



We have declared a climate emergency! What is next?

A guide for municipalities to plan for adaptation to climate change

Developed in the frame of the " Dialogue Climate Adaptation Berlin-Budapest " project

Imprint

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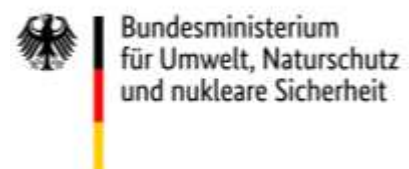




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1. Introduction

The aim of the guide is to present the specifics of the planning process adapting to climate change and to provide a practical assistance to leaders of municipalities and their professionals in planning the measures needed for adaptation in Hungary. This document is the translation of the original Hungarian guide. Annexes and literature not available in English are not presented in this document.

Climate change has serious consequences for human society and its well-being. These consequences need mitigation which require immediate action. On the one hand it is needed to mitigate to climate change by reducing greenhouse gas emissions and on the other hand, as change is already causing specific problems, learning to adapt to these new circumstances is of high priority. The “recipe” for reducing emissions in Hungary and in similarly developed countries in general is by greening energy production and by radical reduction of the energy consumption of buildings and transport.

The adaptation to climate change requires local responses: the problems to be faced depend to a large extent on local environmental, social, and economic conditions. **Increasing the adaptive capacity at the municipal level will play a key role in ensuring the smooth operation of settlements and the well-being of the local population in the near future.**

The **keyword of adaptation is vulnerability**, which means the tendency of a system to suffer damage. In the case of a settlement, several subsystems (e.g., different infrastructures, human health, etc.) need to be examined in order to get a clear picture of vulnerability.

For the preparation of this guide, the authors relied on the experiences gained during the elaboration of the adaptation concept and action plan for Budapest’s IX. district Ferencváros. It has been developed for the district in close cooperation with the municipality in 2019 and 2020 within the scope of the “Dialogue Climate Adaptation: Berlin - Budapest” project.



2. What to adapt to?

One of the greatest challenges of our time is climate change - a challenge that can be felt in almost every area of life. Greenhouse gas emissions resulting from human activity have increased at an unprecedented rate over the past century compared to pre- industrial times. Climate change is not a phenomenon that will not only be directly perceived by future generations, but its effect can also already be seen in the present in the form of extreme weather events such as long, dry periods, sudden rainfall, increasingly intolerable heat waves, floods, and flash floods.

In long term, the Carpathian Basin can be classified as a warmer region than the average. The 1.23 °C increase in the national average temperature since the beginning of the last century is already significantly higher than the estimated rate of global temperature change.

The distribution of precipitation within a year has also changed: there are fewer days of precipitation registered and the tendency to drought has increased. According to the data of the National Meteorological Service (OMSZ), **the changes affecting Hungary most are extreme temperatures - the number of heatwaves and days with frost - and the longer lasting drought periods experienced in all seasons.**

Based on the changes already identified - and until we can achieve considerable results in cutting emissions at the global level - we can expect changes and trends that we already observe to continue or even strengthen. This may also mean that events which have been considered extreme in the past 5-10 years may become more common. According to the Second National Climate Change Strategy (NÉS II), **"The expected development of extreme events will show a characteristic spatial distribution affecting more negatively the central, southern and eastern parts of Hungary, which calls attention to the importance of territorial vulnerability analysis."**¹

According to the Report on the Scientific Assessment of the Possible Effects of Climate Change on the Carpathian Basin, further temperature rise is expected in Hungary². Based on pessimistic scenarios, the average temperature may rise by 3.5-4.5 °C by the end of the century. This temperature rise of only a few degrees can result in significant changes in the frequency of rare, extreme events. **Extremely hot days and periods will become more frequent in the future, while the frequency of frosty days will clearly decrease. Not only the number of persistent heat waves, but also their average length and intensity will be increasing significantly."**



As adaptation to climate change requires local responses (the problems to be faced depend to a large extent on local environmental, social, and economic conditions), areas of intervention and needed actions to be taken should be determined not on the basis of national trends, but on the basis of local specificities.

¹ NES II: http://nakfo.mbfisz.gov.hu/sites/default/files/files/N%C3%89S_Ogy%20%C3%A1ltal%20elfogadott.PDF

² ITM, 2020

3. Planning for adaptation to climate change

3.1 Strategic level

The European Union is increasingly addressing the issue of climate change, planning to spend significant resources in 2021-2027 on realizing the vision of a greener, climate-friendly Europe. In 2021, the European Union will adopt a new adaptation strategy.

