

NEW CZECH & CERTIFIED METHODOLOGY „TOOLS OF RESILIENCE“

Pavel DOBEŠ¹, Petr NOVOTNÝ², Pavel DANIHELKA³, Barbora BAUDIŠOVÁ⁴,
Veronika NEŠPOROVÁ⁵, Erik THORSTENSEN⁶, Fulvio TOSERONI⁷

Research article

Abstract: The article deals with possibilities of better governance regarding natural and anthropogenic risks and building of resilience of medium towns and cities against disasters. Such systematic approach could be applied for example using new Czech certified methodology “Tools Of Resilience”, which has been developed recently within the short project number no. VF20152016047 under the grant of Czech Ministry of the Interior in period 2015-2016 and afterwards certified in 2017 by Czech Ministry of the Environment. Basic starting points, used methods, steps of new methodology and its annexes, will be briefly described in the topic.

Keywords: Building resilience, tools, adaptation, disaster risk reduction, environmental security.

Introduction

In last 5-10 years, the term "resilience" getting to be very intensively used worldwide, both by scientists and politics, especially according to the Hyogo Framework for Action (2005-2015), the Sendai Framework for Disaster Risk Reduction (2015-2030), ongoing climate change and obvious shifts in ecosystems. A lot of potentially useful tools, strategies, guidelines and publications have been written and promoted (for example by experts from Resilience Alliance, Organisation for Economic Co-operation and Development, The United Nations Office for Disaster Risk Reduction, World Economic Forum, Stocholm Resilience Centre, etc.). The questions are: How can we wisely implement to live some of these great concepts, ideas and tools in the conditions of Middle Europe? How can we

change the current not very resilient behavioral patterns of children and adults in the cities from rather passive reaction (mostly just waiting for rescue in the time after any disaster), towards more active pursuit of self-protection and self-rescue? How can we adapt rather old city systems to climate change and other new threats?

Societal development in the 21st century development also points to the fact that most of the world's population will live in cities (UNDESA, 2015). Ensuring good and sustainable quality of life within complex city systems requires well done nets of interconnected institutions, infrastructures, information and involved stakeholders. Cities are perceived by people (Gerland et al., 2014) as centres of social life with greatest economic development and good opportunities and innovations. Regarding the ever-increasing costs of living in family houses,

¹ VŠB - Technical University of Ostrava, Faculty of Safety Engineering, Ostrava, Czech Republic, pavel.dobes@vsb.cz

² VŠB - Technical University of Ostrava, Faculty of Safety Engineering, Ostrava, Czech Republic, novotny.petr@vsb.cz

³ VŠB - Technical University of Ostrava, Faculty of Safety Engineering, Ostrava, Czech Republic, pavel.danihelka@vsb.cz

⁴ VŠB - Technical University of Ostrava, Faculty of Safety Engineering, Ostrava, Czech Republic, barbora.baudisova@vsb.cz

⁵ VŠB - Technical University of Ostrava, Faculty of Safety Engineering, Ostrava, Czech Republic, veronika.nesporova@vsb.cz

⁶ Oslo and Akershus University College of Applied Sciences, Work research institute, Oslo, Norway, erik.thorstensen@afi.hioa.no

⁷ Universita Politecnica dell Marche, Department of Life and Environmental Sciences, Ancona, Italy, f.toseroni@staff.univpm.it

it is not possible to exclude the view (Hoornweg and Pope, 2014) that rather wealthy people will be able to live in small villages, communities or solitudes in the future.

Cities are also places where accumulation of long-term stressors or the occurrence of sudden shocks occurs. These may even result in the collapse of the community or society, physical collapse, natural disaster or economic shortage (Da Silva, 2013). This has already happened in the past, but it is also happening now and may happen again in the future, if the city or village would not be resilient enough.

Cities have faced the risks since ancient times, and many cities that have existed for centuries already have shown their resilience. This occurred mainly in times of shortage of resources, threats of natural origin and conflicts (Hodge, 2002; National Geographic, 2012; Ebrey, 1999). In the 21st century, new challenges are posed by globally threatening threats, such as climate change, disease pandemics, economic fluctuations, social unrest and various forms of terrorism.

