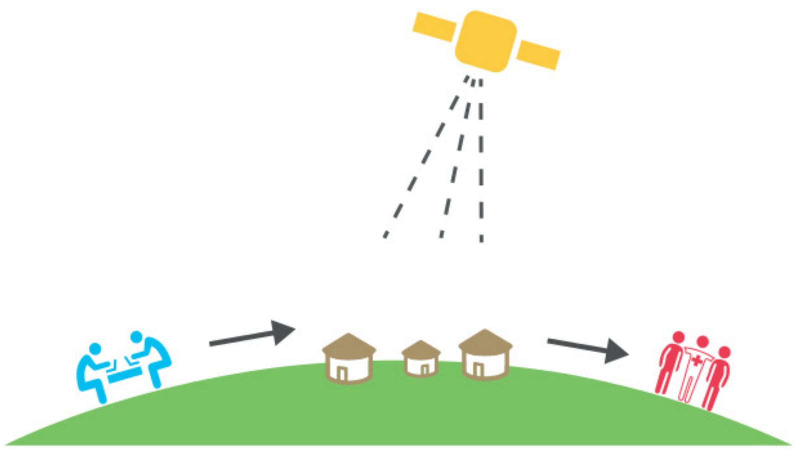

*Figure 5. General concept of VGI (GIS Unit, Médecins Sans Frontières). Source: HOTOSM (2014).*

In recommendations from Cancun (Global Platform, 2017) remind above is mentioned, among others:

- people affected by disasters should be integrated into the decision-making process,
- VGI data should be integrated as a new source of data,
- used data should be open-access and accessible through common platforms and portals

Example of such using of volunteers (including locals), using VGI data and open-access platforms are Humanitarian OpenStreetMap Team (HOT, https://www.hotosm.org/) and Missing maps project (https://www.missingmaps.org/). Both projects are not competitive; they are complementary and deeply connected to each other. HOT is one of Missing Maps project founder. They are examples of connections and differences between crisis management and disaster risk reduction.

Haiti was heavily hit by earthquake in January 2010. Number of victims is estimated to more than 100,000 (some estimates placing the number as high as 316,000). Rescue teams and humanitarian aid was transferred into Haiti in very short time. However, organisation of rescue work and distribution of humanitarian aid was very problematic because of destroyed infrastructure and also because of lack of maps and information. One reason was that Haitian government and authorities were also heavily hit. Buildings of national mapping agency of Haiti (Centre National de l'Information Géo-Spatiale-C.N.I.G.S) collapsed, destroying most of the SDI and killing its director along with five staff members (Clark and Guiffault, 2018).

Volunteers solved the lack of available maps with using OpenStreetMap platform – free, editable map of the world. Mappers produced map of Port-au-Prince precise enough for humanitarian work (Meier, 2015). Effectivity of this action led to foundation of Humanitarian OpenStreetMap Team (HOT) in August 2010. OpenStreetMap data is updated and analysed by HOT and various tools are developed for the needs of humanitarian organisations in Third World countries with the lack of quality data. HOT usually works as a response to crisis. It is an example of mapping for disaster management. Any organisation is allowed to ask for mapping some area that is important for its work.

Missing Maps project was founded in 2014. Its founders are British and U.S. Red Cross, Doctors without borders (MSF) and also above mentioned Humanitarian OpenStreetMap team. Many other organisations, universities etc. joined the project since that. The goal of this project is mapping the most vulnerable places in the developing world where MSF or other humanitarian organisations plan to work. Typical example is planning of vaccination campaign. It is an example of mapping for disaster risk reduction.

HOT and Missing Maps use volunteers in three steps:

1) Map drawing: remote volunteers along the world map the focus area from safety of their homes using internet and freely available remote sensing imagery. It is important that the goal is not cartographically complete map. Only the most important data for humanitarian work are mapped. It means that needed data can be prepared very quickly:

- villages – to know where people live,
- ways and tracks – to know how to get to village,
- buildings – to know how many people live in village.

2) Field mapping: volunteers from the local community verify remotely mapped data and add information that is not visible from air – source of water, which house is school etc.

3) Using the map in field. Volunteers – specialists (doctors, humanitarian workers etc.) use the data to organise effectively their field work. One story can be described as example.

Yellow fever outbreak occurred in slums on the suburb of Kinshasa (DRC) in August 2016. Population density in that area is 36,000 hab./km$^2$! No official map of slums existed (8,000 buildings were on the map of the whole Kinahasa). Volunteers from HOT and Missing Maps prepared the quality map of that slums (76,000 buildings were added in 15 days), so vaccination was fast and well organised. MSF vaccinated 720,000 habitants in 10 days and critical situation was solved (GIS Unit, 2017).

