Agenda 2030 and Settlement Adaptation to Climate Change Impacts

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Abstract: - Adopted by the UN member states in 2015, the Sustainable Development Agenda 2030 is detailed into 17 Sustainable Development Goals. It was the first time that the UN and the international community had generally recognised the key role of municipalities for development. The development agenda is to address issues that are primarily local problems that cannot be resolved without local government participating. It is towns and cities that are the bodies that have the means and the skills to improve administration and plan for and implement solutions locally. Towns and communities are targeted primarily in Goal 11 'Make cities and human settlements inclusive, safe, resilient and sustainable', which is comprised of a range of secondary targets and tasks including mitigating climate change impacts, adapting settlements to climate change impacts and reducing disaster risk. Complex strategies of municipalities adapting to climate change impacts will be demonstrated on an example of a city and two towns in the Czech Republic: Hradec Králové, Žďár nad Sázavou and Dobruška.

Key-Words: - Agenda2030, SDG goals, Sustainable Cities, Climate change, Strategies of municipalities adapting to climate change, Czech Republic

1 Introduction

The 2030 Sustainable Development Agenda (the 2030 Agenda), detailed into 17 Sustainable Development Goals, was adopted by the UN member states in September 2015. The Agenda's purpose is to ensure a life of dignity for all, which can only be achieved if all the development problems are addressed comprehensively because they are all interrelated. The 2030 Agenda places emphasis on a pro-active involvement of the developed countries, including the Czech Republic. [8] The 2030 Agenda is detailed into seventeen Sustainable Development Goals – SDGs – that have defined a new development framework for 2015–2030.

In this Agenda it is the first time that the UN and the international community have generally recognised the key role of municipalities for development. The development agenda is expected to address issues that are primarily local problems that cannot be resolved without local government participating. It is towns and cities that are the bodies that have the means and the skills to improve administration and plan for and implement solutions locally. [5]

Towns and communities are targeted primarily in Goal 11 'Make cities and human settlements inclusive, safe, resilient and sustainable'.

This goal is detailed into the following ten secondary targets and tasks:

1. By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums.
2. By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.
3. By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.
4. Strengthen efforts to protect and safeguard the world's cultural and natural heritage.
5. By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.
6. By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
7. By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities.

8. Support positive economic, social and environmental links between urban, per-urban and rural areas by strengthening national and regional development planning.

9. By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015–2030, holistic disaster risk management at all levels.

Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials. [8]

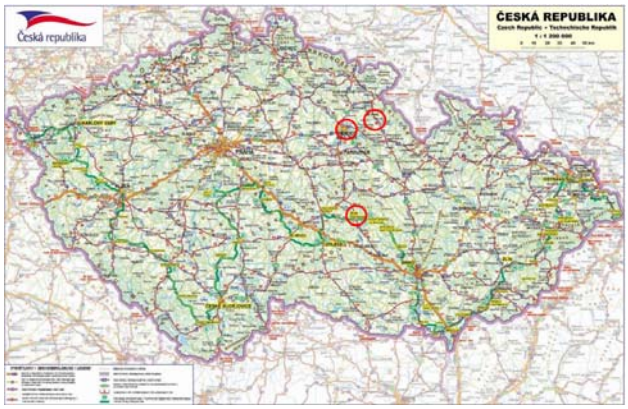
This clearly shows that all these targets are relevant to cities and communities in the Czech Republic.

Two indicators are attached to Goal 11: indicator 11.1 *Air Pollution* and indicator 11.2 *Number of Residential Rooms*. The first indicator provides information on air pollution and the potential adverse impacts on a population's health as a result of dust (particle) pollutants and shows the portion of population exposed to PM2.5 concentrations exceeding the limit. The second indicator shows the risk of overcrowding by giving information on the number of residential rooms per a single person and the residential space available to people. [1]

2 This Paper's Purpose and Methodology

As the overall agenda for Goal 11 is very extensive, this paper will only address some selected and topical aspects, namely Target 9, which expresses the need to add to the number of the cities and communities that adopt and implement integrated policies and plans supporting inclusion, the effective utilisation of resources, adaptation to the climate change and the mitigation of its impacts, disaster resilience, and the preparation and implementation of comprehensive disaster risk management. This paper will deal with the issues connected with preparing and implementing strategies of adapting to climate change impacts. This paper is based on the authors' knowledge and experience from three case studies – three strategies for three municipalities of different sizes and geography: Hradec Králové (a large city in a plain along a large river); Žďár nad Sázavou (a medium-sized highland town on a medium-sized river); and Dobruška (a small foothills town on a small river with flow rates influenced by the near mountain range), and **wishes to present the basic general methodology approach for cities and communities to preparing and a comprehensive strategy of climate change impacts adaptation.** Therefore, the methodology framework of this paper is take the field data, analyse them in respect of each study, and make a synthesis leading to a generally applicable methodology for cities and communities.

