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Visegrad Experts at Resilience Forums in the South Caucasus

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Visegrad Experts at the Resilience Forum Events in the South Caucasus

Four experts from Hungary, Slovakia, Czechia and Poland brought their experience into the 3rd Regional Resilience Forum events that took place in Tavush (02/06) and Adjara (30/05). The experts shared with the Armenian and Georgian participants their knowledge and V4 countries' best practice as well as discussed a potential for linkages and sharing the developed models with the stakeholders in the South Caucasus.

Radim Tolash presented the climate change context in Chechia, with a focus on mitigation and adaptation work and relevant national level Climate Change Strategy that has been elaborated by the Czech government. Eva Pauditsova from Slovakian Comenius University concentrated on adaptation measures for climate change in strategic planning, presented tools for building resilience of the cities and the Bratislava Action Plan of Adaptation aiming at the evaluation of the climate change restoration, mitigating the adverse impacts of climate change taking into account the requirements of adaptation to climate change in spatial planning activity, in the decision-making and approval procedures of local policies and regulations of the City of Bratislava and its boroughs. One of the key issues presented and discussed were preventive measures to which contributed Miklós Székely from Hungarian Energia Club and Tamara Tokarczuk representing the Polish Institute of Meteorology and Water Management. The Polish experts presented the Institute's systems for modelling, forecasting and management of floods and droughts (Flood Risk Management – FHM, FRM, FRMP; Drought Risk Management - POSUCH@ - drought assessment and forecasting system. The Hungarian brought a practical example of EU funded programme on development of the disaster risk assessment method for the South-East Europe and raising local communities' climate change and risk awereness and enhancing their preparedeness.

All experts also took part in the learning sessions for local governments, non - governmental organisations and academic representatives.

The regular Resilience Forum gatherings, facilitated by local NGOs: OxYGen in Tavush, Armenia and Bridge in Adjara, Georgia, bring together policy makers, civil society organisations, academia, media and other sector representatives and key stakeholders to discuss cross cutting issues related to resilience, such as disaster risk reduction, climate change adaptation, agriculture and livelihoods.

The series of events aim to facilitate a regional multi-sectoral and multi-stakeholder dialogue on challenges and best practices in policy and practice work to support rural and urban resilience in Adjara. The initiative aims at contributing towards intensifying the know - how transfer and communication on the key country and regional about strategies and the Sendai Framework for Disaster Risk Reduction 2015 - 2030 and other frameworks and plans at all governance levels related to climate change adaptation, disaster risk reduction, livelihoods, environmental protection and synergies among them.

The experts' visit to the Tavush Region and Adjara Autonomous Republic was supported and funded by the International Visegrad Fund and Ministry of Foreign Affairs of the Kingdom of the Netherlands organised by the OxYGen Foundation in Armenia and its partner in Georgia, Bridge - Innovation and Development.

[add photos from both forum events & link to the Visegrad video]

FLOOD AND DROUGHT RISK MANAGEMENT IN POLAND

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INTRODUCTION

Poland is situated in a transitory temperate climate zone. Floods and droughts are characteristics phenomena for climate in Poland. On the one hand flooding is the most destructive natural hazard in the Baltic Sea Basin in general and in Poland in particular. Most of Poland is located in the drainage basins of two large rivers: the Vistula (whose drainage basin covers 54% of the country's area) and the Odra (34%). Both have their sources in mountain areas and empty into the Baltic Sea. Many towns and large cities are situated on the two rivers and their tributaries. Flood risk and flood preparedness became matters of broad concern, following the dramatic inundations in Poland in 1997 and 2010, during which the number of fatalities exceeded 55 and 20 respectively. National flood losses were estimated to reach billions of euros and made headline news. In 1980, 1997 and 2010 flood damage reached or exceeded 1% of the Polish GDP. Floods have also caused serious social damage: the ill health of inhabitants, stress, social disruption, and losses to the natural and cultural environments (Kundzewicz 2014). On the other hand droughts in Poland have a character of atmospheric anomaly following the rainless period. Lack of precipitation over a large area that lasts for a longer period of time forms first phase of drought - meteorological drought. Scarcity of water resources propagates through the subsurface part of the hydrological cycle causing soil drought and finally groundwater recharge reduction evolving into a hydrological drought. Droughts is defined as a sustained and regionally extensive occurrence of below average natural water availability, and is usually characterized as a deviation from normal conditions [Tallaksen and Van Lannen, 2004]. It is commonly assumed that droughts in Poland appear every 4-5 years [Lorenc 2006]. Drought phenomena on the territory of Poland was mentioned in the chronicles since the fourteen century and were recognized to occur with the following frequency: in the XIV century 20 times, in the XV 25 times, in the XVI 19 times, in the XVII 24 times, in the XVIII 22 times. Since the XIX century a regular measurements have been commenced and the number of droughts were estimated on 23 and 20 for the XX century.

Poland as a Member States od UE in the referring to flood hazard is obligated to assess if their water courses and coast lines are at risk from flooding, to map the flood extent and assets and humans at risk in these areas and to take adequate and coordinated measures to reduce flood risk preparing flood risk management plans. The Directive also requires that the flood hazard and flood risk maps, and flood risk management plans are prepared in cooperation and coordination with neighbouring states in cross-border river basins. As defined in the EU Floods Directive (CEC 2007), the term 'flood'means 'the temporary covering by water of land not normally covered by water'. The notion includes floods from rivers and mountain torrents, as well as floods from sea surges in coastal areas. In some interpretations, it also includes floods from sewage systems.

In the referring to drought in Poland the Water Law Act of 2001 (with amendments) is the most important one, it gives basic regulations concerning requirements that the user of water should comply with. This act precise so-called especial use of water that requires the permission. The act also states that water management is based on shaping, protection and exploitation of ground and surface waters according to a rule of sustainable development and especially on protection against floods and droughts.

Protection against floods and drought risk management is one of the main task of water management in Poland imposed by Water Low. Water management is one of the sectors of the national economy which is strongly connected with other fields of economic activity.

The main administrative organ dealing with water management is the Minister of the Environment, responsible for rational water policy in the country. The tasks of the Minister are set out by the Water Act and include in particular: development of a national program for the aquatic environment, draft River Basin Management Plans, a plan for flood risk management and drought risk management across the country, approval of draft conditions for the use of waters in a water region; discharging the obligations of the owner of waters which are important for the development of water resources and flood protection, supervising the activities of the Directors of the Regional Water Management Boards; supervising functioning the State Hydrological and Meteorological Service and the State Hydrogeological Service. These tasks comprise also agreeing with the president of National Water Management national strategy of water management and actions for mitigating flood and drought impacts as well as shaping the state's policy by proposing proper laws, creation of legal and economic instruments. The President of the National Water Management Authority is a central government administration authority responsible for the management and use of waters. The most important institutions supervised by President of the National Water Management Authority that are responsible for the management of water resources in the hydrographic areas are the Regional Boards of Water Management [RZGW]. The RZGW are the regional non-affiliated governmental administration units that executes tasks issued by the Minister of the Environment in water management field as well as those related to conservation of the state-owned waters and to the implementation of water management investments of global significance. The administration of the state-owned surface waters, being beyond the RZGW's administration are divided between the marshal of the voivodship and the director of national park (waters located within park territory). The management system of water resources comprises both the central and local government administrative bodies. The planning, executive and investment tasks are subject to the local governments of all levels – of the voivodeship, county and commune.

There are following instruments that enable performing those tasks: strategies of voivodeship development, voivodeship programs of sustainable development and environmental protection, and principally, the local plans worked-out by the communes. The management tasks, regulating the legal status of the use of water resources are carried out by the governmental units – the Voivodeships as well as by the heads of County (as tasks assigned by the Central Government).

The task of flood and drought monitoring is within the scope of activities imposed by Water Low on the State Hydrological and Meteorological Services. The Institute of Meteorology and Water Management - National Research Institute (IMGW-PIB) is a research-development unit merging responsibility of State Hydrological and Meteorological Services and the Institute of Water Management. The Institute is supervised by the Minister for Environment. Basic statutory tasks of the Institute include scientific and development activities as well as state services in the following domains: meteorology, hydrology, oceanology, water management and engineering and water resources quality. These tasks cover carrying out scientific-research, making regular measurements and observations with the use of basic systems and measurement networks, acquisition, archiving, processing and making available measurement and observational materials, for both national and international bodies, preparation and dissemination of forecasts and warnings for general public and national economy protection as well as for state defence against hydrological and meteorological hazards. The obligation to provides continuously the state authorities, general public and national economy with current information on the state of the atmosphere and hydrosphere, forecasts and warnings both in normal as well as in emergency situations requires development of the tools addressing flood and drought monitoring and forecasting.

FLOOD RISK MANAGEMENT

Flood is one of the most dangerous phenomena in the country. In order to increase safety of citizens and mitigate adverse effects of a flood, acting pursuant to the Flood Directive and the Act on Water Law, the National Water Management Authority (KZGW) was carrying out works dedicated to drafting flood risk management plans (PZRP) for the river basins and water regions. Those works have been preceded by the drafting of the preliminary flood risk assessment (WORP) as well as flood hazard maps (MZP) and flood risk maps (MRP.) WORP aimed at indicating areas at risk of flood, i.e. areas where potential significant flood risk exists or might be considered likely to occur.

Flood hazard maps and flood risk maps as planning documents represent in practice nontechnical means for protection against flood aiming at limitation of potential negative effects of flood. The aim of creation of these documents is proper management of risk which flood may create for life and health of people, environment and economy. Access to information on areas threatened with flood and the level of such a threat as well as indication which risk is related to occurrence of flood in a given area, will certainly contribute to making aware decisions in respect of location of investments by inhabitants and by local authorities. The maps constitute also the basis for rational spatial planning in the areas threatened by flood and thus for limiting negative effects of flood. Information contained in the maps is also useful in responding and in managing crisis in the event of flood. The maps may represent an initial point for preparing further analyses necessary to complete actions of various administration authorities, including crisis management.

The maps of flood hazard and flood risk were developed under the project ”IT System of the Country's protection against extreme hazards” (ISOK) by Institute of Meteorology and Water Management National Research Institute (PIB) and Centres of Modelling Flood and Drought in Gdynia, Poznań, Cracow and Wroclaw. On 22 December 2013 flood hazard maps and flood risk maps, transferred by Institute of Meteorology and Water Management, National Research Institute, were published on Hydroportal of MZP and MRP in pdf format (http://www.isok.gov.pl/en/flood-hazard-maps-and-flood-risk-maps).

Aim and scope of the flood hazard maps and flood risk maps

Flood Hazard Maps

The flood hazard maps were prepared for the areas exposed to a danger of flood indicated in the preliminary flood risk assessment (WORP).

Areas with a defined probability of flood occurrence are presented on the flood hazard maps:

- areas, in which the probability of flood occurrence is low and amounts to once a 500 years (Q 0,2%);
- areas, in which the probability of flood occurrence is medium and amounts to once a 100 years (1%),
- areas, in which the probability of flood occurrence is high and amounts to once a 10 years (Q 10%),

and areas covering the land exposed to flooding in the event of:

- destruction or damage of a river embankment,
- destruction or damage of a counter storm embankment (protective structures of the service strip – in compliance with the Water Law Act valid before 12 July 2014)

Moreover, the flood hazard maps present:

- water depth;
- and speed of water and directions of water flow – for voivodship cities and cities with poviat rights and other cities with the population above 100 000 people.