The scale of urban risk is changing (growing, stagnating or decreasing) with the changing population of the city, respectively with the number of vulnerable people. This risk is also becoming more and more unpredictable in view of the complexity of urban systems and the uncertainty associated with many threats (notably, for example, with climate change and the subsequent manifestations of this change). Risk assessment and the implementation of measures to mitigate specific foreseeable risks will continue to play a significant role in spatial and urban planning processes and reciprocally, spatial planning fundamentally affects level of safety and security (The Conception, 2015). Cities need to ensure that their development strategies and investments will increase and do not undermine their resilience.

During introductory phase of project, the team deals with clarification of basic terms and finding of best available approaches and schools on resilience around the world. World leading institutions, communities and scientists, publishing on resilience topic, were found for example in the USA (Cox, 2012; Moore, 2012; Cutter et al., 2013; U.S. EPA, 2016), in Europe - (Folke, 2006; Rockström, 2009 et al.; Renn, 2011; OECD, 2014; Moberg and Simonsen, 2014) as well as on the global level (UNISDR, 2015). Obviously, a lot of basic principles, theories, approaches and tools for resilience were published and described in last decades.

From available definitions of „What is Resilience“ we see as most applicable following ones:

- Video: senior research fellow Brian Walker explains the concept of resilience (Video, 2015).

- Resilience is the capacity of a social-ecological system to absorb or withstand perturbations and other stressors such that the system remains within the same regime, essentially maintaining its structure and functions. It describes the degree to which the system is capable of self-organization, learning and adaptation (this definition has roots in ecology) (Holling, 1973; Gunderson & Holling, 2002; Walker et al., 2004).
- Disaster resilience is „the capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure“ (Hyogo Framework for Action, see UNISDR, 2005). According to this, disaster resilience is determined by the degree to which individuals, communities and public and private organisations are capable of organising themselves to learn from past disasters and reduce their risks to future ones, at international, regional, national and local levels.
- Disaster resilience is part of the broader concept of resilience - ‘the ability of individuals, communities and states and their institutions to absorb and recover from shocks, whilst positively adapting and transforming their structures and means for living in the face of long-term changes and uncertainty. (OECD, 2013).

Materials and methods

During the project solution mostly theoretical and simulation methods were used:

- Literature search, focused on current available approaches (e. g. Zio, 2016) and strategies in the area of resilience, building resilience of cities and their citizens (including „build back better“ approach).
- Analysis and evaluation of gathered approaches and information.
- First draft of the methodology algorithm (developed on the results of literature search, with consideration of widely accepted scheme of risk management - ISO 31000:2009 Risk management - Principles and guidelines; and following related standards: ISO Guide 73:2009, Risk management - Vocabulary; ISO/IEC 31010:2009, Risk management - Risk assessment techniques).
- Repeated brainstorming on the proposal of the methodology basic scheme.
- Simulation and communication of the building resilience process according to proposed methodology scheme, on the example of small town municipality, with the Union of Towns and Municipalities.

- Development of 4 tools, annexed to the methodology in the MS Excel format. Recommendation of other public available tools.
- Collection and implementation of critical comments, remarks and supplements in to the text of methodology.
- Completion and certification of the methodology.

According to the key points of the call of the Czech Ministry of Interior and Ministry of Environment, the work of VSB-TUO team was focused especially on finding of suitable approaches and tools, applicable in local conditions.

Following tab. 1 presents a short summary of possible types of approaches and tools, which was identified during literature search process within the project.

Tab. 1 General list of possible approaches and tools regarding building resilience

ID	Approach/Tool useful in the process of building resilience
1	General strategic documents fostering the strategies for disaster risk reduction and building resilience
2	Checklist with the identified threats/risks/dangers for the assessed area, prepared in preliminary preparation phase
3	Risk analysis and assessment tools (all possible, trusted by expert groups, scientists, government authorities, communities) - could deliver different results (qualitative, semi-quantitative, quantitative). Including methods and guidelines for resilience assessment
4	Examples of good practices and joint adaptation and mitigation solutions
5	Solutions for individual threats (existing or newly implemented solutions, measures - preventive, repressive, ...)
6	Risk governance tools, techniques, measures
7	Tools for communication between all stakeholders, used as much as possible during whole process of proposed new methodology)
8	Methods for identification/evaluation of residual risks regarding further increase of resilience and adaptation level
9	Procedures for application of "BBB" principle (Build Back Better) and for permanent growing of resilience level

For concrete approaches & tools, founded by the project team, there were proposed 5 simple evaluation criteria:

- I. Is the approach or tool applicable rather on global (score: 1), national - regional (score: 2)

or local level (score: 3/regarding the focus on the local municipalities and towns)?