Fig. 1. Geographical Positions of Case Study Communities



Source: Authors' Drawing into Basic Map

3 Methodology Procedure – Steps to Preparing a Settlement's Strategy of Climate Change Impacts Adaptation, or 11 Steps to Adaptation

If a city or community wishes to have a climate change impacts adaptation strategy, it should follow the steps described below. These steps are:

1 Initiate and build up a team;
2. Collect data and make a situational analysis;
3. Get the general public involved and make an opinion poll;
4. Make a SWOT analysis;
5. Evaluate the threats and vulnerabilities analysis (by employing a participative approach);
6. Choose and prioritise measures and tools;
7. Adaptation options;
8. Finalise measures;
9. Approve the adaptation strategy;
10. Implement the adaptation strategy – the action plan;
11. Monitor and update.

Each step will be described in more detail on the examples from the case studies of Hradec Králové, Žďár nad Sázavou and Dobruška.

3.1 Initiate and Build up a Team

The first step lies in that the persons in charge of the community formulate their initial declarations and the core of the implementation team is set up. In our case studies these persons were mayor, deputy mayors and selected stakeholders – central government and local government employees in charge of, or involved in, crisis management, planning or environmental protection, plus any related organisation such as the fire fighting rescue service, the police, the administrators of water mains and sewer systems, the administrator of water courses, public transport organisations, non-government non-profit organizations and other bodies. [3,7]

3.2 Collect Data and Make a Situational Analysis

A next step necessary for preparing the strategy is obtaining documents on the territory managed by the local government and using these materials for a situational analysis.

The principal and important documents that need to be obtained for local government are:

- Local land use plan
- Analytical land use planning documents for region
- Strategic local development plan
- Local socio-demographic analysis
- Population development outlook
- Community plan of local social services
- Regional land use development guidelines
- Analytical land use planning documents at regional level
- Regional crisis plan
- Local flood emergency plan
- Regional flood emergency plan
- Regional flood emergency plan
- Regional energy use strategy
- Environmental incident response plan
- Local energy use strategy
- Water supply and sewer system development plan
- Regional crisis plan
- Local crisis management map. [3]

The situational analysis should particularly focus on hydro-meteorological threats, which can be split into the following fundamental topics:

1.1. Water (basic data on precipitation, hydrographical system in the territory, water recipients, water bodies etc.)

1.1.1 Torrential rains and local rapid floods (potential risk of heavy torrential rains, and a risk of various types of natural floods in relation to the hydrographical system; sudden (rapid) thaws; ice blocks clogging up a water course; flood areas for Q5, Q20 and Q100 floods, whether officially declared or not)

1.1.2 Floods over an area caused by regional rains (existing flood control protection in addition to as stated above)

1.1.3 Hailstorm (average annual days of hailstorms; extreme hailstorms over a history of 5 years)

Findings obtained are shown in Figure 2.

Fig. 2. Dobruška Buildings Vulnerable to Floods

Source: [7] Dobruška local government data

1.2 Drought

1.2.1 Extreme (low) precipitation and drought (basic climatic data, total precipitation, dry spells, restricted use of drinking water), desiccation of water courses and bodies of water

Figure 3 shows a data example used for all the three case studies.

Fig. 3. Total Precipitations between 1 January and 13 July 2014 Compared against the Czech Republic's Long-term Average for 1961–2010

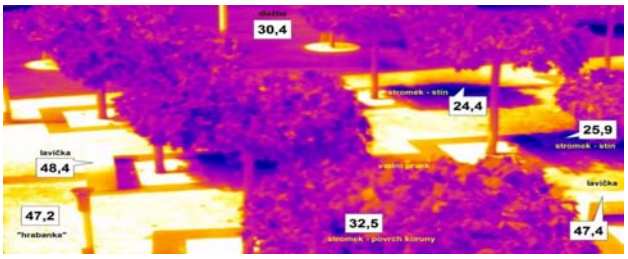
Source: [2,4,7] Intersucho data

1.3 Temperatures (climatic area, average annual air temperature over a reference period, average on annual maximum air temperatures, average on annual minimum air temperatures, average temperatures in the vegetation period, vegetation period duration)

1.3.1 Extremely high temperatures (over a long term) and urban heat islands (average number of tropical days/nights, occurrence of urban heat islands)

1.3.2 Extremely low temperatures (over a long term) – black frost (average number of days with frost, average number of arctic days)
Thermovision imaging was carried out in the situational analysis for Hradec Králové and the results are shown in Figure 4.