In Hungary, at the national level, the primary guiding and strategic document in the field of climate adaptation is the National Climate Change Strategy (NÉS-2), which identifies the most necessary measures in the field of adaptation. The Climate Change Action Plan contains the implementation framework. The National Clean Development Strategy, which is currently being developed and negotiated, also covers adaptation.

However, as adaptation to climate change requires local responses, a comprehensive program was launched in 2018 to support local municipalities in this regard under the Environment and Energy Efficiency Operational Program. The aim of the program was to support local municipalities in developing local climate strategies with a detailed methodology and financial resources.

If municipalities wish to prepare their settlements for the impacts of climate change, first a decision and a commitment are needed, then the preparation of strategic plans with a focus on climate change or adaptation to climate change can be initiated including targeted and necessary interventions. Strategic planning for climate change adaptation follows the same principles as other topics (broadly: situation analysis, setting goals, defining possibilities to action).

In Hungary, municipalities have the opportunity to develop local climate strategies based on national methodology provided by the Association of Climate Friendly Municipalities of Hungary, which devote a part to both, the situation analysis and the setting of goals and measures for climate adaptation.³ Another option is to develop a Sustainable Energy and Climate Action Plan (SECAP) based on the international methodology set by the EU Covenant of Mayors, which will address the issue of adaptation to climate change in addition to the measures needed to achieve the 40% reduction in GHG emissions by 2030.

	SECAP	Climate Strategy
Observed area	Public administration	Public administration
Methodology	International (CoM)	Hungarian
Topics	Reduction of emission, adaptation, energy poverty	Reduction of emission, adaptation, shaping attitude
Emission reduction target	40% by 2030 *	optional

* In 2021, in line with the EP decision of December 2020, the expected rate of emission reduction is expected to increase to 55% by 2030.

Table 1: Comparison of SECAP and Climate Strategy

³ <http://klimabarát.hu/tudastár>

Whichever methodology is used by a municipality to prepare its strategic document, it has the following additional benefits:

- Based on the collected data, rationalization, detection of errors and cost savings can be realized.
- The process of preparation can also be used for shaping attitudes and awareness, e.g., aimed towards the citizens or municipal colleagues.
- Opportunity to access targeted resources after 2021 - there is already a source of funding dedicated to municipalities where the existence of SECAP is a prerequisite.
- Joining the Covenant of Mayors opens the door to a much broader professional support and international cooperation.

3.2 Action planning

In Hungary, commitment to the topic and strategic planning have already taken place in many municipalities, but there are still very few examples of practical progress, especially in the field of adaptation. However, planning cannot stop at the level of strategy. According to its name, SECAP is an action plan, but in fact its level of elaboration – similar to the Hungarian climate strategy methodology – is not enough for the concrete implementation of the measures.

Figure 1 is showing the process from the strategic objective of action planning to its implementation.