- II. Is the approach or tool sufficiently described in the research article (score: 1), guideline (score: 2) or in the book (score: 3)?
- III. Is the approach or tool recommended or written by single expert (score: 1), group of experts (score: 2) or by international organization (score: 3) (like UN, OECD, UNISDR, NATO, ...)?
- IV. In which language is the approach or tool described? In Czech language (score: 3), in English (score: 2) or in any other language (score: 1).
- V. Does the approach contain or recommends specific tools for building resilience? Link to 0-1 tool (score: 1), link to 2-5 tools (score: 2), link to more than 5 tools (score: 3).

In the following tab. 2, it is presented example of evaluation, done using proposed criteria. Approaches and/or tools with highest ranking, was recommended within the specific steps of newly developed methodology.

Tab. 2 Example of approaches/tools evaluation

ID	Examples of selected approaches/tools	Evaluation Criteria					SUM
		I	II	III	IV	V	
1	How To Make Cities More Resilient - A Handbook For Local Government Leader (UNISDR, 2012)	3	2	3	2	3	13
2	An Inventory of EPA's Tools for Enhancing Community Resilience to Disasters (US EPA, 2016.)	3	2	3	2	3	13
3	City Resilience Index (Da Silva, 2013).	3	2	2	2	1	10
4	Developing a model and tool to measure community disaster resilience (Arbon, 2014)	2	1	1	2	1	7
5	What is resilience? An introduction to social-ecological research (Stockholm Resilience Centre, 2015)	1	2	2	2	3	10
6	Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015)	1	2	3	2	1	9

Results

The methodology “Tools of Resilience”, as a main result of the project, was conceived as a gradual fulfilment of a democratic process, focused on a voluntary increasing of the resilience of a city, its citizens, infrastructure and, last but not least, eco-systems connected to the city (respectively)

against identified, prioritized, analysed, evaluated potential threats of a natural, anthropogenic or combined origin. The methodology respects the basic standards for risk analysis and management (particularly ISO 31 000:2009).

The diagram of individual methodology steps is shown below in Fig. 1. For better clarity, the diagram is colour coded with respect to the competencies of