Fig. 4. Surface Temperatures in Riegrovo náměstí in Hradec Králové



Temperature 26 °C at 2 m above ground, date 19 Aug 2016, time 14.10

Source: [2] Hradec Králové Local Authority data

1.4 Snow and frost
1.4.1 Rime, glaze ice, black ice and snow calamity (number of days with snow cover, average date with first snow cover, maximum depth of snow cover)
1.5 Wind
1.5.1 Extreme wind: (strong) wind / tornado / hurricane / wind frost (most frequent directions of wind, high wind velocity)
1.5.2 Inversion, calm (inversion weather and extreme calm)

1.6 Storms
1.6.1 Storms/Lightning (average annual days with a storm, average number of sultry days).
In different settlements these hydrometeorological threats can generate additional related phenomena: geological (soil erosion by wind or water), hydrological (reduced capacity of water sources and shortage of water) and other phenomena. If it is established through the situational analysis that any of these threats is significant to a settlement, such a threat should be included in the evaluation.

3.3. Involvement of General Public and an Opinion Poll

A general public opinion poll should be carried out along with the situational analysis because preparing and implementing a strategy is impossible without an active involvement of the general public, in terms of an opinion poll, the sharing of the knowledge about the area, and the raising of awareness of the possible climate change impacts and the adaptation thereto.

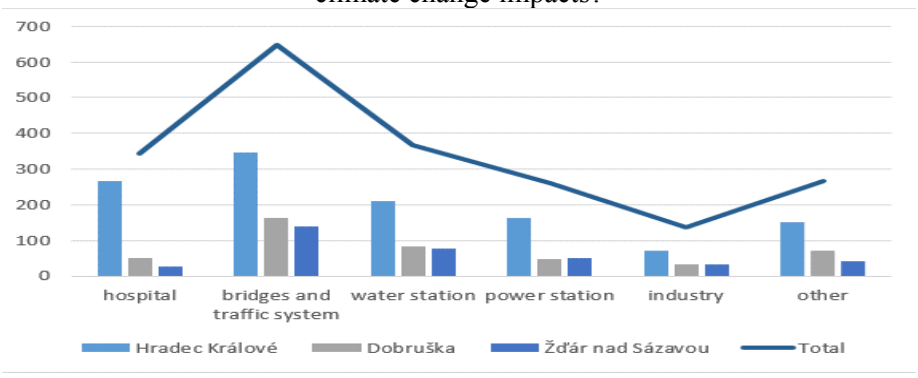
The responses obtained in the opinion poll should then be processed statistically as shown in the examples given below.

Table 1. Results of Opinion Poll in Dobruška

Question	YES	NO
Have you ever experienced any extreme weather related to climate change?	63%	37%
Do you believe that your town is currently exposed to any threat related to climate change?	23%	77%

Source: [8]

Fig. 5. Which locations in your town do you believe are the most vulnerable to a natural disaster related to climate change impacts?



Source: Authors' data

All the data obtained need to be assessed, as shown in the following step.

3.4. Making a SWOT Analysis

The method is based on classifying information into 4 basic groups listed above. The interactions between strengths, weaknesses, opportunities and threats can generate qualitatively new information that describes and assesses those interactions. SWOT analysis is normally structured into a matrix as shown below (using the data of the Dobruška case study):

Table 2. SWOT Analysis Example: Dobruška

Strengths	**Weaknesses**
-Detailed flood warning system in place. -No risk-posing structures that could be a hazard in the event of flood are situated in any flood district of any river on the territory of the town. ….	-Sewer system capacity not always sufficient to drain off torrential rain water (Javorová street, 1. máje street) -Municipal sewers tend to clog up; dirt on roads and other hard-surface areas
Opportunities	**Threats**
Completion of the Mělčany water work. Find locations for dry polders in the upper and middle segments of the Brtevský brook catchment area.	Torrential rains more frequent Mělčany water work fails to be completed. Recurrent floods on the River Dědina. …

Source: [7]

The situational analysis and the SWOT analysis results are then used to infer the types of threat seen as relevant for the city or community by local experts and stakeholders and desirable to be addressed by the implementation team.