The areas of flood hazard presented on the maps have been obtained as a result of a mathematical hydraulic modelling. Very accurate space data obtained with use of air laser scanning I. e. Digital Terrain Model and Digital Surface Model have been used in the process of modelling..

Flood Risk Maps

The flood risk maps defining values of potential flood losses and presenting locations exposed to flooding in the event of flood occurrence with a defined occurrence probability will be a supplement of the flood hazard maps. These are locations which will facilitate evaluation of flood risk for life and health of people, environment,cultural heritage and business activity so the groups for which negative effects of flood should be limited according to the objectives of the Flood Directive. For this reason, for the areas presented on the flood hazard maps, elements such as the following will be marked:

- assessed population inhabiting a threatened area;
- houses and buildings of special social significance (hospitals, schools, nursery schools, hotels, commercial centres and others) – for which the water depth amounts to > 2 m and < 2 m (the limit value of water depth -2m has been assumed in relation to assumed brackets of water depth and their influence on a degree of threat to people and building structures);

- historic areas and buildings and structures;
- protected areas i.e. water intakes, protective zones of water intakes, bathing zones, environment protection areas;
- potential sources of water pollution, in the event of flood occurrence i.e. industrial plants, wastewaters treatment plants, wastewaters pumping stations, landfills, cemeteries;
- values of potential losses for individual classes of land use i.e. areas of residential development, industrial areas, communication areas, forests, recreation areas, agricultural land, and waters.

Flood Risk Management Plans

The responsibility to draft such plans has been brought by the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, the so called Flood Directive. Consistent with the Act on Water Law. The party liable for drafting the plans for the river basins is the President of the National Water Management Authority, while the responsibility for the plans covering water regions falls upon the directors of the individual Regional Water Management Authority.

Basing on the prepared planning documents and collected data, flood risk management plans are being developed for two different levels relating to the country's area – river basins and water regions. The works are conducted simultaneously for the river basins of Odra, Vistula as well as Pregoła and 9 water regions. In order to ensure that all interested entities are able to take part in the development process, several working groups have been formed and assigned to the river basins, water regions as well as sub-basins. Their task is to use their knowledge and experience to assist those responsible for developing FRMP.

By selected measures dedicated to minimising the identified threats, flood risk management plans aim at reducing potential negative consequences of the flood for the life and health of people, environment, cultural heritage and business. Those measures lead also to reducing the losses caused by the flood.

DROUGHT RISK MANAGEMENT

Risk management for drought is defined as the process of identifying and understanding the relevant components of drought risk followed by analysing alternative strategies to manage that risk (Knutson et al. 1998; Hayes et al. 2004). Risk management involves hence the application of analytical tools to decision making, as well as the development of management strategies that appropriately deal with uncertainty and the perception of risk. Moreover observed and projected climate changes prove to have unfavourable impact on the frequency and intensity of droughts in Poland. This causes increasing need for consistent and timely information on drought situation that is crucial for water management system, national and regional economy and public. Replaying to this requirement IMWM NRI has been developing a concept to amplify existing Hydrometeorological Monitoring and Warning System with a drought protection and management procedures in order to issue and disseminate warnings and alerts on drought.

The scheme as planning process that can facilitate the preparation of decision support systems for drought risk management and to provide a Framework for Drought Risk Management Scheme presenting the interrelationships and functional linkages between these elements for decision support in drought oriented systems. Framework is based on institutional, methodological, public and operational structures serving to compose integrated body of methods). The scheme includes meteorological and hydrological drought detection and analysis of drought intensity and duration, vulnerability to drought assessment as well as drought hazard evaluation.

Applied drought indices

The EDI (Effective Drought Index) [Byun and Wilhite, 1999] is a measure of precipitation needed for a return to normal conditions. It is calculated with daily time step. First step is a calculation of weighted precipitation accumulation over a defined preceding period (EP). In the study this period is set on 365 days corresponding to hydrological year duration in Poland. The concept of the EDI is a standardized daily difference between EP and the climatological mean of EP (MEP) for each calendar day. EDI values are standardized, which allows comparing drought severity at different locations regardless of climatic differences among them.

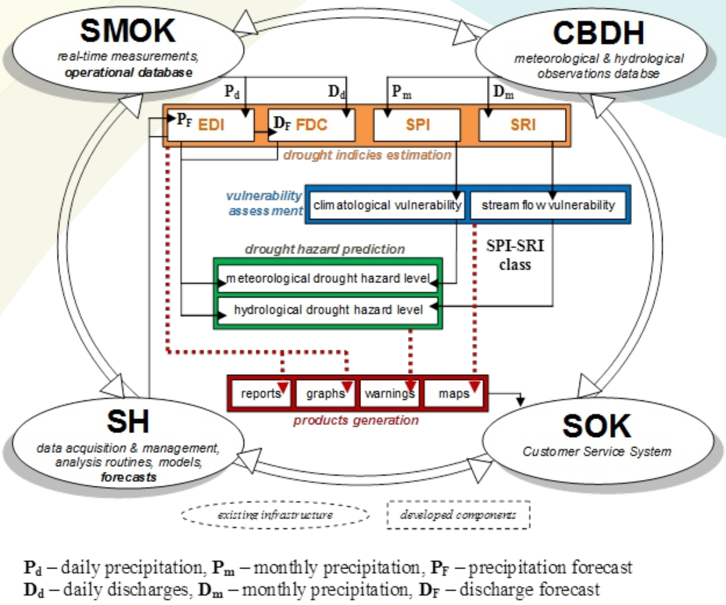
The SPI (Standardized Precipitation Index) [McKee, Doesken & Kleist 1993] is based on a long-term precipitation record at a station fitted to a probability (gamma) distribution, which is then transformed into a normal distribution so that the mean SPI is zero. In the study, SPI is computed with 1 month time step [Smakhtin and Huges, 2004]. Similar to EDI values SPI values are standardized representing deviations of the transformed precipitation totals from the mean.

The FDC (Flow Duration Curve) [US Geological Survey http://water.usgs.gov] represents the empirical cumulative frequency of discharges as a function of the percentage of time that the discharge value is exceeded. FDCs are constructed for each calendar day basing on long-term discharge data. Each FCD is divided into 5 classes which correspond to the humidity conditions.

The standardized runoff index (SRI) is based on the methodology developed for the SPI with the application for assessment of the hydrological runoff (Shukla & Wood, 2008). The computation of the SRI involves fitting a probability density function to a given frequency distribution of monthly runoff for a gauge station. Typically, the gamma probability density function is used. This cumulative probability is then transformed to the standardized normal distribution with mean zero and variance one, which results in the value of the SRI. The drought severity categorization follows the same gradation as the SPI. Despite being a relatively new index, the SRI is gaining more and more application (Kingtse 2008).

Hydrometorological drought hazard assessment system operated by Institute of Meteorology and Water Management

The operational risk assessment approach is directed towards better understanding drought occurrence trends, vulnerability and impacts of droughts for particular drought prone areas with the use of operational drought indices. The operational decision support system for drought risk management in the Odra River basin was lunched to run operationally for the selected catchments of the Odra River and the Wisla River basins. The crucial resulting products are presented on the website operated by IMWM-NRI: POSUCH@ (Operational System for Providing Drought Prediction and Characteristics) (http://posucha.imgw.pl/).



Hydrometorological drought hazard assessment system operated by Institute of Meteorology and Water Management (source: Tokarczyk, Szalinska, 2013)

The existing system allows for comprehensive analysis of values of selected drought indices coupled with long-term data studies and short-term precipitation and discharge forecasts. Communication chart and specification of the transmitted information was developed to meet the requirements for decision-making tool. While the overall scheme remains the same a selection of different indicators and thresholds to assess drought allows for application in different sectoral approach i.e. agriculture, water supply etc.

The framework for drought risk management scheme is based on proactive approach. A proactive approach consists of planning in advance the measures necessary to prevent drought impacts and reduce vulnerability to drought. This approach should include preparedness planning tools with continuous monitoring of drought variables and the status of water reserves. Therefore, adequate information is required for drought declaration as well as to avoid severe shortages through efficient drought management during drought periods.

SUMMARY

In order to be prepared for the flood risk, flood protection and flood management strategies are necessary to strengthening the flood protection and flood preparedness systems include floodplain management and watershed management. Moreover, implementation of the Floods Directive of the European Union (EU) is a useful vehicle for assessing, improving and managing the flood risk.

In order to successfully introduce drought risk management approach into development processes, capacity and knowledge gaps in drought related data collection and sharing must be identified and an enabling policy and institutional environment established to bridge these gaps. Drought management requires a joint efforts of institutions and organizations representing different fields of science and different levels of management To provide integrated institutional and sectoral approach the institutional framework should be composed of institution related to water, meteorology, agriculture, environment and socio - economy. Integrating different management levels (federal, state, district, local/individual) requires tackling with different community participation and political commitment, networks and mechanism as well as resource availability.

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DISASTER RISK ASSESSMENT IN THE DANUBE MACRO-REGION

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SEERISK project

Natural hazard is a "natural process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage". Experiences of disaster management (DM) authorities in Europe and climate studies show that these natural incidents and threats have become more and more intense and unpredictable in the last three decades. Evidently climatic variability and the occurrence of various extreme meteorological and hydro meteorological events always had their significant imprints on socio-economic activities and the natural systems. However according to observations, the number and intensity of these extreme events have increased throughout the recent decades. With regard to the changes in the climate, in the past years there have been major disasters which seem to justify that these events point to a direction where the frequency and severity of weather anomalies are changing as well. There are research results and forecasts (climate models) stating that notable trends could be observed especially for droughts, floods, heavy rainfalls and heat waves. It is essential to better understand these natural processes, to find appropriate risk management options and to address the potential changes resulting from socio-economic and environmental development.

In terms of both material and human resource management, these new, intensified climatic challenges represent increasing burden to disaster management. The costs of disaster preparedness, response, recovery and mitigation has been steadily rising. Therefore it is important to explore and utilize tools, techniques such as risk assessment which support the reduction of specific risk factors related to disasters and allow developing management capabilities. Risk assessment contributes to ensuring that policy decisions are prioritized in ways to address the most severe risks with the most appropriate prevention and preparedness measures.

According to European Commission's working paper on risk assessment and risk mapping "risk assessment is the overall process of risk identification, risk analysis, and risk evaluation". The process allows to perform assessments of the likelihood and the potential impact of a wide range of risks relevant

[1] UNISDR: UN International Strategy for Disaster Reduction
Sec, 15 January 2009
[2] http://www.met.hu/doc/omsz_hirek/ 2011.08.23/melleklet_2_szakmai.pdf
[3] Climate change and Hungary: mitigating the hazard and preparing for the impacts (the „VAHAVA" report); ed. by T. Faragó, I. Láng, L. Csete; 2010, Budapest

for a region or a country. One significant aspect of disaster risk reduction (DRR) deals with managing the risk of natural hazards. The overall risk assessment process (or ideally feedback cycle) as presented by the ISO 31010:2009 standard can take different shapes and forms but the general concept always revolves around the three steps mentioned above. Different supporting tools such as risk scenarios, risk maps and risk matrices help to better understand the profile and the nature of a risk type. DRR in general is an effective climate adaptation option as it systematically analyzes and manages the causal factors of disasters, including through reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness for adverse events.