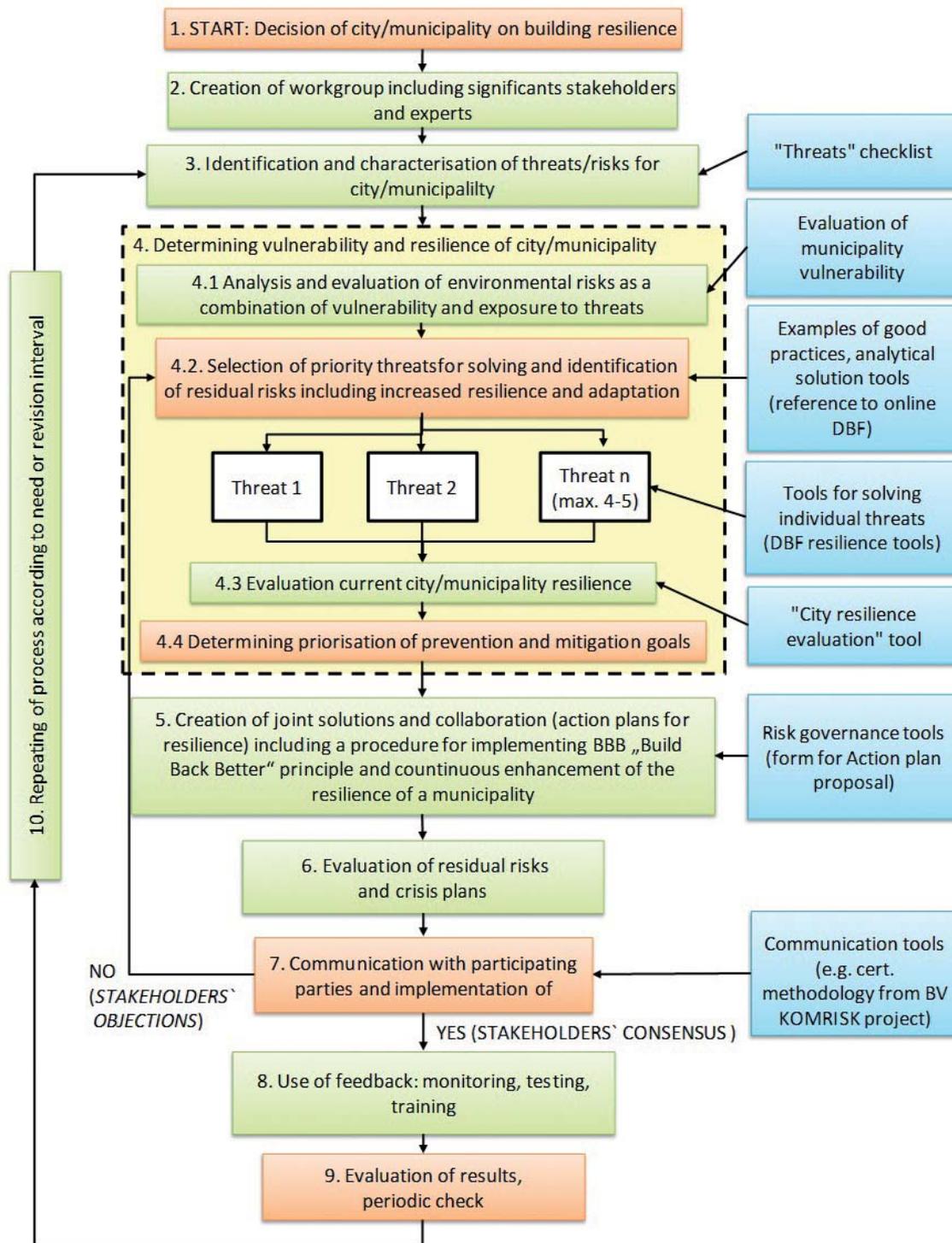


Fig. 1 „Tools of Resilience“ methodology scheme

actors who are key members of the given step or part of the methodology. Colour coding is as follows:

- Decision-making process steps are always coloured orange. Making of the respective decisions should be the work of the respective responsible bodies.
- Green marks the so-called “action parts”. These are the specialized parts of the methodology which should be implemented by a workgroup, an executive body of municipality management or experts.
- Blue represents possible tools which can be used for solving respective steps of the methodology. Some of these tools are contained directly in the electronic appendices.

Individual steps of methodology implementation are subsequently specified in detail.

1 START: The decision of a city/ municipality or other community about build-ing resilience

The decision to build resilience in a municipality or city is an important political step with broad implications. For this purpose, it is necessary to realize that the solution of a future, maybe short-term, problem must be prepared over the long-term. Similarly, it is important to acknowledge that some crisis events may occur and then it will be necessary to evaluate which solutions are possible; however, these solutions may correlate with the idea that it will be necessary to invest part of one’s resources to successfully avert a threat or make its impacts bearable.

The decision to build resilience does not lie in the creation of new structures, but, on the contrary, to change the method of thinking in the process so that it successfully targets prevention and problem solving not only today but also in the future. Resilience typically also includes a change in approach to management at any level in the community, meaning a move from crisis management to risk management (pursuant to the Framework from Hyogo).

2 Creation of a workgroup including significant stakeholders and experts

For the successful creation of a workgroup, for building resilience and the subsequent formulation of necessary strategies and action plans, it is necessary to set up an environment for participation by involving representatives from all interested parties. Whereas, the very basis is to define participation not by community according to place, but by community according to interest. Participative (bilateral, mutual) communication helps build community capacities, as well as build resilience.

However, it is not a matter of creating new structures, but creating a suitable environment with suitable actors. It is suitable to modify structures functioning up to now so that they function even in case of an event (activation of threat). When looking for representatives of all interested parties it is necessary to focus not only on parties defined by respective laws but also on their roles and position in the given process related to specific threats. This achieves a greater complexity during the subsequent solving of a given goal, and this also eliminates the possibility for one representative of an interested party to engage numerous roles.