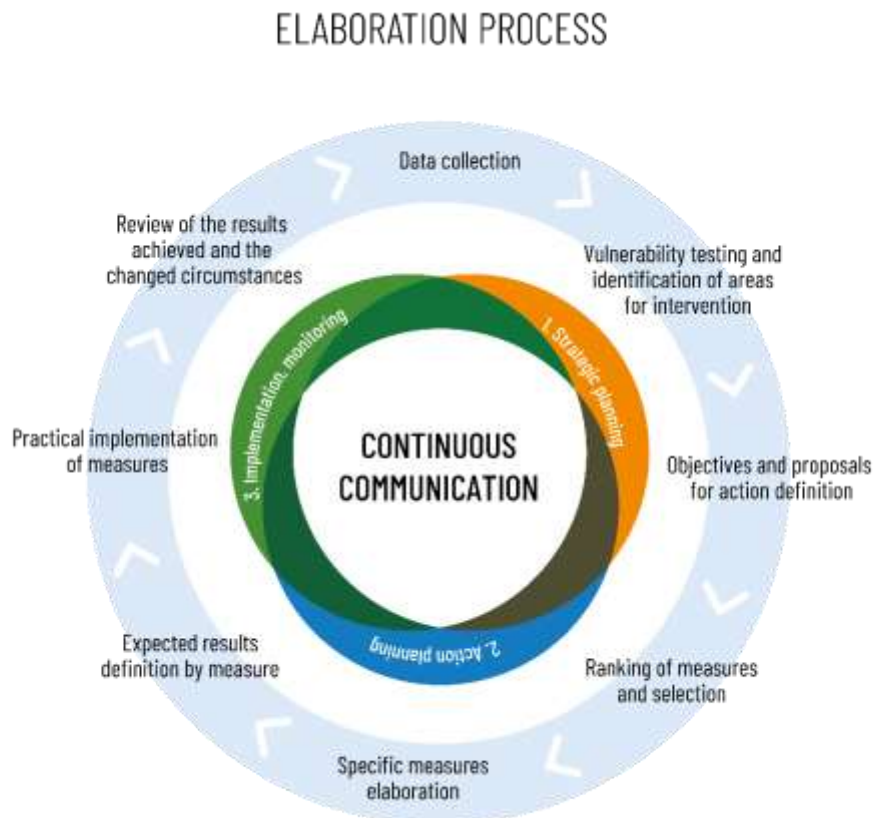


Figure 1: From strategy to implementation - the process of action planning (own edition)

The essence of the action planning is to define each measure to be implemented (possibly also each sub-topic of the implementation) in detail: exactly **how and what kind of steps should be taken by who** in order to achieve the goals of the implementation successfully.

The following factors have to be defined in the action plan:

- people, organizations to be involved in the implementation and their responsibilities,
- preconditions of implementation,
- concrete steps: what and how,
- the required time and schedule,
- costs and other resources required,
- related communication needs and possibilities as well as opportunities to involve the relevant target groups.

In the meantime, the goals set at the strategic level and the sub-goals to which the given measure contributes must be remembered sight.

In our experience, local decision-makers or professionals may not have a realistic picture of how long it takes to prepare a strategy or action plan. Figure 2. shows the ideal time frame (min. 9 months) for planning. However, this can be significantly prolonged, e.g., depending on the following factors:

- If there is no local expertise or capacity for planning and an external expert needs to be involved (this process usually takes 1-2 months). External experts may take more time to develop a realistic picture due to lack of local knowledge. Although it is useful to involve an unprejudiced professional with suitable knowledge in adaptation topics.
- Internal decision-making processes, competence issues can complicate and prolong the work.
- Difficulties in collecting data arise very often (a hindering particularity is that in Hungary, data owners often protect their data jealously instead of sharing large open-to-use data sets). Sometimes even the definition of the specific range of data needed is difficult.
- If there is a need for more detailed modelling for certain public spaces (see Chapter of Microclimatological Modelling), this will also extend the process by at least two months.

ELABORATION PROCESS TIMELINE



Figure 2: Minimum time required for the design process (own edition)

Strategies and plans completed in a shorter period of time will either require extraordinary capacities and resources or will not be qualitatively equivalent to materials produced through thorough planning.

Example of Ferencváros

The action plan for Ferencváros contains the details of three pre-selected measures. The following example - a table from the elaborated action plan, summarizing one of the measures selected - provides basic information for developing a heat emergency concept informing the public during heat waves. The detailed action plan also includes a map of public buildings in the district that could function as a "climate shelter".

Developing a heat emergency concept including an information system for the general public		HEAT WAVE
Aim of measure:		
Elaboration of a detailed heat plan which contains the concrete steps of intervention in case of extreme heat waves and UV radiation.		
Summary of measure and desired outcome(s)		
"Municipal UV and heat plan and heat alarm system development; including a system of connection with hospitals and general practitioners to maintain adequate capacity"		
<ul style="list-style-type: none"> • "Create a database of climate shelters for extreme heat waves and other extreme weather circumstances (e.g., shaded outdoor areas, cool (public) buildings with free access, public water fountains). Selection of suitable buildings. • Desired outcomes: <ul style="list-style-type: none"> ○ municipal heat emergency plan in line with the national heat emergency system ○ definition of "climate shelters", defining their different types ○ info map of climate shelters ○ communication plan to reach different target groups 		
Type of measure		Target groups
<ul style="list-style-type: none"> - regulation - awareness raising 		Direct: <ul style="list-style-type: none"> • vulnerable groups in the district (elderly, homeless, handicapped, children) Indirect: <ul style="list-style-type: none"> • Citizens of Budapest IX District and tourists
Stakeholders		
involved		Related responsibilities
<ol style="list-style-type: none"> 1 deputy mayor 2 environmental referent 3 National Center for Public Health 4 Heads of institutions in the district 		proposal submission, topic supervision, topic supervision, contact with stakeholders current standards, professional materials, elaboration and application of institutional heat plans
Steps required before implementation		Timeframe for implementation
<ul style="list-style-type: none"> • Appointing the responsible position of the municipality • contacting heads of institutions in the district • contacting the National Center for Public Health • developing a proposal for the panel 		<ul style="list-style-type: none"> • amendment of legislation - 1 year • development of a heat plan - 0,5 year • introductory information campaign- 0,5 year
Costs and other required resources		Related public communication and engagement processes
<ul style="list-style-type: none"> • involving an external expert • communication campaign • website development 		<ul style="list-style-type: none"> • informing about objectives • public forums and online surveys on the subject • consultation with institutional leaders • setting up working groups in the district