The case study unveiled below will highlight the use of the aforementioned climate adaptation risk tools in practice and the elaboration of a tailor-made risk assessment methodology for a coherent geographical area in Europe, i.e. the Carpathian Basin.

SEERISK project – a case study

SEERISK was a transnational EU funded project called "Joint Disaster Management - risk assessment and preparedness in the Danube macro-region" launched in 2012 and concluded in early 2015. The project consortium comprised 20 project partners representing 9 countries, namely Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Slovenia and Bosnia and Herzegovina. The consortium was coordinated by the National Directorate General for Disaster Management (NDGDM) of Hungary.

Fitting to the global trends the frequency and severity of the extreme climatic events in South-East European (SEE) region has been increasing due to climate change. Even though this phenomenon affects countries, territories and municipalities differently, there are common and region-specific challenges. SEERISK project took into account particular risks and horizontal challenges as well. The countries involved are territorially coherent: the cooperation concentrated on the Middle and Lower Danube Basin, where a wide range of natural risk types occur. There are regions or municipalities where flood is the predominant risk factor (e.g. in Senica, Slovakia), whereas in other project territories, unforeseeable thunderstorms cause serious damages (e.g. in Siófok, Hungary) or frequent draughts induce damage to agriculture (e.g. in Kanjiza, Serbia). In addition to climate related hardships, institutional, societal and organizational gaps hinder the adaptive capacities in the region such as low level of climate awareness, weak preparedness, territorial planning and administrational inefficiencies.

The 2.5 year long project implemented the main outputs and products of the project at 6 pilot municipalities or regions from Romania (Arad), Serbia (Kanjiza), Bosnia and Herzegovina (Sarajevo), Slovakia (Senica), Hungary (Siófok) and Bulgaria (Velingrad).

The project applied climate change related disaster risk assessment, social awareness survey, GIS based disaster risk mapping, emergency preparedness and gap analysis: a comparison between risk assessment and risk perception of local communities.

[4] Risk Assessment and Mapping Guidelines for Disaster Management; Commission Staff Working Paper, Brussels, 21.12.2010 SEC(2010) 1626 final
[5] ISO/IEC 31010:2009–Risk management–Risk assessment techniques. ISO and IEC
[6] UNISDR: UN International Strategy for Disaster Reduction Sec, 15 January 2009

Common but differentiated challenges

Countries from the Danube macro–region have been often affected by a range of natural hazards that have caused a significant number of negative effects resulted in human casualties, infrastructure damage and environmental impacts. Many hydro-meteorological hazard events, such as storms or flash floods are direct consequences of climate extremes (extreme weather events), while others like floods or wildfires are becoming even more frequent or extreme due to climate change. Various simulations show a decrease in summer precipitation of about - 20% to - 35% for SEERISK project countries in the Danube macro–region.

Climate change, in combination with socioeconomic changes is expected to modify the spatial distribution of risks too in SEERISK countries. Furthermore, climate-related extremes and hazards are not restricted within national boundaries. For this reason, collaboration between neighboring countries and harmonization of the existing practices and methods are essential. Although changes in climate are expected to influence the frequency and intensity, spatial extent, duration and timing of hazardous phenomena, extreme weather and climate events may lead to disaster only if:

1. communities are exposed to those events,
2. the vulnerability of these communities is high, and
3. their adaptation potential/capacity is low.

Common risk assessment approach

Communities in the SEERISK project scope (municipalities and regions) aimed to reduce natural disaster risks for a better resilience so that recovery costs and injuries caused by damages from natural disasters could be reduced. At the same time a more efficient institutional and legal framework was meant to improve the disaster preparedness and planning capacities of the local and national disaster management capabilities. The overall objective of the SEERISK was to assist disaster risk management practitioners and decision makers in taking appropriate risk assessment and climate change adaptation measures and actions in the SEE region. The specific objectives were to:

1. Carry out the process of risk assessment by developing a common risk assessment methodology;
2. Explain how the common risk assessment methodology can be put into practice at the six case study areas;
3. Reveal gaps between the challenges imposed by the natural hazards related to climate change and the level of overall preparedness of the local communities;
4. Suggest possible adaptation solutions to the challenges imposed by the changing climatic conditions;
5. Raise people's awareness of climate change and enhancing overall local-level disaster management preparedness.

[7] Guideline on climate change adaptation and risk assessment int he Danube Macro-region, NDGDM, 2014, Budapest

The common methodology developed by the SEERISK consortium is solution-oriented: it considers drawbacks, such as lack of significant data sets and it offers alternative way-outs. It has a step-wise approach regarding the risk assessment procedure, the development of risk matrices and scenarios and a theoretical approach to risk mapping.

SEERISK's local level common **risk assessment guideline** consists of the following steps:

1. Defining the context (aims, end users, risk criteria, etc.) of the assessment and identifying the risks locally (type of hazard, scale, extent, susceptible groups, risk metrics) ;
2. Analyzing the identified risks: hazard analysis and impact analysis. Preparation of risk matrices to compare and rank risks;
3. Evaluating risks: decisions to be made on the need for treating a risk, priorities for treatment, activities to be taken, paths to follow;
4. Constructing municipality level risk maps for the pilot areas.

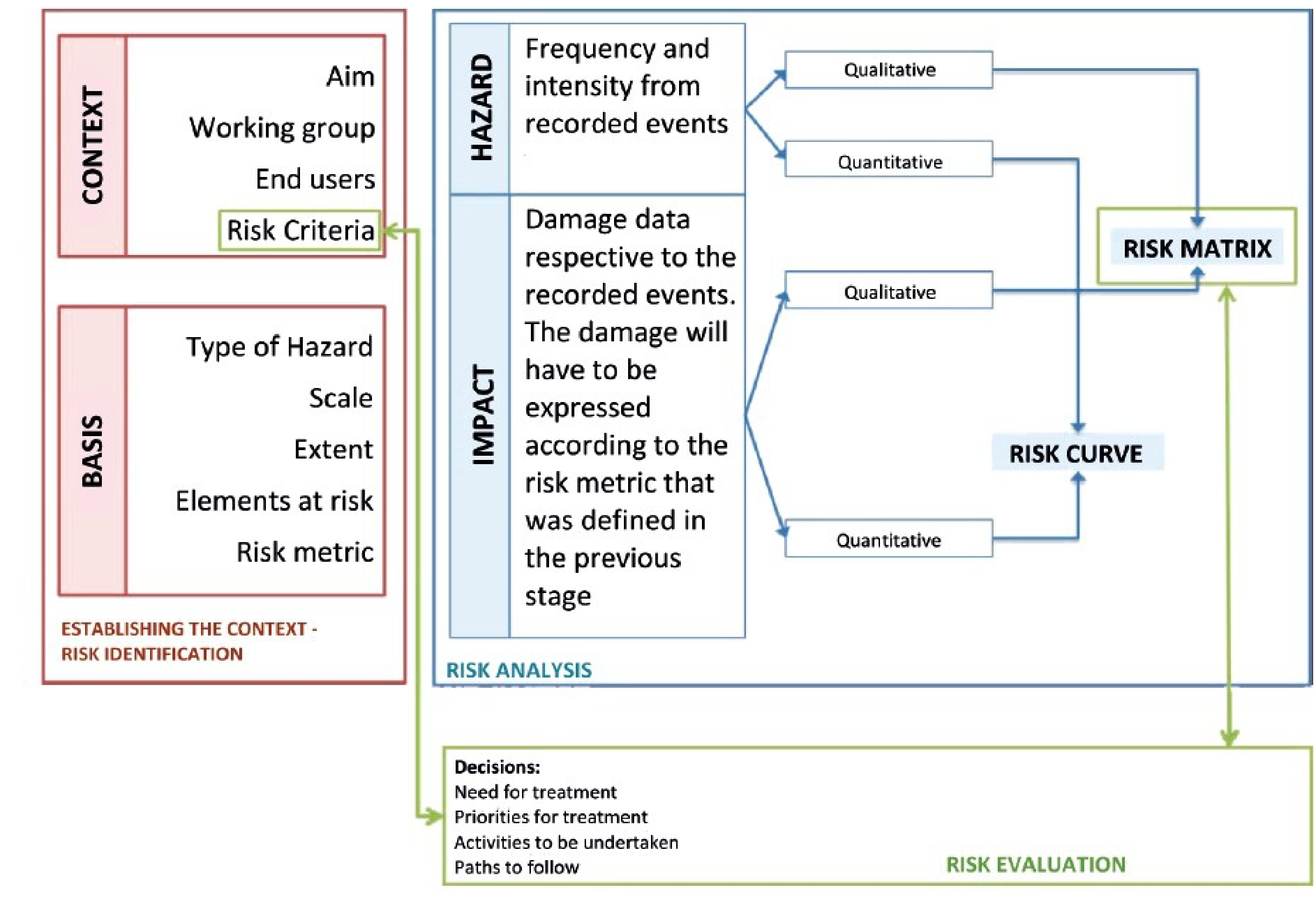

Figure . Risk Assessment Process of SEERISK (SEERISK 2014)

One of the most spectacular visual output of the implementation of the risk assessment was the construction of pilot municipality risk maps by NDGDM's GIS Team. These static offline as well as dynamic online risk maps provide information for decision makers on which regions or districts are exposed to the highest risks in an urban environment. The risk maps are the result of combining hazard (frequency of the incident) and impact (consequence of the incident) maps. The below figure portrays one example of a municipality level offline SEERISK risk map:

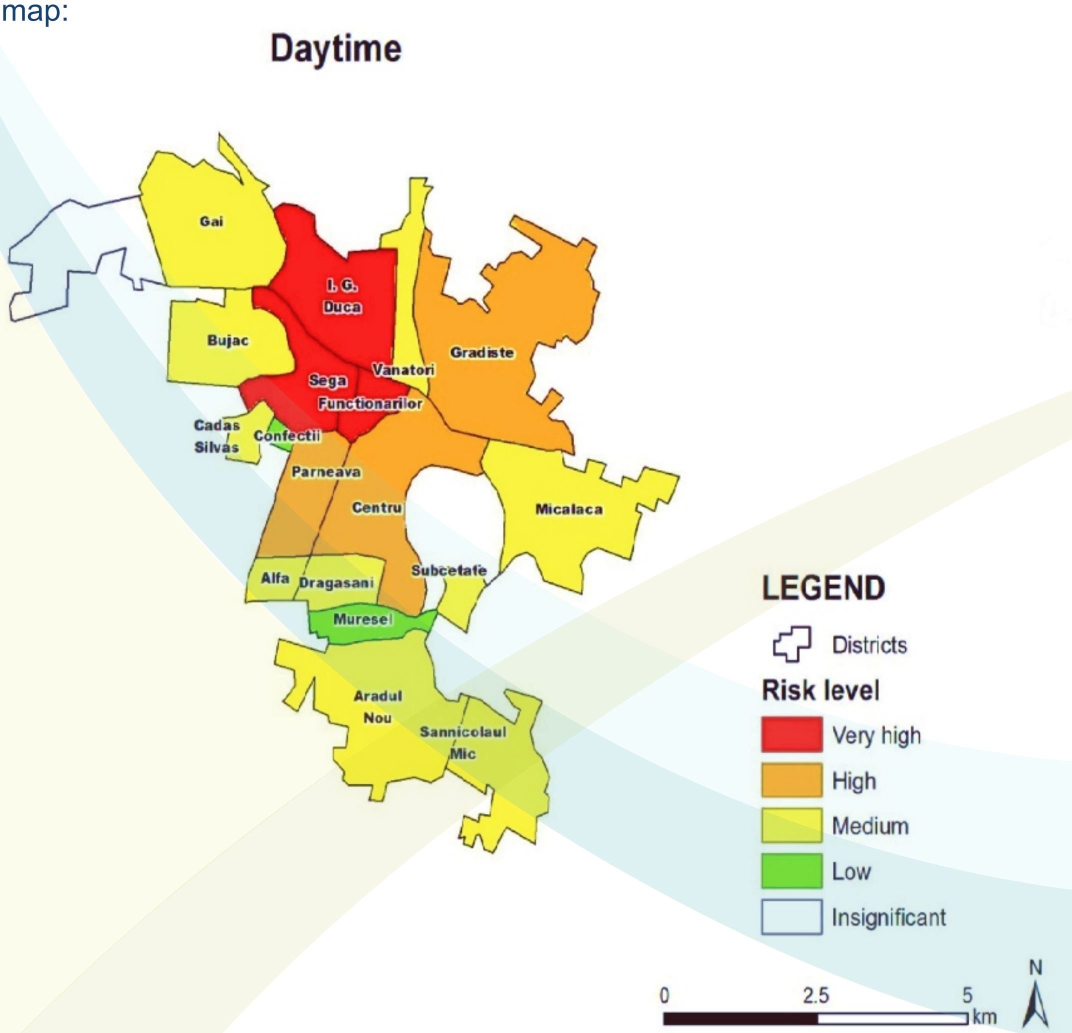

Figure . Daytime heat wave risk map of Arad, Romania (SEERISK 2014)

The social aspect of the project conducted a **social climate change and risk awareness questionnaire survey** in the pilot areas, semi-structured interviews with local decision makers, a **local planning document analysis and** a gap **analysis.**

As a major practical trial of the theoretical risk assessment guideline and the risk maps, four **disaster simulation field-exercises** was organized at the end of the project in 2014 at the following pilot areas: Siófok, Arad, Velingrad, Sarajevo-Ilidza. An additional international, comprehensive field and table top urban search and rescue (USAR) exercise was organized in Hajdúszoboszló as well.

In order to better communicate risks and threats to vulnerable population groups a **common emergency communication strategy** has been developed by SEERISK to provide a scheme that can be used as a template, containing prevention and emergency communication steps in case of a weather related hazard or disaster event.

The project was implemented with the involvement of all project partner experts covering different types of tasks according to their appropriate professional profiles.

Type of solutions:

SEERISK aimed to implement a mixed people and technology based solution. The main focus was on climate change related knowledge transfer, community involvement, international cooperation, institutional capacity building and more importantly public awareness raising. Technology based solution included GIS based risk mapping, disaster simulation field exercises, improving emergency preparedness and emergency communication strategies.

Role of actors in the solution:

The project consortium was led by the National Directorate General for Disaster Management (NDGDM), Hungary and all the other consortium member organizations were invited (after a thorough selection procedure using specific criteria) to take part at the cooperation. The collaboration was not public or inclusive as the project was a scientific research cooperation with strict project partner policy framework.

NDGDM, being the lead partner, was the most active stakeholder during the implementation, however local level decision makers were also effectively facilitated the project.

The involved municipalities were the pilot areas where SEERISK's outputs and results were tested. They provided local knowledge and assistance during the implementation phase especially in case of the public awareness questionnaire survey, the semi-structured interviews of the decision makers and the local planning development analysis.

SEERISK, being mainly a social science and climate adaptation research project, involved state funded public organizations with national and local scope such as DM authorities, universities, hydro-meteorological and research organizations. NGOs were only indirectly involved in the implementation e.g. civil protection volunteer organizations during the disaster simulation field exercises. Local peoples were contributing to the result by taking into part the public awareness questionnaire survey.

Pilot area municipalities benefited the most from the improved resilience as the types, the geographical distribution and the levels of risks were visually illustrated in the risk maps thus the general level of emergency preparedness have been improved as well as the knowledge on the connection between climate change and the extreme natural disasters.

Outcomes and lessons learnt from case study

The most significant and transferable element of the project is the common comprehensive disaster risk assessment methodology which helps communities to systematically identify, analyze and evaluate risks from climate change related natural hazards in their regions. Other, particularly useful results are the risk maps that are linked with the risk assessment methodology and help visualize risks over a geographical area.

In order to suitably transfer this solution it is vital to educate disaster management and local level decision makers about the concept of disaster risk assessment and its possible benefits for the communities. A couple of trainings, specific guidelines and lectures would suffice to pass on the basic knowledge regarding the risk assessment methodology. It is important to make it clear that risk assessment does not necessarily require quantitative data input as the technique is able to draw up comprehensive risk profiles by relying on qualitative information as well. Although the more quantitative data have been used during the process the more precise the risk profile will be. GIS based risk mapping would involve slightly more resource and specialized knowledge. An experienced GIS expert, a GIS software and a proper hardware would be needed to construct detailed risk maps. SEERISK consortium has developed a GIS Best Practices guidelines which aims to transfer the specific technical knowledge acquired during the project's lifetime (http://www.rsoe.hu/projectfiles/seeriskOther/download/GIS_Best_Practices.pdf). The document's main aim is to provide a practical complementary material to the Common Risk Assessment Methodology; present a detailed explanation of the work done by NDGDM's SEERISK GIS Team; share the know-how of developing online risk maps.

Local authorities in the SEERISK project consortium were keen taking part in the cooperation as specialized state programs (in this case climate adaptation) are mostly absent in the SEE region. Decision makers realized that climate change are now poses a major threat to local communities and available, mostly EU, financial sources can be mobilized to tackle this problem. Local authorities of municipalities are the biggest employers in many cases, therefore they have the most means and influence to raise public awareness and change public opinion. Most of the bottom-up or external climate adaptation initiatives are approved and endorsed by local authorities and organizations with national scope (mayors, city councils, notaries, DM authorities) although some SEE region municipalities started to implement top-down programs too. So local authorities are the key players in the success or the failure of a climate adaption actions, they can either facilitate or hinder implementation.

The process was meant to extensively rely on partner cooperation however the activity of some partners was unbalanced. What is important, especially in the SEE region, is that public, higher education and research institutions, DM authorities, municipalities can be successfully motivated only if the program carries financial benefit or substantial cost reduction for them.

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Miklós Székely

Miklós Székely has been working in the field of climate policy - both mitigation and adaptation - for more than 7 years. He has moved his attention to adaptation issues 4 years ago and gained experience particularly in natural disaster risk assessment and local level adaptation strategy development. He is currently working on renewable energy projects in Hungary. He is fluent in English and understands German.

ADAPTATION MEASURES FOR CLIMATE CHANGE IN STRATEGIC PLANNING – TOOL FOR BUILDING RESILIENCE OF THE CITIES

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Climate change as a phenomenon of 21st century is becoming one of the greatest challenges of environmental politics. World Economic Forum Global Risks 2013 Report 1, which regularly evaluates 50 top global threats in terms of their effects, probability and interactions, ranks climate change among five top risks today. Although the effects of climate change across the world and regions are different, its adverse effects on socio-economic and natural systems are increasingly important and require an active solution. The fifth IPCC Assessment Report (IPPC2, 2013) confirms that global warming is definitely going on (Fig.1), it is faster than predicted by some scenarios in the past, and by 2100 Earth can grow on average by 1.5 to 4.5 °C compared to the pre-industrial level (Fig. 2).

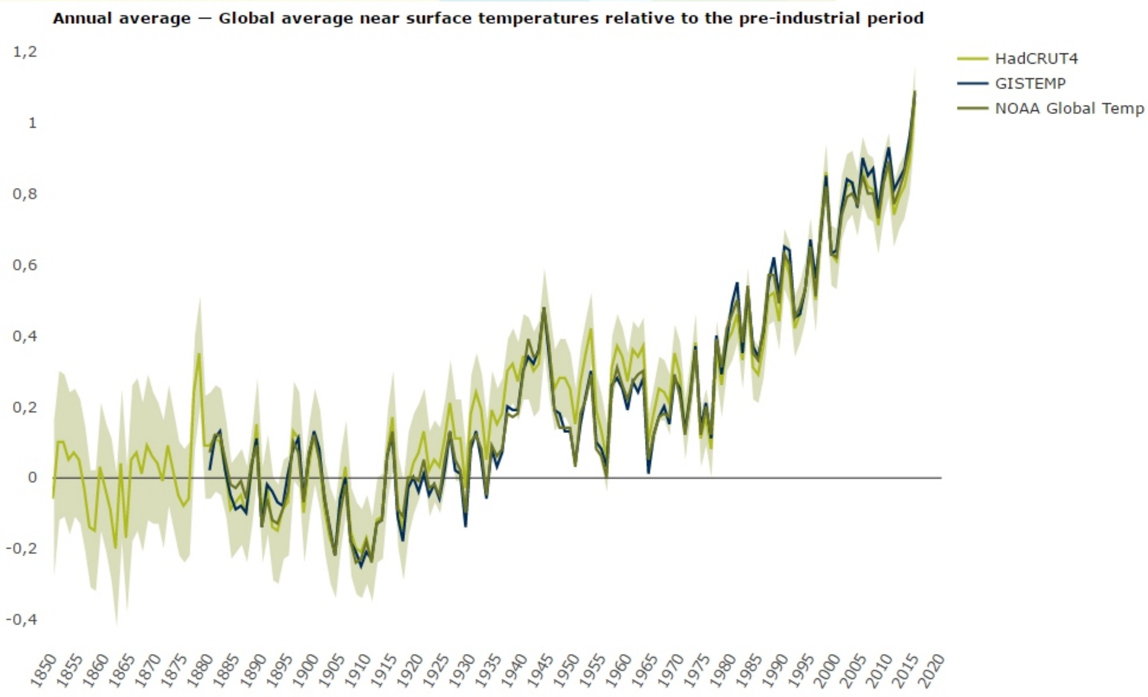

Fig. 1. Global average near surface temperatures relative to the pre-industrial period (EEA, 2016)

protection policies. Related and equally important objectives are also to strengthen the sustainability of cities in the EU and to ensure the use of state-of-the-art knowledge in environmental policy making.