3 Identification and characterization of threats

Identification and characterization of threats to the municipality, city, community, infrastructure and environment is the initial step to building resilience and this step must not be underestimated.

Tab. 3 illustrated possible threats and oriented particularly at potential threats of catastrophes (crisis situations) in the Czech Republic, due to which the municipality can be vulnerable. One must realize that this is not an exhaustive list of possibilities; therefore, it is necessary to consider the specificity of the given territory in relation not only to the mentioned threats, but also to other possibilities.

Tab. 3 Illustration part of „Threats“ checklist for city/municipality

Threats Category	Threats Type	Selected for solution	Justification for selection
Acute	Strong wind		
Chronic	Soil degradation		
Combined	NATECH (natural hazard triggering technological disaster)		

4 Determining vulnerability and the resilience of a municipality/city

This is a key block (highlighted in the diagram) of the methodology focused on analytical work in relation to selected threats, and risks, which the threats present for vulnerable, exposed target systems of cities, municipalities or communities. This step also includes further analyses and evaluation of only those threats, selected in the previous step of the solution using a checklist.

The whole process of determining the vulnerability and resilience of a municipality/

city or community, is divided further into three interlinked parts. First it is necessary to analyse and assess evaluate environmental risks, whose output is mainly the prioritization of threats, performed on the basis of subjective assessment by members of the workgroup and the available knowledge base. Following onto these steps, it is necessary to evaluate the current condition of resilience, which will, amongst others, identify gaps in the current level and quality of the target system against threats. This evaluation of city resilience should in the future be repeated periodically with the purpose of improving some areas in reaction to the implementation of action plans for the future building of resilience.

4.1 Analysis of environmental risks as a combination of vulnerability and exposure to threat

The potential vulnerability of targets may, for the purposes of the methodology, replace the actual seriousness of occurrence of risk in real time. The above concept of vulnerability was already accepted by the expert public as suitable. In this step, the authors of the methodology, use the tools of the “Methodical procedure for the vulnerability analysis” (Dlabka et. al., 2016), which was accepted by several modifications.

The combination of vulnerability and exposure for each risk from the “territories analysis” part (“selection of vulnerable territories and activities” potentially exposed to the impact of the given threat). Furthermore, it is complexly solved in the section “evaluation of vulnerability” for each threat.

4.2 Evaluation and selection of priority threats for solving, identification of residual risks including an increase in resistance and adaptation

The solution is closely linked to the previous methodology step. Based on the filled in values for threats in procedure for the vulnerability analysis, the resulting position of respective threats will be shown automatically in an independent matrix (vulnerability of city/municipality vs. probability of solved threat) under the analyses of respective threats (always on each list) and at the same time it is supplemented in the final matrix “Prioritization of threats”, see final “Matrix” list.

Increase of resistance and adaptation of the city/municipality/community system is contained to a certain degree on each threat analysis list, under questions related to evaluation of system ability to

manage threats. It is necessary to solve the need for increases system resistance and adaptation and consider under detailed analyses processed for each selected threat, after threats are prioritized based on procedure for the vulnerability analysis. The resultant graph on the “Matrix” list shows all threats for which all impacts, ability to manage threats and probability are evaluated.

4.3 Evaluation of city/municipality resilience

Specific tools for this step in the Czech Republic have as yet not been processed and applied. Global experience and research show that the sole analysis and evaluation of municipality or city vulnerability is insufficient for the further building of resilience. The preceding methodology steps provide numerous impulses for decision-making; however, they do not look in detail for weak areas in resistance of a resilience solved system to catastrophes. Therefore, the evaluation of resilience represents a certain upgrade above the standard evaluation of threats and risks and its output should be outputs from the evaluation of current system resilience, including information - in which areas and parts the system is more and less resilient, and in which areas, or indicators, it is necessary to look for, plan and implement measures for status improvement.



Fig. 2 Scheme of the City Resilience Index approach (Da Silva, 2013)

Evaluation of current resilience can be done either in a simplified form by brainstorming, SWOT analysis and “cost - benefit” analysis (suitable rather for smaller municipalities), based on the results of previous steps, or adaptation of the City Resilience Index approach (Da Silva, 2013) can be used for this

purpose, prepared by the authors of the methodology for end users (see fig. 2). The authors recommend looking into this tool even though you decide to use the expert abbreviated evaluation of resilience, containing a more detailed description of seven qualities or features of resilient cities, confronted with seven principles of resilient thinking (Moberg and Simonsen, 2015).