Very interesting is investigate how are cartographic approaches used in various countries. In the Czech Republic are in international cooperation investigated dynamic mapping methods in Big Data era developing heterogenic spatial data and creation of maps in real-time (Kubicek et al., 2018). Fire and Rescue Service of the Czech Republic compiles every year the Statistical Yearbook. In this Yearbook are beside the standard maps, the maps which reflect the current hot topics on the field of emergency management (Fire and Rescue Service, 2020). Chinese Academy of Surveying and Mapping (CASM) is elaborating intelligent mapping servises for DRR purposes (Liu et al., 2018). Interesting and helpful atlases are created in Russia (Rotanova et al., 2016). Switzerland has long tradition of solving DRM and DRR and methodological approaches are often accompanied by maps (e.g. Federal Department of Foreign Affairs, 2020). In

Bulgaria appeared high quality and actual maps about development of situation with COVID-19 in Europe (Fig. 6), DataMap-Europe Ltd. (2020).

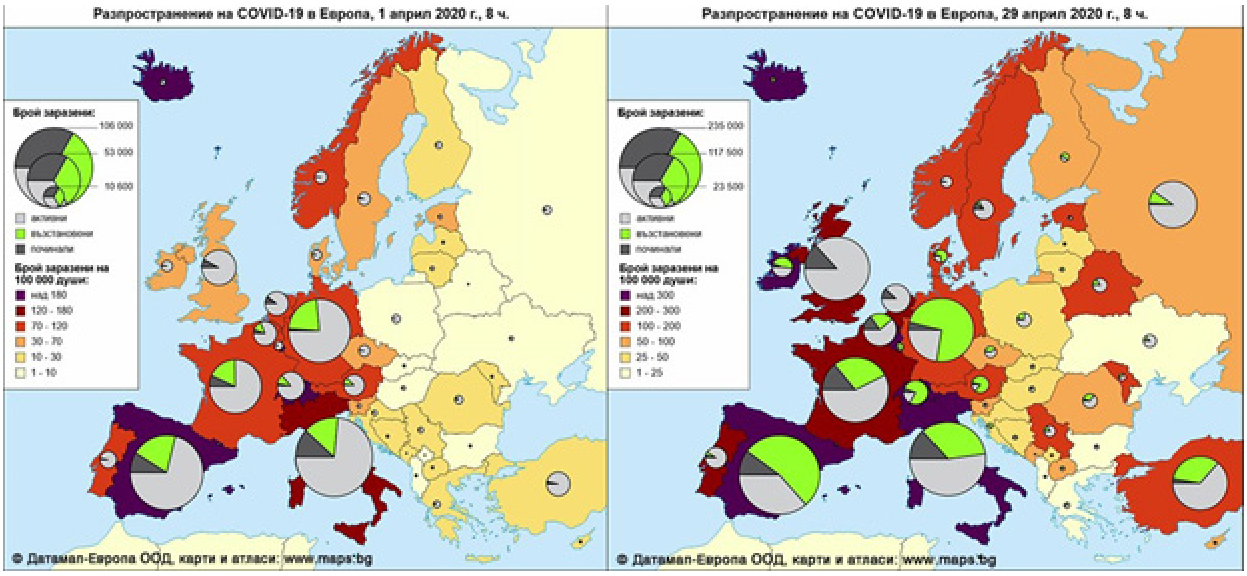


*Figure 6. Maps represent the development of the COVID-19 in Europe from between April 1 and April 29. Source: DataMap-Europe Ltd. (2020)*

## 8. CONCLUSIONS AND RECOMMENDATIONS

The main task for the future is to emphasise aspects of cartographic communication in the context of early warning and disaster management such as the use of remotely sensed and other geospatial data, including concepts of Volunteer Geographic Information (VGI) and Public Participation Geographic Information Systems (PPGIS), cartographic modelling of state-of-the-art visualisation technologies, geospatial processing and publishing tools, dynamic and real-time cartographic visualisation for enhanced operational early warning and DRR activities through active collaboration with governmental authorities.

Big official platforms for the collection, management and providing of data for like U.N. GGIM, DBAR, GEOSS, Copernicus and others aim to make data available for disaster management and disaster risk reduction. Their efforts can be successfully supplemented by using of VGI data from free and open sources created by enthusiastic work of volunteers.

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## BIOGRAPHY OF AUTHORS

**Prof. Dr. Milan KONEČNÝ** is a professor of Cartography and Geoinformatics at Masaryk University, Brno, Czech Republic. He was a Guest Professor of The Chinese University in Hong Kong, The Henan University, Kaifeng, and the Shenzhen University, China, the Vienna University, Austria, Constantine the Philosopher University, Nitra, SR, etc. He was a President of International Cartographic Association (ICA)( 2003-2007); he founded and chaired of ICA Commission on Cartography on Early Warning and Crises Management (2005-2019), now he is its vice-chair; he was both - an Acting President and the Vice-President of ISDE and Academician and Vice-President of International Eurasian Academy of Science. He leaded/participated in domestic and international research projects, like Dynamic Geovisualization in Crises Management, EU- China Disaster Risk Management project of the highest level (European Commission and Chinese State Burreau), Dynamic mapping for risk and crisis management in big data era, etc. and in HORIZON 2020 EU-China SieuSoil project Soil Observatory for Intelligent Land use Management. He is an author (co-author K. Rais) of the first textbook of GIS in the World (1985), and author/co-author of more than 120 research papers and 7 books and editor of approx. 20 proceedings of international conferences of GIS, cartography, EW and CM.