Table 3. Example Using Data from the Dobruška Case Study

As Seen by Local Community
1. Torrential rains and local floods
2. Extremely low precipitation and drought
3. Extremely strong wind, tornado
4. Large-area (large river) floods
5. Extremely high temperatures and UHIs
6. Storms (lightning)

Source: [7]

3.5. Threats and Vulnerabilities Analysis Evaluation (by employing a participative approach)

The severity of threat scenarios and the vulnerabilities are the two components used in calculating the risk. Both components are assessed using a participative assessment, i.e. by involving an expert group. The overall severity of each threat scenario is the combination of the scenario's likelihood and five degrees of severity. Likelihood is assessed on the scale between 0 and 3, where 0 = none to very low likelihood and 3 = very high likelihood. Threat severity is assessed by assigning a score to five characteristics for each single threat scenario. No threat characteristics need to be specified for any scenario of *very low likelihood*. Threat characteristics are scored on the scale between 1 and 5, where 1 = low severity and 5 = high severity. Vulnerability is only assessed in those threat scenarios which are assessed as *severe* in the first round (threat severity). Each sector's vulnerability is assessed on the scale between 0 and 3, where: 0 = none to very low vulnerability; 1 = low vulnerability; 2 = high vulnerability; 3 = very high vulnerability. In this system the risk is a resultant of the severity of each threat scenario and the vulnerability to the scenario. [3]

Table 4. Sample Final List of Risks (Only 5 risks are considered in this sample.)

Risk	Score* Evaluator 1)	Score* Evaluator 2)	Score* Evaluator 3)	Total Score	Ranking
Extremely high temperatures (heat waves) and UHIs – longer than a week with Tmax > 30 °C (scenario E2; see attachment HODNOCENÍ.xlsx)	50	45	45	140	1. (R1)
Torrential rains and local floods – longer than 5 mins (scenario A2)	45	50	40	135	2. (R2)
Flood over a large area – Q100 (scenario B3)	35	40	50	125	3. (R3)
Hailstorm – hailstones > 2 cm in diameter (scenario C1)	40	30	35	105	4. (R4)
Rime and glaze ice – rime: YES (scenario G3)	30	35	30	95	5. (R5)

* Risks scored by each evaluator's score as given in their evaluator's sheets.

Source: [3]

The following table shows the results of a risk analysis for Dobruška done by experts.

Table 5. Example Using Data from the Dobruška Case Study

As Seen by Experts
1. Torrential rains and local floods
2. Extremely low precipitation and drought
3. Large-area (large river) floods
4. Extremely high temperatures and UHIs

Source: [7]

With a list of risks made for a city of community, measures and tools can then be defined for each risk.

3.6. Choosing and Prioritising Measures and Tool

Measures are divided by fundamental feature into:

- Grey (hard) – Approaches that cover physical measures and construction work, such as flood control walls, dikes and other structures.

- Ecosystemic – Approaches that strengthen ecosystem resilience in order to prevent any loss of biodiversity, ecosystem degradation and water cycle corruption. These further split into:
  - Green infrastructures – for example, green roofs (enhancing buildings' energy efficiency), green facades, greenery in public spaces and other measures; and
  - Blue infrastructure – for example, measures to improve water retention, terrain permeability in urban areas, and utilisation of stagnant and running water in urban areas.
- Soft measures – Those implementing an overall organisational approach to risks and risk management:
  - Preventive measures – awareness campaigns targeting the negative impacts of the climate change and the options for adaptation;
  - Crisis plans and early warning systems – preparing and updating crisis plans and warning the population about an imminent threat and providing instruction how to behave during the event;
  - Insurance – indemnity insurance in case of natural (hydrometeorological/climatic) disasters);
  - Stimulation tools – support of adaptation measures implementation. [3]

Databases and good practice examples can be used to suggest the most appropriate adaptation measures for the given city or community and create a strategy most beneficial for the given city or community as shown below.

3.7. Adaptation Options

Using the treats and risks analysed through the previous procedure, work continued to create a relevant adaptation strategy by discussing possible and appropriate adaptation measures. Analogously to threat significance evaluation, local stakeholders evaluated the significance of adaptation measures – the priority the local community attaches to an adaptation measure and how adaptation measures can be incorporated into local government policies. The outputs of the discussion about available measures are summed up in the following table created on a participative basis.