The authors recommend familiarization with the relevant tool even if the city/municipality can definitely apply easier access, e. g. based on expert estimate, simplified form of brainstorming, SWOT analysis (see more in publication UNISDR, 2012).

5 Formulation of joint solution and collaboration (action plans for resilience)

Based on the summarized outputs and impulses from the previous determination of vulnerability and the resilience of cities or municipalities (especially steps 4.2 and 4.3 of the methodology), the workgroup should further look for existing, or propose new, joint solutions and plan their implementation in the conditions of the city or municipality.

In this process we recommend applying the BBB - "Build Back Better" (plan, build, renew even better after impact of catastrophe) principle and the approach of continuous enhancement of resilience in the municipality or communities. See the Sendai Framework (UNISDR, 2015) for disaster risk reduction per pages 10-25, chapter IV. Activity priorities - four priority areas:

Priority 1: Understanding disaster risks.

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.

In order to draw up an action plan for resilience it is possible to find inspiration in documents of a various kinds (Commission Staff, 2013; Resilience Alliance, 2004; Amper, 2016).

6 Evaluation of residual risks, mitigation measures and current crisis plans

Residual risks in this methodology are those threats which fall in the orange area of the matrix during the solving of the previous step 4.2, respectively in the filled in matrix summarizing the threats matrix in the conclusion of procedure for

the vulnerability analysis, i.e. they shall be considered as "conditionally acceptable" in the evaluation and selection of priority threats for solving. The group of residual risks must also include threats falling in the red area of the matrix (unacceptable risks), which were not currently selected in the subsequent period, defined in the action plan, for priority solution.

7 Communication with participating parties and the implementation of measures

Communication with participating parties (stakeholders) is recommended in the contemporary crisis management concept during the whole process of risk evaluation and management (ISO 31 000:2009). Under this methodology, it is suitable to invite experts from the interested parties to the process of building resilience already from step 2, when forming the workgroup.

In this methodology step, it is suitable to focus primarily on communication of goals and measures set out in the proposed action plan for building resilience, with the broad public, e.g. during public meetings of the city or municipality government. As a useful tool for this step seems to practical using of certified methodology KOMRISK (Daníhelka et. al., 2015).

8 Use of feedback: monitoring, testing, training

To build resilience and the sustainable life of inhabitants and sustainable ecosystems of the city, municipality or community, it is recommended to use feedback, findings and recommendations, arising from the long-term monitoring of residual and currently solved threats. Similarly, it is necessary to regularly verify and test the technical and organizational measures against individual threats or their combinations. As was already mentioned at the beginning of the methodology, regular topical training can prepare the system for unforeseeable or unknown threats.

9 Evaluation of results, periodic check

Evaluation of results from the implementation of planned goals, set out in the implemented action plan and regular checks of performance, linking to previous solution steps. In Deming's diagram of continuous improvement, this is the third step (1. Plan - 2. Do - 3. Check - 4. Act further).

10 Repeating of the Process According to Need or Set Revision Interval

After the lapse of the implementation term of the approved action plan for the building of resilience, it is recommended to start with the next round of methodology application in compliance with the principle of continuous improvement.

According to general experience, the time or repetition of the cycle of similar processes in public administration and municipal government is from three to five years or in the case of the occurrence of any serious changes in the evaluated system.

Discussion

Risk assessment and the implementation of measures to reduce specific foreseeable risks will continue to play a significant role in spatial and urban planning processes. Similarly, in the opposite direction, spatial planning has a significant impact on the safety and security in the specific area. The proposed methodology procedure was developed as a guideline for a holistic expression of city or community resilience. The process is structured for each identified threat, or a combination of threats that are considered critical to the measurability of the resilience of cities/communities.

The presented methodology contains two sets of tools. The first of these are mandatory (legislative) tools to assist in the implementation of key actors' obligations, all of which are legally applicable. The second group is optional (voluntary tools) that are available in the world or have been newly created specifically for use in the proposed procedure. Both sets of resilience building tools are recommended in parallel during the process. In addition to the main obligations that take account of the resulting regulatory obligations and strategic requirements related to public authorities, voluntary instruments are listed and linked.