Table 2: Main information about the measure of developing a heat emergency concept

When developing the Action Plan, make sure you have:

- experts on board in the relevant fields (at least: social and health care, climate change, urban planning, water engineer, accredited green city planner etc.).
- if needed: delimitation of the part of the settlement affected by the action
- direct contacts to the competent authorities
- involvement of a communication expert



4. Let's get started!

In this chapter, practical support for the development of adaptation action plans in key areas that will determine the future success and effectiveness of the plan are provided.

4.1 Methods for setting up a vulnerability analysis

The vulnerability analysis is needed to reveal the weak points (vulnerabilities) where intervention is absolutely necessary in order to ensure that the well-being of the population and the operation of the settlement are not endangered by the effects of climate change. Vulnerability can be actively reduced by increasing adaptability, which is the focus of such plans (for example SECAP, and Climate Strategy) requiring a vulnerability study as basis. Vulnerabilities can be examined with a focus on society, economy, buildings, infrastructure, or organizational culture. In the case of settlements, all these systems need to be examined (at the local level).

Widely used methods can be divided into two main groups based on their approach. These are "top-down" and "bottom-up" approaches. To increase efficacy, or depending on the information available, it is common to use a combination of these two. The basic features of both approaches are briefly presented below.

"Top-down" approach		"Bottom-up" approach	
The study begins with climate change and its effects.		Work begins with the analysis of the target groups affected, by studying the factors which make people vulnerable.	
Mostly used in global, national, and regional studies.		The fundamental assumption is, that social groups are in varying degrees vulnerable to climate change.	
It is based on the results of simulation modelling.		Mostly used in local studies.	
Mainly uses quantitative data and scenarios for socio-economic processes.		Focuses on the current vulnerability rather than trying to estimate the future.	
It refers to future climate impacts from the current level of adaptability.		It is often used in developing countries, where large social groups are already exposed to climate change under the given circumstances.	
		Analyses are based on locally collected information / locally estimated / derived model results (e.g., weather, census data).	
STRENGTHS	WEAKNESSES	STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Possibility to show the direct effects of climate change on the biophysical environment. • Scientifically based analyses of climate impacts and their consequences (for example rainfall and field crop production) • Forecasts can also be produced for decades / centuries. • Can be paired with economic scenarios. • Suitable as a basis for international forecasts for a largescale area. 	<ul style="list-style-type: none"> • High degree of uncertainty in modelling procedures • Uncertainty about the future adaptability of society and economy • Less applicable at regional and local levels. • In most cases, it focuses on ecological conditions and less on social processes, as less information is available on the social processes. 	<ul style="list-style-type: none"> • Shows which social groups are at risk. • Shows the difference between social groups in terms of exposure. • It is made with the involvement of different representatives of society. • Small-scale, local reports can be generated. • Direct inputs for local decision making. 	<ul style="list-style-type: none"> • No conclusions for the wider environment can be drawn from the results of local analyses. • It represents present conditions, so it is difficult to draw conclusions about the expected vulnerability in the future. • In order to draw the right conclusions, special consideration must be given to a careful selection of appropriate interest groups and influencing factors.

Table 3: Comparison of the „Top-down“ and „Bottom-Up“ approaches



Figure 3: Top-down-approach - Climate change effects on the biophysical environment



Figure 4: Bottom-up-approach - climate change effects on society



4.3.1 Combination of approaches:

Top-down and bottom-up studies contain complementary information, so a combination of the two is often used to measure vulnerabilities. While the top-down approach focuses on the vulnerability of the physical environment and uses quantitative data, the bottom-up study analyses the vulnerability of social groups and their systems, relying primarily on qualitative information. These two approaches can complement each other well. In many cases lack of data makes it obvious to derive conclusions and forecasts from both in order to build a more complex picture when it comes to assess the vulnerability of a given area. Of course, both approaches require credible information. For the data and information collection, expert assistance is required.

Good examples of the top-down approach in Hungary are the first (2008) and second (2013) National Climate Change Strategies (NÉS) and the Budapest Climate Strategy (2018). The climate change trends and their socio-economic consequences presented in these documents may form the basis of smaller, e.g. settlement-level bottom-up studies, strategies and action plans.