The report also says that concentrations of atmospheric carbon dioxide, methane and nitrous oxide have risen to levels over the last 800,000 years, mainly due to human activities (emissions from fossil fuel combustion and land use change and deforestation). Adaptation to these climatic conditions would be associated with enormously high costs. The topic of climate change was part of the 6th Environmental Action Programme (EAP, 2002). Currently, the 7th Environmental Action Programme (EAP, 2013) with the subtitle "Living well, within the limits of our planet" is valid and covers the period until 2020. The key feature of the programme is the protection and improvement of natural capital, the promotion of a better use of today's resources and an accelerated transition to a low-carbon economy. One of the priority objectives of the 7th EAP is to provide sufficient resources and investment to support environmental and climate

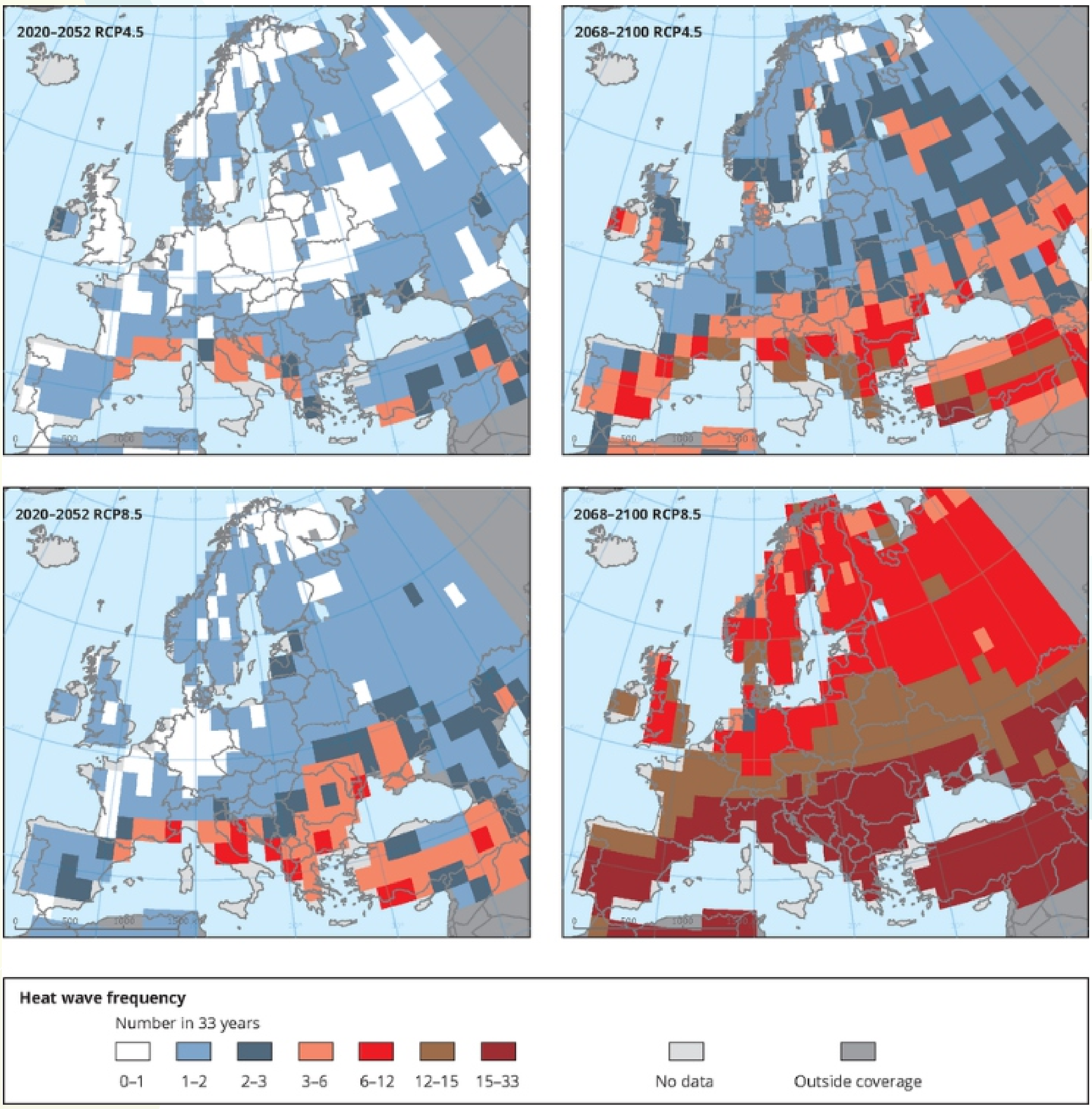

Fig. 2. Number of extreme heat waves in future climates under two different climate forcing scenarios (The top maps show the median of the number of heat waves in a multi-model ensemble of the near future (2020–2052) and the latter half of the century (2068–2100) under the RCP4.5 scenario, and the lower maps are for the same time periods but under RCP8.5) (EEA, 2016)

Strategic planning as a tool for building the resilience of cities to the impacts of climate change

Strategic planning models have been developed to assist in the planning process. A generic overview of traditional strategic planning is typically divided into three levels: strategic, tactical, and operational (Westcott, 2014).

Strategic planning tools at local, regional and national level are strategic documents. These are draft policies, development concepts, plans and programme that are subject to preparation and approval by parliamentary (or government) procedure. At local level, strategic documents are approved by self - governance.

The concept (strategy), plan and programme are generally defined as follows (Sadler, Verheem 1996; Thérivel, Partidario, 1996):

1. The concept (strategy) generally expresses the direction of activities or the proposed overall direction of management and which influences the decision-making process.
2. The plan is a purposeful, long-term strategy with often coordinated priorities, alternatives and measures that make up and implement the concept.
3. The program is a coherent, organized content or schedule of duties / activities, suggestions, tools and / or activities that make up or implement the concept.

The relationship and hierarchy of the concept, plan and programme is as follows (Wood, Djeddour 1992): the concept can be considered as an inspiration and guidance for action, a plan for a set of coordinated and time-driven goals for the implementation of the concept and the programme for a set of projects in a certain area (Belcakova, 2015).

In preparing adaptation strategies, it is always important to assess the vulnerability of the individual components of the environment as well as the vulnerability of the population. The fifth IPCC Assessment Report 2013/2014 (IPPC2, 2013) is aimed at assessing the impacts of climate change, the vulnerability of human and natural systems, and the ways in which impacts and risks associated with climate change can be reduced and managed through adaptation and mitigation measures. The mitigation measures themselves were addressed by the third IPCC Working Group, which has three parts:

1. Observed consequences, vulnerability and adaptation in a complex and changing world
2. Future risks and opportunities for adaptation
3. Managing future risks and building resistance to climate change.

For spatial planning and strategic documents at national, regional and local level, the third part is essential, because building the resilience of settlements to the impacts of climate change is a fundamental issue. In building the resilience of cities against the impacts of climate change, it is essential to determine the vulnerable areas of the settlements and subsequently to identify the degree of their resistance or vulnerability. Based on the knowledge of these parameters, it is possible to plan appropriate measures (adaptation and mitigation) in the strategy papers. By co-operating well-chosen and implemented adaptation and mitigation measures, it is possible to reduce overall risks, although in some regions they remain specific.

Adaptation means adapting to changed conditions as a result of climate change and mitigating the impact of climate change or adapting to learning to live with climate change, i.e. protection against their negative impacts and the use of positive effects for their benefit. **Mitigation** represents measures aimed at mitigating or attempting to eliminate the impact of climate change. It is also often defined as minimizing impacts that could increase the adverse impact of the expected climate change. These include, for example, measures to reduce the amount of greenhouse gases emitted, increase the ability to deplete carbon dioxide from the atmosphere, and so on. **Vulnerability** is the degree of sensitivity of the system to the adverse impacts of climate change, or the inability of the system to cope with these impacts. Thus, vulnerability is a function of the sensitivity of the system to climate change (study to which the system will respond to climate change, including beneficial and deleterious effects), adaptive capacity (i.e., the extent to which procedures, processes or structures can affect potential damage caused by climate change), and the degree of exposure of these systems to climatic hazards (IPCC2, 2013). **Resilience** is the property of a flexible system or population that is not susceptible to climate change and has the ability to adapt (IPCC, 2001).

International Activities on Adaptation to Climate Change

Compatibility with transnational climate change conventions is important for strategic planning including the impacts of climate change. The basic convention is the United Nations Framework Convention on Climate Change (UNFCCC) which was assumed on 9th May 1992 in New York. The convention entered into force in 1994. The objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner (UNFCCC, 1992).

The Convention was subsequently complemented by the Kyoto Protocol (the protocol was debated in Kyoto, Japan in December 1997, the agreement entered into force on 16 February 2005, signed by 141 countries worldwide).

At present, the current Paris Agreement - a global agreement on climate change - has made several years of efforts by the various countries' policies to reach an international agreement on tackling adaptation to climate change. The Paris Agreement was adopted at the Conference of the Parties of the UN Framework Convention on Climate Change in Paris and is the basis for a successful global response to climate change. The agreement came into force worldwide on 4 November 2016 (Minister of the Environment of the Slovak Republic handed over to the UN depositary in New York the ratification letters of the Paris Climate Agreement on Slovakia and the European Union on 7 October 2016 after ratification was approved by the ministers of environment of the European Union in extraordinary negotiations and subsequently also by the European Parliament).

This agreement represents an action plan aimed at limiting global warming well below 2 °C. It covers the post-2020 period. The role of cities in fulfilling the obligations under the Paris Agreement will be crucial. The Paris Agreement deals not only with the issue of reducing greenhouse gas emissions but also with the importance of adapting the signatory countries to the already negative impacts of climate change.

The main elements of the Paris Agreement are:

– Long-term goal: governments have agreed to keep the global average temperature increase well below 2 °C compared to pre-industrial levels and continue efforts to reduce this increase to 1.5 °C
– Contributions: before and during the Paris conference, the countries submitted comprehensive national climate action plans aimed at reducing their emissions
– Ambitions: governments have agreed to report on their contributions every five years to set even more ambitious targets
– Transparency: in addition, they agreed to provide each other and the public with information on how they are progressing towards achieving their objectives in order to ensure transparency and supervision
– Solidarity: the EU and other developed countries will continue to provide financial assistance to climate action to help developing countries reduce emissions and build resistance to the effects of climate change.

By introducing these measures, carbon neutrality should be achieved, and therefore only so many greenhouse gases should be emitted, how much the Earth's ecosystem can handle without destructive manifestations.

For 185 countries, including Slovakia, the Paris Agreement means a phasing out of dependence on fossil fuels, increasing energy efficiency to 40% and speeding up the switch to renewable energy. In the Europe 2020 strategy (also known as the 20-20-20 Strategy), targets are set in particular to reduce primary energy consumption, greenhouse gas emissions by 20% and increase the use of renewable energy sources to 20% of the share of total energy consumption set by the year 2020. However, these challenging objectives will not be sufficient to meet the Paris Agreement if Article 7, which deals with adaptation to climate change, is not fully implemented. This article states that the parties set a global adaptation target such as increasing adaptive capacity, enhancing resilience and reducing climate vulnerability in order to contribute to sustainable development and ensure an adequate response in the context of the thermal target. In October 2015, the European Commission announced the new Covenant of Mayors for Climate and Energy Initiative, as a forefront of the UN Conference on Climate Change conference in Paris. This is a combination of two current initiatives:

– The Covenant of Mayors, which was adopted in 2008
– The Mayors Adapt, which was adopted in 2012, and commits the signatories to take concrete adaptation steps to the negative impacts of climate change on their territory.