The holistic approach in the proposed process also combines the physical aspects of cities with less tangible aspects that are related to human behavior. These intangible aspects are also important for assessing the resilience of the entire city system in the context of possible threats (environmental, economic, physical and social). The above is mainly for a comprehensive view of the system (or city or municipality) rather than considering its individual subsystems (more can be found for example in Moberg and Simonsen, 2015).

The resilience building process substantially extends the traditional disaster management methods, which are based on risk assessments taking into account only the threats in their particulars and for a short period of time. Conversely, the idea of

resilience accepts (Zio, 2016) the fact that a wide range of undesirable events (long-term stresses and acute shocks) may occur suddenly or in a short period of time, which may not necessarily be foreseeable. Part of the resilience is usually adaptation - e.g. a change in the government approach at any level to the community), which switches from disaster management to risk management - in accordance with the Hyogo Framework (UNISDR, 2005).

The current world trend encourages cities and communities to build their resilience. It is the building of complex resilience on several levels, namely the resilience of urban / municipal resilience, citizens, infrastructures and environmental compartments located in the cadastre of the city and the municipality. The above-mentioned approaches therefore fully respects, and takes into account all the objectives set by the Sendai Framework, postulated in 2015.

Conclusion

New certified methodology „Tools of Resilience“, as the main result of the project no. VF20152016047, was designed to facilitate the Czech Republic's engagement in international activities in the area of reducing the risks of environmental disasters and increasing the resilience of communities. At the same time, it contributes to the preventive and mitigating part of reducing the risk of disasters of environmental origin more effectively, using current scientific and social knowledge.

The resilience building process is focused on increasing the performance and efficiency of a system facing multiple threats rather than addressing individual prevention or mitigation of assets (values) as a result of individual undesirable situations. A particular aspect of resilience is that it increases the community's preparedness also for unknown threats, so it can be compared with the hardiness and fitness of a person.

Thus, resilience of the city describes the ability to function in such a way that residents and workers (especially the poor and those with increased vulnerability or reduced ability to respond to disasters) survive the occurrence of potential threats (especially disasters) without major harm and continue to benefit from the city system and its services. Resilience is focused in the long run.

Acknowledgement

The article was supported by the project no. VF20152016047 "Tools of Resilience as Modern Methods of Disaster Risk Reduction within Environmental Security", supported by the Ministry of the Interior of the Czech Republic in the year 2015.