**Prof. Dr. Temenoujka BANDROVA** is president of the Bulgarian Cartographic Association and head of Laboratory on Cartography, University of Architecture, Civil Engineering and Geodesy, Sofia. Vice-President of ICA (2019-2023) Co-chair of the ICA Commission of Cartography and Children (2007-2011), a treasurer and member of the Bureau of International Society of Digital Earth, a member of Commissions on Map Projections, on Cartography in Early Warning and Crises Management – International Cartographic Association (ICA); of Editor's group of the International Journal of Digital Earth, and Cartographia and Geoinformatika Journal, Croatia. She is a Project manager in DataMap Ltd where her school atlases and maps are published. She is an author of 30 school atlases and more than 100 wall maps in geography and history, approved by the Ministry of Education for Bulgarian schools. She published more than 100 articles, reports, papers, book chapters and edited books published in Springer and ESRI Press.

**Associate Prof. Petr KUBÍČEK, Ph.D.** is a Nemoforum Vice-Chairman. He received his master's degree (1987) as well as his Ph.D.(1992) from the Department of Geography Faculty of Science Masaryk University in Brno (further DG); 1988 - 2000 a lecturer of physical geography, geomorphology, and GIS in DG; he actively participated in EU projects dealing with the transfer of GI/GIS technologies, cross-border cooperation, and the development of data warehouses (Panel GI, CREDO, Well GIS). From 2001 he spent 5 years in the commercial sector as a business representative for INTERGRAPH. Since 2005, he has been working at the DG. in 2020 as its director. He defended the habilitation thesis in 2012 (Selected aspects of geospatial data uncertainty visualization) and currently specializes in digital cartography and GI infrastructure. He cooperates with the ICA commissions on Use, User and Usability Issues and Cognitive Issues in Geographic Information Visualization (as a commission vice-chair). He is also member of the national GeoInfo Strategy team and is preparing a document for the national government. He currently has over 90 publications focused on geoinformation and digital cartography.

**Dr. Zdeněk STACHOŇ, Ph.D.** works as an assistant professor at the LGC, Department of Geography, Masaryk University, Czech Republic. He participated on several scientific research and educational national and international projects. He focuses mainly on spatiotemporal analysis, principles of map design, cognitive aspects of cartographic visualization, and geographic support of decision making. He is a member of the Czech Cartographic and Geographic societies, vice-chair of the UX commission of International Cartographic association.

**Dr. Radim ŠTAMPACH, Ph.D.** is a lecturer and GIS specialist at the Department of Geography, Faculty of Science, Masaryk University, Brno, Czech Republic. He is a member of the Laboratory on Geoinformatics and Cartography (LGC) at Masaryk University. He is interested in open source GIS and VGI data and using maps, GIS and spatial data for crisis management and for humanitarian purposes. His role on scientific projects during last four years: Sino-EU Soil Observatory for intelligent Land Use Management (2019-2022) - project administration, data analysis; and Dynamic mapping methods oriented to risk and disaster management in the era of big data (2017-2019) – project administration, data analysis. He is leader of humanitarian mapping Missing Maps project team in Brno, Czechia.

**Prof. Jie SHEN** is the director of Department of Survey Engineering, School of Geography, Nanjing Normal University, Nanjing. Vice Chair of ICA Commission Cartography on Early Warning and Crises Management (2019-2023), a member of ICA Commissions on Location Based Service. She mainly engages in the research of indoor map design and cartographic generalization, dynamic mapping for risk and disaster management, regional ecological civilization mapping and service based on big data and various types of map design and production. In recent years, she lead the national key research project of international intergovernmental cooperation projects, the national natural science foundation projects and took part in the Sino-German international cooperation projects. She has published more than 70 papers in academic journals and important conference proceedings. At present, 4 national invention patents have been authorized and 13 computer software Copyrights have been obtained.

**Associate Prof. Irina ROTANOVA** is Associate Professor of Department of Physical Geography and GIS and head of Laboratory of Geoinformation Systems (Center GIS), Institute of Geography, Altai State University, CSc (Ph.d equivalent); member of the Commission for spatial data infrastructure under the Department for Informatization of the Administration of the Altai Krai; member of the International Cartographic Association, a member of the GIS Association, Deputy Chairman of the Altai regional branch of the Russian geographical society, scientific expert of the International coordinating Council "Our common home Altai". Author and co-author of more than 800 scientific papers in the field of geography, geoecology, cartography, geoinformatics, GIS, remote sensing, environmental mapping, including: 120 journal articles, 12 books, 2 atlases.

**Capt. Eng. Pavel ŠPULÁK** is a member of the Department of Information and Communication Technologies of General Directorate of Fire and Rescue Service of the Czech Republic. He focuses on various ICT, GIS and programming issues. His favourite programming technologies are Python, Java, JavaScript, CSS3, HTML, Oracle, PostgreSQL, SQLite. He is also Ph.D. student at Department of Geography and LGC of Masaryk University, Brno, CZ.

**Jan BRODSKÝ, MSc.** is a PhD student developing his research in disaster risk management and disaster risk reduction including volunteer projects. He is a member of European Geography Association (EGEA; since 2014).