The Covenant of Mayors for Climate and Energy includes the EU's 2030 goals and an integrated approach to adapting to and mitigating climate change. In June 2016, the European Commission and the UN Initiative joined together to create the "Global Covenant of Mayors for Climate and Energy". Cities and municipalities joining this joint initiative will commit to reducing CO2 emissions by at least 40% by 2030 compared to the reference year, increasing energy efficiency and renewable energy use by at least 27% and combining adaptation issues with the negative impacts of the climate change with the issues and mitigation targets outlined above. None of these ambitious targets will be met if it does not become part of the strategic documents (at the relevant hierarchical level) that are binding.

Case study: Action plan of Adaptation – Strategic Document

The capital of Slovakia, Bratislava, signed the accession documents of the European Commission's Initiative of the Covenant of Mayors in 2012. The accession of the city to this initiative was approved in April 2012 by the City Council Resolution no. 545/2012. By signing the agreement, the city has committed itself to developing and adopting an Action Plan to reduce emissions and greenhouse gases by 20% by 2020. "Action Plan of Adaptation to the Adverse Effects of Climate Change on the Capital of the Slovak Republic of Bratislava for the Years 2017-2020" (Action Plan of Adaptation) follows the Strategy of Adaptation to the Adverse Effects of Climate Change on the Territory of the Capital City of Bratislava (2014). The Action Plan of Adaptation is based on the vision of active cooperation between the capital city of Bratislava, municipalities, external partners and residents in the implementation of the necessary adaptation and mitigation measures to eliminate the negative impacts of climate change. For the creation of environmental policies and strategies, the cooperation of various stakeholders is crucial.

The Action Plan of Adaptation for the territory of Bratislava was elaborated within the project "Bratislava is preparing for climate change – the pilot application of the measures in the field of the sustainable rainwater management in urban area" supported by the European Environmental Agency and Norwegian financial mechanism. Within this project, selected adaptation measures were implemented between 2014 and 2017 such as increasing the share of vegetation areas, ensuring the accessibility of public green areas, realizing vegetation roofs and creating water-sloping elements.

Action Plan of Adaptation – A tool to increase the city's resilience to the adverse impacts of climate change

The Action Plan of Adaptation is a document that helps to meet the main goal of the Adaptation Strategy, which is "ensure that the capital of the Slovak Republic, Bratislava is protected against the increased risk of climate change impacts by appropriate adaptation measures, to increase the city's resilience to the expected challenges of further development of the society and provide the necessary information and tools to facilitate the entire decision-making and management process of the city."

The idea of the action plan is based on the 16 strategic adaptation measures defined in the Adaptation Strategy. When drawing up the Action Plan of Adaptation, these measures were assigned to the thematic strategic objectives and thus formed the basic structure of the design part of the document. Each measure includes:

– The strategic objective for adaptation to climate change;

– Sectors (areas) relevant for urban development and adaptation to climate change;

– Expected date of completion of the task;

– Responsible supervisor and co-operating subjects for each measure;

– Form of financial security of the measure (from the city budget, external sources, no expenditure);

– Measurable indicators (to assess performance of tasks and measures).

The set of strategic measures should be progressively implemented in three time horizons:

– Short-term measures over a 1 to 3 year time horizon;

– Medium-term measures over a 3 to 5-year period;

– Long-term measures over a time horizon of 5 years or more.

Preparation and processing of the Action Plan of Adaptation to the expected climate change was directed and covered by the Chief City Architect Office of the City of Bratislava. The working team was composed of representatives of: a) department of the municipality; B) the boroughs of the City of Bratislava; C) municipal enterprises of the City of Bratislava; D) the academic sphere (Faculty of Natural Sciences, Comenius University in Bratislava); E) non-governmental organizations.

The Action Plan of Adaptation was commented on in three rounds. The comments were always summarized, discussed subsequently, and, if relevant, they were added to the Action Plan of Adaptation. To meet the above-mentioned goal of the Adaptation Strategy, the strategic objectives in the Action Plan of Adaptation are identified as being achievable through the implementation of the different actions proposed under the measures:

Strategic objective 1: Evaluation of the climate change restoration – The aim is to identify different degrees of threats to urban areas, assess the vulnerability of critical infrastructures to the expected impacts of climate change within selected sectors, and identify appropriate adaptation measures.

Strategic objective 2: Adaptation to climate change and local policy – The capital city of the Slovak Republic, Bratislava has the possibility to objectively mitigate the adverse impacts of climate change taking into account the requirements of adaptation to climate change in spatial planning activity (in the form of changes to the Land use Plan of the city), in the decision-making and approval procedures of local policies and regulations of the City of Bratislava and its boroughs.

Strategic objective 3: Climate neutral city – Measures to achieve this strategic objective are geared, in particular, to ensuring the necessary adaptation and mitigation measures linked to the protection, modernization and strengthening of existing systems.

Strategic objective 4: Awareness – information sharing – participation – cooperation – The aim will be to implement "soft" adaptation measures that would contribute to raising knowledge and awareness of the impact of climate change on the public and professionals. These also include institutional capacity-building measures that support adaptation measures that affect the overall organizational performance of the city, its boroughs and its functioning (competencies) as well as the use of the expertise potential of the city and its boroughs.

Strategic objective 5: Evaluation of progress in climate change adaptation – It is necessary to evaluate the progress made in meeting the strategic objectives of the Action Plan of Adaptation with time. To this end, a working group consisting of representatives of the city, municipalities, the Bratislava Self-Governing Region research organizations, local communities, non - governmental organizations, partner city organizations and other stakeholders involved in the implementation of the strategic objectives of the Action Plan of Adaptation in the City of Bratislava.

Measures need to be implemented in parallel in a number of sectors that are identified as important in terms of the current needs of urban development and adaptation to climate change.

The identified areas and sectors are as follows:

– Health and quality of life of the population;

– Green and blue Infrastructure;

– Urbanized environment;

– Rain water and water resources;

– Transportation;

– Energy.

The measures of the Action Plan of Adaptation can be divided into:

– Green and blue, or close to nature or ecosystem-based measures,

– Gray, i.e. technical or mitigation measures,

– Soft, i.e. in particular information and awareness-raising activities, planning activities, institutional changes, regulation, guidelines, subsidy policy, etc.

This strategic document contains specific measures, including the determination of responsibilities for the implementation of individual actions, the design of deadlines for the implementation of tasks, monitoring progress in the adaptation process, and also the possible sources of funding for the implementation of the proposed adaptation measures. The aim is to ensure, through adaptation measures, adequate quality of living and natural environment, protection of health and property and create long-term conditions for the quality of life of the inhabitants and visitors of the city.

The measures proposed in the Action Plan of Adaptation should effectively contribute to reducing the vulnerability and/or increasing the resilience of the city. Another benefit is building adaptive capacity, i.e. creating institutional and information support adaptation measures. Building capacities supporting adaptation measures at the institutional level focuses on the overall organizational performance of the city, boroughs and their functioning (competencies). The selection of appropriate adaptation measures and activities is based on assessing the vulnerability of the city to the adverse impacts of climate change (especially extreme weather events associated with heat waves or storm rainfall). As part of the Adaptation Strategy, the vulnerability of urban development, infrastructure and sectors to the expected impacts of climate change (ICLEI8) was determined.

Applied research on adaptation to climate change is continually advancing, resulting in the latest Intergovernmental Panel on Climate Change (IPCC9). World experts emphasize the need to move further from the vulnerability assessment of cities to identifying risks and determining their significance in terms of: 1) the probability of adverse effects of climate change, 2) their intensity, 3) the vulnerability of the city and 4) the exposure. These are also illustrated by the scheme in Figure 2. Risks that represent a climate change for a society not only in cities, are therefore directly proportional to the consequences and probability of occurrence and intensity of threats.

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CLIMATE CHANGE CONTEXT FOR THE CZECH REPUBLIC

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The Czech Republic is a nation state in Central Europe bordered by Germany, Austria, Slovakia and Poland. The Czech Republic covers an area of 78,866 square kilometres, with 10.5 million inhabitants and the capital city is Prague, with over 1.2 million residents. The Czech Republic includes the historical territories of Bohemia, Moravia, and south Silesia. The Czech landscape is exceedingly varied. Bohemia, to the west, consists of a basin drained by the Elbe and the Vltava rivers, surrounded by mostly low mountains, such as the Krkonoše range of the Sudetes. Moravia, the eastern part of the country, is also quite hilly. It is drained mainly by the Morava and Odra rivers.

The Czech Republic lies within the Atlantic-continental area of the moderate climate zone of the northern hemisphere. Average annual temperature fluctuates in relation to geographic factors between 1.1 and 9.7°C. Average spring and fall season temperature reaches 7 to 8 °C, during the summer the temperature rises to 16 or 17 °C; in winter the average is -1 °C. Changes in average annual temperature over the last 150 years indicate incremental rise in temperature; between 1861 and 1910 the average annual temperature reached 7.4 °C, between 1911 and 1960 also 7.4 °C while between 1961 and 2010 the average temperature rose to 7.7 °C (CHMI, 2017).

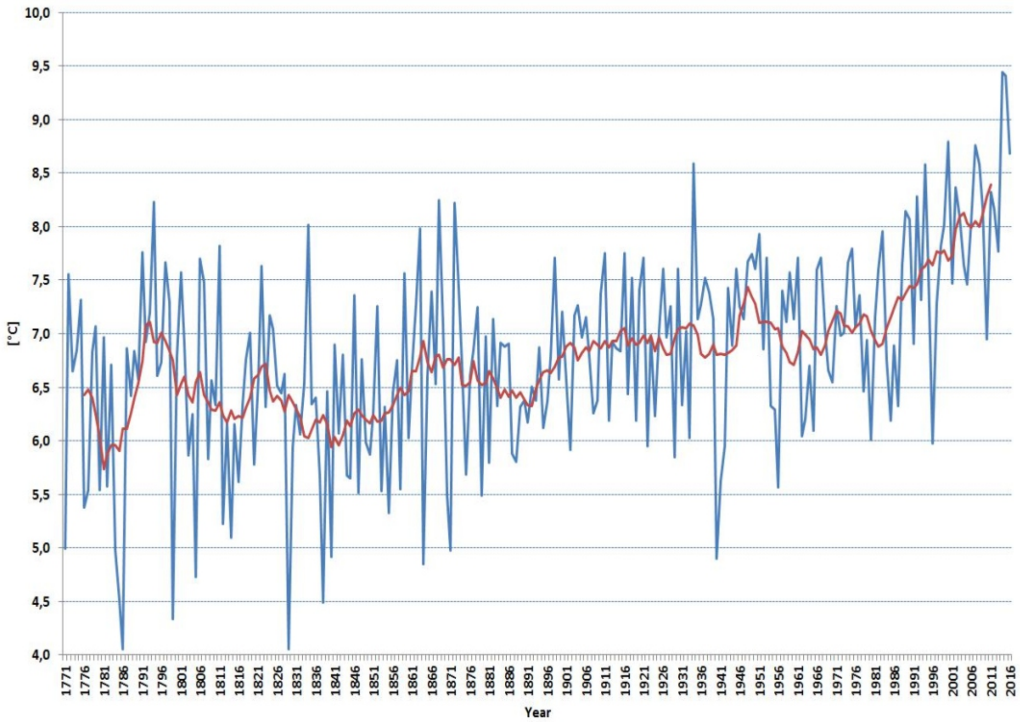

Fig 1Average annual air temperature (°C) in the period 1771-2016 for Czech Republic (Štipánek, 2005).
Legend: blue line - annual average temperatures; red line - 11-year moving average. Source: CHMI, 2017.