References

- Amper: Resiliency and adaptation on climate change in regional strategies. Another good practise examples [online]. Amper.ped.muni.cz, 2016 [cit. 2016-29-11]. Available at: http://amper.ped.muni.cz/gw/resilience/priklady/Dalsi_zdroje.pdf. (in Czech)
- Arbon, P. 2014. Developing a model and tool to measure community disaster resilience. *The Australian Journal of Emergency Management*, 29(4): 12-16. ISSN 1324-1540.
- Commission Staff Working Document, SWD(2013) 227. Action Plan for Resilience in Crisis Prone Countries 2013-2020.
- Cox, L. A. 2012. Community Resilience and Decision Theory Challenges for Catastrophic Events. *Risk Analysis*, 32(11): 1919-1934. DOI:10.1111/j.1539-6924.2012.01881.x.
- Cutter, S. L., Ahearn, J. A., Amadei, B., Crawford, P., Eide, E. A., Galloway G. E., Goodchild, M. F., Kunreuther, H. C., Li-Vollmer, M., Schoch-Spana, M., Scrimshaw, S., Stanley, E. M., Whitney, G., Zoback, M. L. 2013. Disaster resilience: a national imperative. *Environment: Science and Policy for Sustainable Development*. 55(2): 25-9.
- Da Silva, J. 2013. City Resilience Index: Understanding and measuring city resilience. New York City: Rockefeller Foundation (Arup Internationad Development).
- Danihelka, P., Blazkova, K., Dlabka, J., Rehacek, J., Baudisova, B., Ruzickova, P., Richter, R. 2015. Methodology for public informing about risks in the framework of the prevention of major accidents. VSB-TU Ostrava, MV-GR HZS CR IOO Lazne Bohdanec.
- Dlabka, J., Danihelka, P., Novotny, P., Roznovsky, J., Hollan, J., Krist, J., Gaillyovy, Y., Thorstensen, E., Baudisová, B., Danihelkova, K., Suchankova, J. 2016. From vulnerability to resilience. Brno: ZO CSOP Veronica. ISBN 978-80-87308-32-5.
- Ebrey, P. B. 1999. *The Cambridge Illustrated History of China*. Cambridge: Cambridge University Press. ISBN 0-521-66991-X.
- Folke, C. 2006. Resilience: The emergence of a perspective for social-ecological systems analyses. *Global Environmental Change*. 16(3): 253-267. DOI:10.1016/j.gloenvcha.2006.04.002.
- Gerland, P., Raftery, A. E., Sevcikova, H., Li, N., Gu, D., Spoorenberg, T., Alkema, L., Fosdick, B. K., Chunn, J., Lalic, N., Bay, G., Buettner, T., Heilig, G. K., Wilmoth, J. 2014. World population stabilization unlikely this century. *Science*, 346(6206): 234-237. DOI:10.1126/science.1257469.
- Hodge, A. T. 2002. *Roman aqueducts & water supply*. Bristol Classical Press. ISBN 9780715631713.
- Hoorweg, D., Pope, K. 2014. Population predictions of the 101 largest cities in the 21st century. *Global Cities Institute (Working Paper No. 4)*.
- ISO 31000:2009. Risk Management - Principles and guidelines.
- Moberg, F., Simonsen, S. H. 2015. What is resilience? An introduction to social-ecological research. Stockholm Resilience Centre. Stockholm University [online]. Available at: <http://www.stockholmresilience.org/research/research-news/2015-02-19-what-is-resilience.html>.
- Natinal Geographic: Giant empires that have no money or shops. How did the Inca economy work? [online]. National-geographic.cz, 2012 [cit. 2016-12-19]. Available at: <http://www.national-geographic.cz/clanky/obri-rise-ktera-neznala-penize-ani-obchody-jak-fungovala-ekonomika-inku.html#.VsHpYvnhCUk>. (in Czech)
- Resilience Alliance: Thresholds and alternate states in ecological and social-ecological systems. [online]. ResilienceAlliance.org, 2004 [cit. 2017-09-21]. Available at: http://www.resalliance.org/index.php/thresholds_database.
- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin III, F. S., Lambin, E., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H., Nykvist, B., De Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B. H., Liverman, D., Richardson, K., Crutzen, C., Foley, J. 2009. A safe operating space for humanity. *Nature*, 461: 472-475 DOI 10.1038/461472a.
- The Conception of Evironmental Security of the Czech Republic 2016-2020 with a view to 2030. Prague: Ministry of the Environment of the Czech Republic. 2015.

- U.S. EPA, 2016. An Inventory of EPA's Tools for Enhancing Community Resilience to Disasters. Washington, DC: U. S. Environmental Protection Agency. EPA/600/R-16/012.
- UNDESA, 2015. World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. Geneva: United Nations, Department of Economic and Social Affairs. Working Paper No. ESA/P/WP.241.
- UNISDR, 2005. Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. Geneva: United Nations International Strategy for Disaster Reduction.
- UNISDR, 2012. How to Make Cities More Resilient - A Handbook for Mayors and Local Government. Geneva: United Nations International Strategy for Disaster Reduction. ISBN 978-92-1-101496-9.
- UNISDR, 2015. Sendai Framework for Disaster Risk Reduction 2015-2030. Geneva: United Nations International Strategy for Disaster Reduction.
- Video: senior research fellow Brian Walker explains the concept of resilience [online]. StockholmResilience.org, 2015 [cit. 2017-09-21]. Available at: <http://www.stockholmresilience.org/research/research-news/2015-02-19-what-is-resilience.html>.
- Walker, B., Holling, C. S., Carpenter, S. R., Kinzig, A. 2004. Resilience, adaptability and transformability in social-ecological systems. *Ecology and society*, 9(2): 5. [online]. Available at: <https://www.ecologyandsociety.org/vol9/iss2/art5/>.
- Zio, E. 2016. Challenges in the vulnerability and risk analysis of critical infrastructures. *Reliability Engineering & System Safety*. 152: 137-150. DOI:10.1016/j.ress.2016.02.009.