Table 6. Example of Prioritisation of Adaptation Measures for Torrential Rains and Local Floods in Dobruška

Adaptation Measure	**Significance/Priority** 1 = very significant, 2 = significant rather than insignificant 3 = neither significant nor insignificant, 4 = insignificant rather than significant 5 = insignificant	**Adaptation Measures Integration into Local Policies** 1 = integrated, 2 = planned to be integrated, 3 = not integrated, 4 = rejected, 5 = not considered at all
Allow for the risk in constructing buildings and infrastructure (design, documents)	3	1/ 3/ 5
Sewer system maintenance or improvement	1.5	1/ 2
Rain water drainage network independent of the sewer system	1.5	1/ 2
Construct temporary water reservoirs	3.5	2/3
Flood control barriers and dikes	1	1
Greenery infrastructure (parks, gardens, bodies of water, green roofs)	2	½
Support soil retention	2.5	1
Revitalise rivers, marshes and river banks	2	1/ 3
Maintain greenery outside the town (retention support)	2.5	1/3
Forecast and early warning system	2	1
Risk mapping, strategic planning and crisis management	1.5	1
Raise awareness and knowledge, encourage change in behaviour leading to damage minimisation	2	1

Source: [8]

3.8. Finalise Measures

The suggested measures need to be structured into a strategic map that classifies the measures by issue and priority.

Table 7. Adaptation Strategy Strategic Map as Demonstrated on High-priority Targets for Dobruška

Vision: Dobruška is a climate-change-adapted town with nice residential and natural environment; the risk of extreme weather impacts is minimised.			
Water Management Measures	**Extreme Temperature Elimination Measures**	**Drought Impact Elimination Measures**	**Extreme Wind Elimination Measures**
Flood control barriers and dikes	Heat insulation in buildings	Changes in the structure of greenery in and outside towns (preference of xerophilous varieties)	
Sewer system maintenance or improvement	Arrange for higher share of greenery	Adequate cost of water	
Rain water drainage network independent of the sewer system			
Risk mapping, strategic planning and crisis management			

Source: [7]

3.9. Approve the Adaptation Strategy

As the local government strategy for climate change adaptation (whether as a separate document or part of the local government strategic plan) exhibits features of a *local development programme*, the laws of the Czech Republic require that approval of such a document be reserved to local council.

3.10. Implement the Adaptation Strategy – Action Plan

If approved, the strategy should be implemented through an action plan, which is a precondition for implementing the targets defined. The action plan must specify the activities and the projects that the local government will implement or support in upcoming years. The following needs to be specified for each activity and project in the action plan: a person in charge of it (usually a member of the council board), overall completion date, the completion date for each stage if any, estimated cost, success indicators, the sources of the data for these, and an auxiliary document (if any) for the activity or project. Activities and projects should be divided by key development area in the manner as defined in the strategic plan. [3]

3.11. Monitor and Update

The phase of monitoring is to evaluate on an ongoing basis the progress in each adaptation strategy target and task and whether the activities carried out do lead to accomplishing the overall goal. Moreover, monitoring is to provide information on whether activities are carried out in accordance with the defined schedule and the expected cost.

The outputs of monitoring and evaluating the settlement's adaptation to climate change needs to be quantified. The quantified evaluation should specify the final deadlines for accomplishing the strategic goals and suggest indicators for monitoring the progress in these goals. The indicators provide information about the current development of the selected phenomenon by continuously monitoring, recording and evaluating a set of precisely defined data. [6] The table below demonstrates indicators appropriate for monitoring and evaluating wind and storms.

4 Conclusion

This methodology procedure verified through three case studies clearly demonstrates that it is possible to create a working strategy for climate change adaptation for small to medium-sized towns in the Czech Republic and even Central Europe and make a contribution to fulfilling the tasks and the goals defined in the 2030 Agenda that local governments face. Each step in the methodology allows for objective assessment and physical and geographical conditions as well as the condition of the city or community and its surroundings, and allows people – those active in public life – to get involved. Any success in creating and implementing a local adaptation strategy has two preconditions:

- Internal activity, that is, an ability to set up a properly working implementation team, take

action and start to adapt the community to the changed conditions; and
- Broader cooperation across the Czech Republic and internationally, which will bring benefit through sharing best practices and practical experience. However, no obsolete models and platforms, which have not been designed for this cooperation, should be employed.

This methodology can be useful wherever public life stakeholders show activity, and can provide them with tools to create a strategic document that, if drafted at least with average effort, will be dateless and really applicable in terms of further community development, and particularly the adaptation to the changed conditions related to the climate change. As some effects of the climate change cannot be predicted, it is especially necessary to enhance prevention and after-treatment in case the given crisis situation does occur.

Adaptation at the community level, that is, the adaptation of towns and cities to climate change effects, is the core. The tactics and the manner of adaptation are up to those who create the strategy.

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