Regardless of considerable year-to-year fluctuations, there is an apparent trend of gradual rise in average annual temperature amounting to approximately 0.3 °C over 10 years. Average number of 1 days with extreme weather / temperature and their changes over decades demonstrate that over the last two decades there has been a marked increase of average number of days with high temperatures and reduction in the number of days with low temperature. Number of summer days during the year increased on average by 12 days, tropical days by 6 and conversely, number of freezing days dropped by 6 (CHMI, 2017).

Similar trends in precipitation development are not apparent. During the last two decades, there has been an indistinctive rise in annual precipitation amount. Decreases in the spring precipitation are balanced out by summer precipitation mainly in the form of rainstorms. Average annual precipitation between 1991 and 2010 was approximately 5% higher than between 1961 and 1990. Year-on-year variability in precipitation amount is high; for instance in 2002 we have recorded the third highest precipitation amount, but in the following year – 2003 – the annual precipitation was the second lowest in 136 years of calculated averages. Rainstorms became more numerous over the last two decades as well (CHMI, 2017).

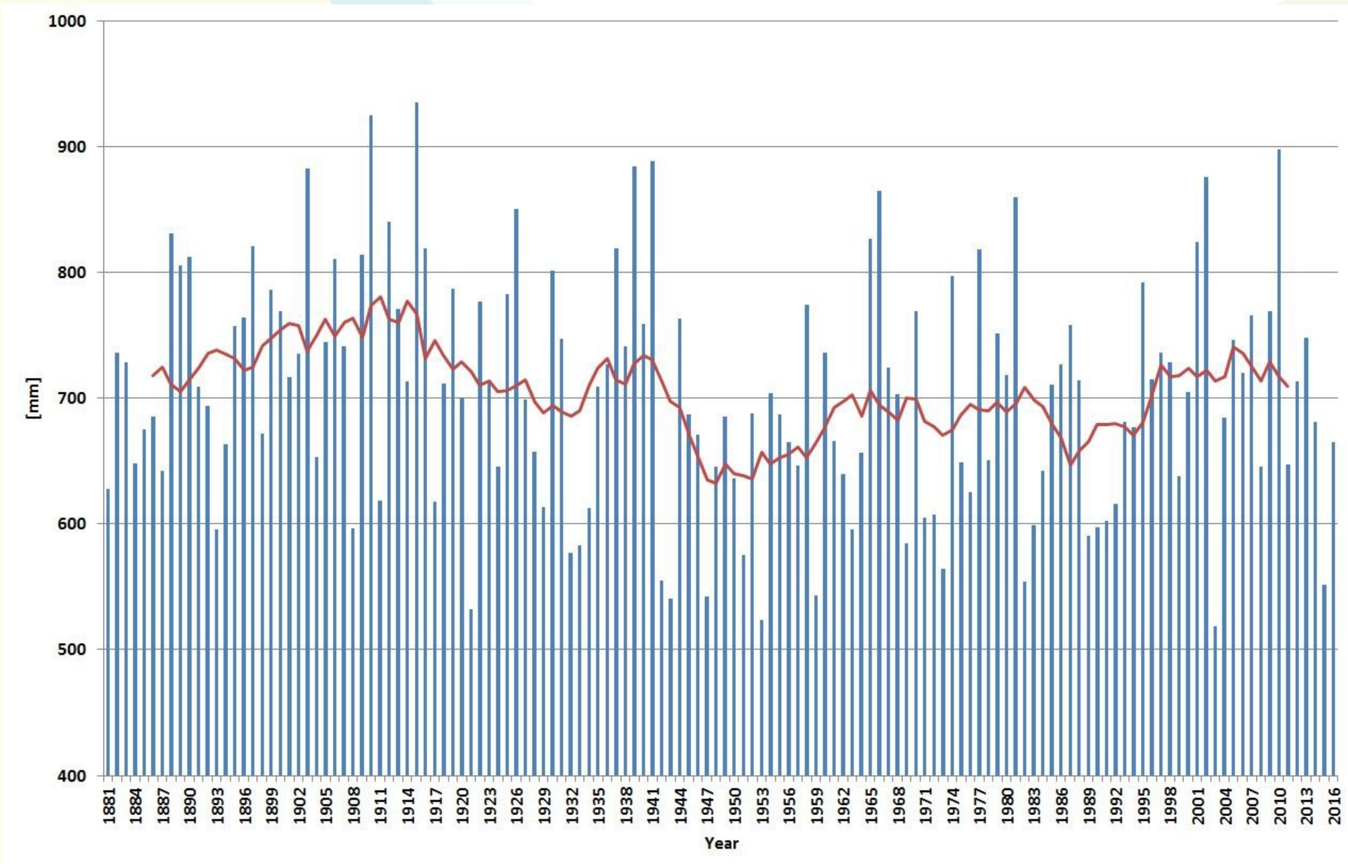

Fig 2The course of annual precipitation totals (mm) in the period 1881-2016 for Czech Republic. Legend: blue columns - annual average rainfall; red Line - 11-year moving average. Source: CHMI, 2017.

The main climate change challenge for Czech Republic is significantly increasing of temperature and moderately decreasing of precipitation resulting to lack of water in the country. The extreme weather is also noticeable.

1. Policies leading to emissions reduction

The human activities are impacting the climate system and United Nations and some of their agencies are coordinating the international cooperation leading to mitigation of climate change. Individual country is responsible for future global development of the Earth (NOAA, 2009). In the Czech Republic, there are several levels of measures used to reduce greenhouse gas emissions (strategic, legislative and programming). Since 2000, the Czech Republic has been implementing a system of strategic and operational planning, which is being continuously modified in line with the Czech international commitment arising from post-2012 process and EU policies and legislation.

The set of strategic instruments includes especially the following measures: Strategic Framework for Sustainable Development (adopted by the Czech Government in 2010), Strategy of the Regional Development for 2007 – 2013 and for 2014 – 2020 (approved by the Government in July 2013), National Programme To Abate the Climate Change Impacts in the Czech Republic, State Environmental Policy 2012-2020 and National Emission Reduction Programme. The ratification of Paris Agreement (http://unfccc.int/paris_agreement/items/9485.php) in Czech Republic is still ongoing. The responsibility for coordination of mitigation processes and for cooperation with United Nations Framework Convention on Climate Change (UNFCCC) belongs to Ministry of Environment (http://www.mzp.cz/en).

2. Adaptation measures

The Strategy on adaptation to climate change in the Czech Republic (Adaptation strategy) was adopted by the Czech Government on October 2015 (MZP, 2015). The Strategy creates a framework for coordination of adaptation measures for a number of sectors. The aim of the Strategy is to mitigate the impacts of climate change by adapting to this change and to preserve and potentially improve the economic potential for future generations. Adaptation strategy of the Czech Republic:

- comprehensively presents observed climate change, projections of further developments and expected impacts;
- identifies the priority areas of the economy, public administration and the environment in relation to the sectors and identifies the priority areas for implementation;
- defines appropriate adaptation measures in response to projected climate change outcomes;
- identifies the obstacles preventing the implementation of adaptation measures to the extent necessary and with the desired effect and proposes ways to eliminate them;
- defines targeted research and analytical needs and
- identifies possible sources of funds.

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Adaptation to climate change should aim at climate - friendly sustainable development – the goal is preparedness for climate change. Since climate change is a dynamic process, the deadline for achieving the target state is not determined. The Adaptation Strategy of the Czech Republic is ready for 2015-2020 with a view to 2030 and will be implemented by the National Action Plan for Adaptation to Climate Change. The ongoing implementation of the Czech Republic's Adaptation strategy will be evaluated in 2019 and further every 4 years.

2.1. Water management

Water retention in the landscape achieved by optimising its structure and by utilization of effective and close-to-nature technical preventive measures forms a fundamental basis for protection against extreme hydrological events. River basin plans pursuant to the EU Water Directive, Adaptation measures supported by Operational Programme Environment in the area of Limiting risk of flood and Optimising the landscape water regime and Programme for restoration of natural landscape functions, focusing on water, forest and non-forest ecosystems. This includes revised River Basin Management Plans integrating Flood risk management plans, implementation of restoration and flood prevention measures that are close-to-nature on watercourses and floodplains within the next programming period of OPE in 2014-2020 and Rural Development Programme for 2014-2020.

2.2. Agriculture

Sustainable use of cropland (incl. protection against erosion and soil degradation, increased water retention in soil, maintaining soil fertility etc.) is the key precondition for adapting to climate change. Solutions should be based on the principles promoting sustainable farming and good agricultural practices.

2.3. Forest management

Adaptation measures will be implemented within the framework of the National Forestry Programme II as approved by the Czech Government Resolution No. 1221/2008. This mainly involves ensuring species, age and spatial diversity of forests, prioritizing natural recovery and stabilisation of carbon bound in forest ecosystem.

2.4. Biodiversity

The most important implemented or planned measures include: protection and restoration of interconnectedness and migration permeability of landscape, protection and improvement of protected and endangered species populations and key biotopes, increasing ecosystem capacity necessary for ensuring key services, measures leading to protection, restoration and improvement of ecosystems and natural areas, analysis of future impacts of climate change to individual species, ecosystem and biotopes, measures preventing and limiting dispersion of invasive alien species of plants and animals and their potential eradication.

2.5. Urbanized landscape

Adaptive measures in urbanized landscape are implemented in connection to and following onto water management measures. Additional measures are being supported especially via Spatial Development Policy of the Czech Republic, which defines territorial planning priorities in order to ensure sustainable development of the territory, which supports restoration of close-to-nature vegetation within urban areas.

2.6. Health and hygiene

Policies and measures in the healthcare sector include: monitoring of pathogens and distribution of information to clinical and laboratory experts, research into zoonotic contagion cycles with emphasis on changes in vector and reservoir animal ecology, identification of risk areas, seasonal changes and groups of population which is especially vulnerable to risk factors, whether of contagious or non-contagious nature and preparation of early-warning system, raising awareness about healthcare within the public.

2.7. Crisis situations, protection of population and the environment

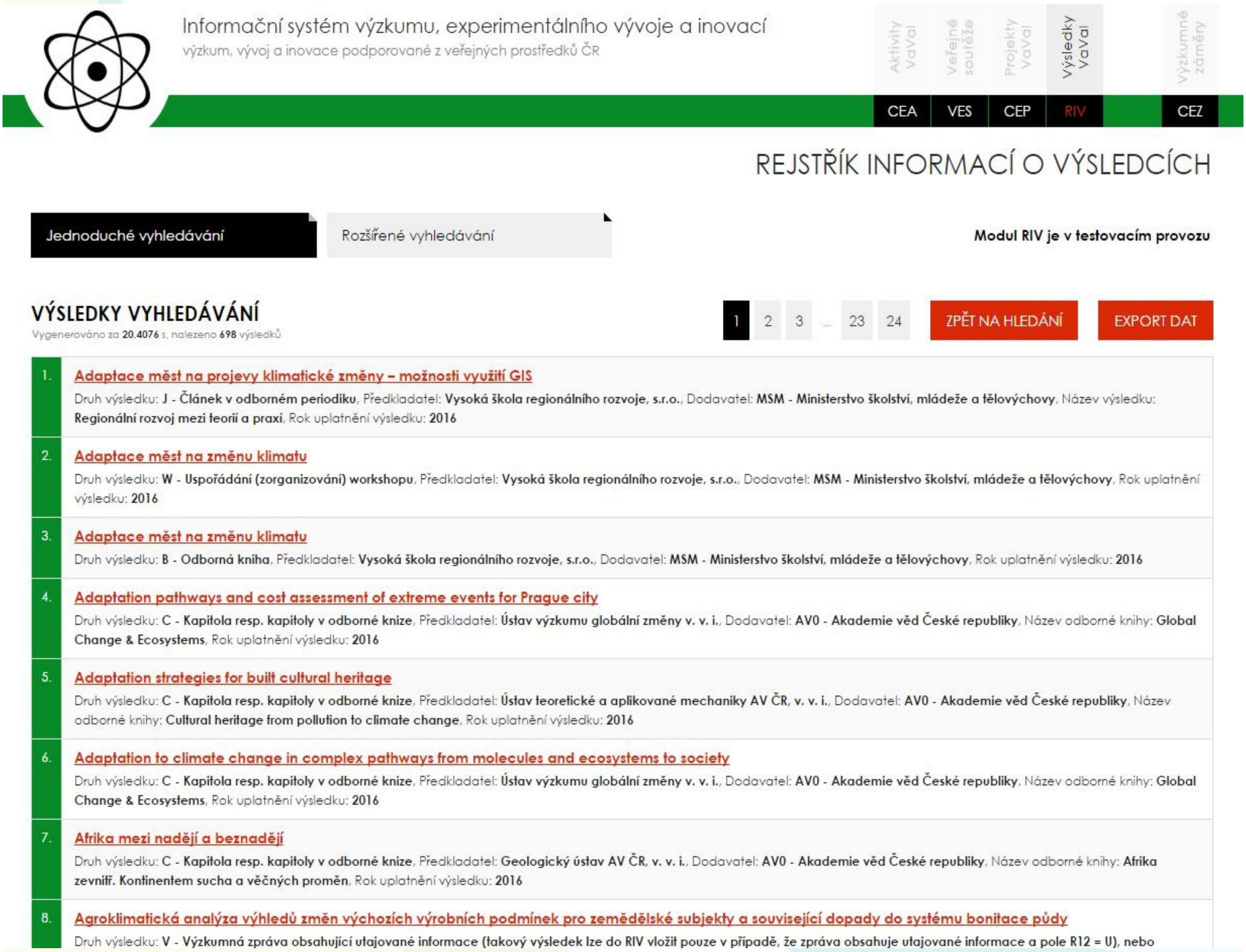
Measures in this particular sector include: development and further strengthening of Integrated rescue system (IRS), which ensures coordinated actions of all its units (Fire Rescue and fire protection units, Police and emergency services), protection of critical infrastructure (protection of information and energy infrastructure, crisis management), environmental security, including crisis management for drought, flood, forest fire situations, improved meteorological and hydro-meteorological services, monitoring and crisis management in areas at risk of landslides, or taking landslides into account in spatial planning. The CHMI is responsible for Early Warning System and for cooperation with European Warning System (METEOALARM, www.meteoalarm.eu/index.php?lang=en_UK). This system includes forecast warning information on 26 dangerous phenomena and each phenomenon is awarded a danger level (low, medium, extreme). Crisis situations often follow natural hazards like, in Czech Republic, floods and droughts. The Czech Republic is a part of European office of United Nations Office for Disaster Risk Reduction (UNISDR, www.unisdr.org).

3. Research

The objective of the research is to contribute to the knowledge of the causes and effects, size and time of climate change factors and their sectoral, economic and social impacts. Attention is also given to international cooperation, respectively exchange of scientific, technical and socio-economic information. Research into current state and development of the global climate system as well as regional climate is focused especially in the following institutions: Environmental Committee of the Academy of Sciences of the Czech Republic (AS CR), National forestry committee, Research institutes of AS CR (Global Change Research Institute; Institute of Atmospheric Physics; Geophysical Institute; The Institute of Hydrodynamics; Institute of Systems Biology and Ecology; Institute of Geology), University departments (Faculty of Mathematics and Physics, Charles University in Prague; Faculty of Science, Masaryk University; Faculty of Science, Charles University in Prague; University of South Bohemia in Èeské Budìjovice; the Mendel University in Brno), sectoral institutes (Czech Hydrometeorological Institute CHMI; National Institute of Public Health; the T.G. Masaryk Water Research Institute; Czech Geological Survey) and other research institutes (Crop Research Institute; Research Institute of Agricultural Engineering; Research Institute of Ameliorations and Soil Conservation; etc.). Some of these institutes are members of or are represented in the National Climate Programme of the Czech Republic, which is an association of legal persons entrusted, amongst other things, with performance at a national level of the tasks of the World Climate Research Programme and Global Observing System of the World Meteorological Organization (WMO, 2013), creation of research teams of scientists in the area of the climate in the Czech Republic and publication of the results obtained.

The research, which is part of the basic tasks of the individual institutions, is financed both from their budgets and also through the Czech grant agencies and the Academy of Sciences of the Czech Republic or grant projects announced by the Ministry of the Environment and Ministry of Agriculture. Some projects are carried out in the framework of international cooperation and co-financed by foreign partners. Both research and cooperation are usually based on the projects. The Czech government operates the special Registry for projects and their outputs (www.rvvi.cz). The user may obtain the list of projects (Fig 3) or list of publications valid to defined part of science, for example for climate change, for adaptation, etc.

Since 2011 the 698 projects involved in research, development and innovations which were connected with climate change (Fig 3). Projects were focused on development of climate scenarios for the Czech Republic, evaluation of water management vulnerabilities, including supply of drinking water, statistical assessments of the probabilities of climate extremes, variability of agricultural production, food security and development of new low-carbon technologies.



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1 2 3 ... 23 24 ZPĚT NA HLEDÁNÍ EXPORT DAT

1. Adaptace měst na projevy klimatické změny – možnosti využití GIS
Druh výsledku: J - Článek v odborném periodiku, Předkladatel: Vysoká škola regionálního rozvoje, s.r.o., Dodavatel: MSM - Ministerstvo školství, mládeže a tělovýchovy, Název výsledku: Regionální rozvoj mezi teorií a praxí, Rok uplatnění výsledku: 2016

2. Adaptace měst na změnu klimatu
Druh výsledku: W - Uspořádání (zorganizování) workshopu, Předkladatel: Vysoká škola regionálního rozvoje, s.r.o., Dodavatel: MSM - Ministerstvo školství, mládeže a tělovýchovy, Rok uplatnění výsledku: 2016

3. Adaptace měst na změnu klimatu
Druh výsledku: B - Odborná kniha, Předkladatel: Vysoká škola regionálního rozvoje, s.r.o., Dodavatel: MSM - Ministerstvo školství, mládeže a tělovýchovy, Rok uplatnění výsledku: 2016

4. Adaptation pathways and cost assessment of extreme events for Prague city
Druh výsledku: C - Kapitola resp. kapitoly v odborné knize, Předkladatel: Ústav výzkumu globální změny v. v. i., Dodavatel: AV0 - Akademie věd České republiky, Název odborné knihy: Global Change & Ecosystems, Rok uplatnění výsledku: 2016

5. Adaptation strategies for built cultural heritage
Druh výsledku: C - Kapitola resp. kapitoly v odborné knize, Předkladatel: Ústav teoretické a aplikované mechaniky AV ČR, v. v. i., Dodavatel: AV0 - Akademie věd České republiky, Název odborné knihy: Cultural heritage from pollution to climate change, Rok uplatnění výsledku: 2016

6. Adaptation to climate change in complex pathways from molecules and ecosystems to society
Druh výsledku: C - Kapitola resp. kapitoly v odborné knize, Předkladatel: Ústav výzkumu globální změny v. v. i., Dodavatel: AV0 - Akademie věd České republiky, Název odborné knihy: Global Change & Ecosystems, Rok uplatnění výsledku: 2016

7. Afrika mezi nadějí a beznadějí
Druh výsledku: C - Kapitola resp. kapitoly v odborné knize, Předkladatel: Geologický ústav AV ČR, v. v. i., Dodavatel: AV0 - Akademie věd České republiky, Název odborné knihy: Afrika zevnitř. Kontinentem sucha a věčných proměn, Rok uplatnění výsledku: 2016

8. Agroklimatická analýza výhledů změn výchozích výrobních podmínek pro zemědělské subjekty a související dopady do systému bonitace půdy
Druh výsledku: V - Výzkumná zpráva obsahující utajované informace (takový výsledek lze do RIV vložit pouze v případě, že zpráva obsahuje utajované informace a pole R12 = U), nebo

Fig 3The example of project registry of Czech government

4. Systematic observation

Systematic observation of the climate system is carried out mostly by the CHMI (CHMI, 2017) which performs the function of a State institute for the area of air quality protection, hydrology, water quality, climatology and meteorology, with a competence to establish and operate State monitoring and observation networks, including international data exchange pursuant to the WMO principles. Its activities also encompass establishment of a state monitoring and observation network for monitoring the quantitative and qualitative condition of the atmosphere and hydrosphere and the causes leading to their pollution and damaging, processing of the results of the observations, measurements and monitoring while complying with the principles of the legislation of the European Communities, creation and administration of databases for the field and provision of up-to-date information on the state of the atmosphere and hydrosphere, including forecasts and warnings relating to dangerous hydrometeorological phenomena and to extreme weather.

A good database and its administration form the fundamental basis for all activities connected with protection of the climate of the Earth. The developed countries, including the Czech Republic, are working on development and improvement of modern databases, permitting integration of the available methods of observation and their coordination with similar activities on an international scale. The climatological database application CLIDATA was created through cooperation between CHMI and ATACO ltd. in Ostrava and has been highly praised by WMO. The Czech CLIDATA system is based on the modern Oracle database environment. It enables to users easy transition from older database systems, especially the internationally used CLICOM system. Work with the CLIDATA system is uncomplicated and comprehensible, but is protected against unauthorized access both to the application and to the data. One of the main objectives in creating this system was maximum safeguarding of information contained in the database. It allows connection of the database with the geographic information system (GIS) and this connection can also be used to control data for other applications. The CLIDATA programme system was developed so as to enable simple creation of language mutations.

Other institutions carry out monitoring for their own needs, usually for a limited period of a certain project. In addition to participation in the activities of the WMO and UN Environmental Programme (UNEP), the Czech Republic cooperates on a number of international projects concerned with the climate. The most important in this respect is participation in the RC LACE project (the ARPEGE- CLIMAT model). Recently, participation of the Czech Republic in international projects concerned with modelling the climate system and estimation of the impacts of climate change has expanded substantially. The Czech Republic for example participates in the Intergovernmental Panel on Climate Change (IPCC), the World Climate Programme (WCP WMO), the International Geosphere-Biosphere Programme (IGBP) and the Global Climate Observing

System (GCOS WMO). The cooperation is mainly based on data delivery to relevant databases and international exchanges. The Czech Republic regularly provides assistance to developing countries in the area of training courses, and assistance in installation and calibration of instruments (e.g. monitoring of the ozone layer, etc.).

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