One of the most important sources to create a complete picture of the situation is to channel local knowledge into the planning process. Possible ways to do this are:

- Questionnaires: these can be used primarily to enquire the population's attitude to climate change, and the problems and phenomena related to climate change perceived by locals. In addition, if it is a larger settlement with a larger number of scientific institutions, public institutions, significant companies, this method can be supplemented by a questionnaire amongst the listed actors.
- Workshops: the involvement of an adaptation expert is essential for their effectiveness, as without prior information, the participants (municipal professionals or other target groups to be involved) cannot link the topic of adaptation to their own field of expertise and are unable to contribute to the work. In about 1 hour, the topic can be introduced so that participants are able to point out local problems, give ideas for possible solutions and formulate priorities.

Of course, both approaches require credible information. Therefore, the collection of data requires expert assistance. The identification of factors related to climate change and vulnerability must be done with scientific thoroughness, otherwise false data may lead to misleading results.

Example of Ferencváros: area-based data collection

Within the framework of the “Dialogue Climate Adaptation Berlin-Budapest” project an on-line portal has been developed, where the public had the possibility to report problems related to climate change with precise locations on the following topics:

- heat
- storm
- flood
- flashflood
- inland water
- allergic plants
- other

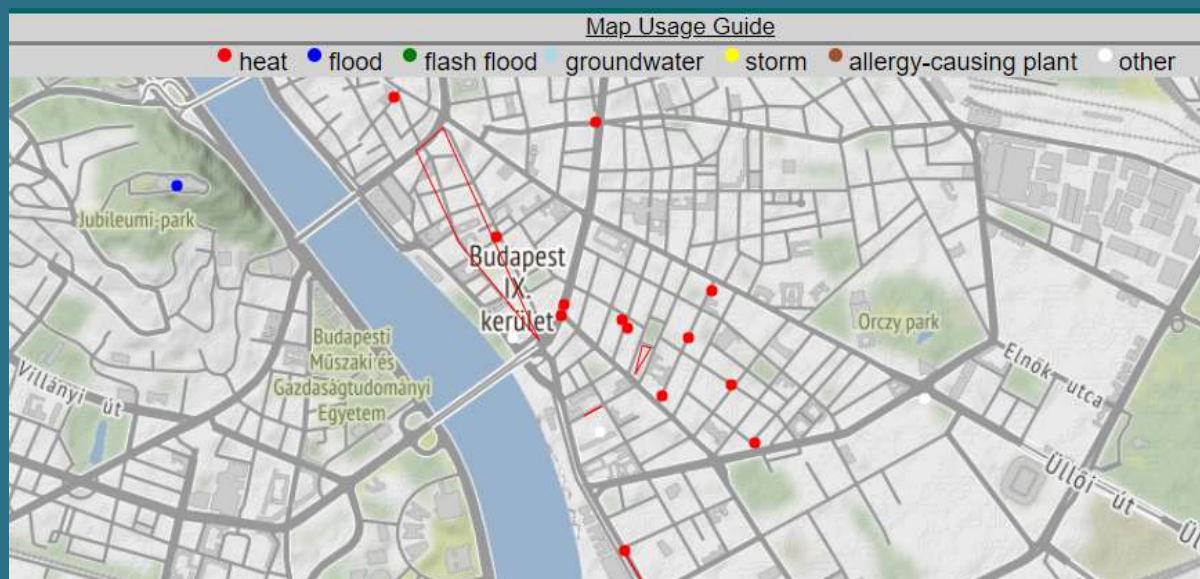


Figure 5: Image crop from <http://klimapanasz.online/en.html>

The given remarks log the extent and frequency of the adverse effects on these sectors/fields:

- buildings
- transport infrastructure
- public utilities
- human health
- natural habitats
- urban green spaces

The used system could record a solution proposal, too. The portal already operates in other areas besides Ferencváros.

The data collection took place in 2019 on a test basis. On one hand, the intention was to use the results to examine the vulnerability of Ferencváros as an input to the climate adaptation concept and action plan, and on the other hand, to raise awareness. The use of the portal further supported the knowledge-sharing and public engagement.

Substantial data collection requires continuous public communication, which must be undertaken by the municipality. Further, long-term operation and communication of such a portal can provide interesting and useful inputs when reviewing the climate strategy. (The portal works nationwide and abroad too, not only in Ferencváros.)

4.2 Data required for a vulnerability analysis and its possible sources

Based on experience, local governments lack basic data for accurate planning and modelling, for example the height of houses or an accurate vegetation cadastre.

Given that modelling is a rather complex topic with a wide range of data needs, in terms of access to data, data has to be **“acquired”**, **„collected”** or **“produced”**.

As a start, take a look at the basis of what the vulnerability itself consists of

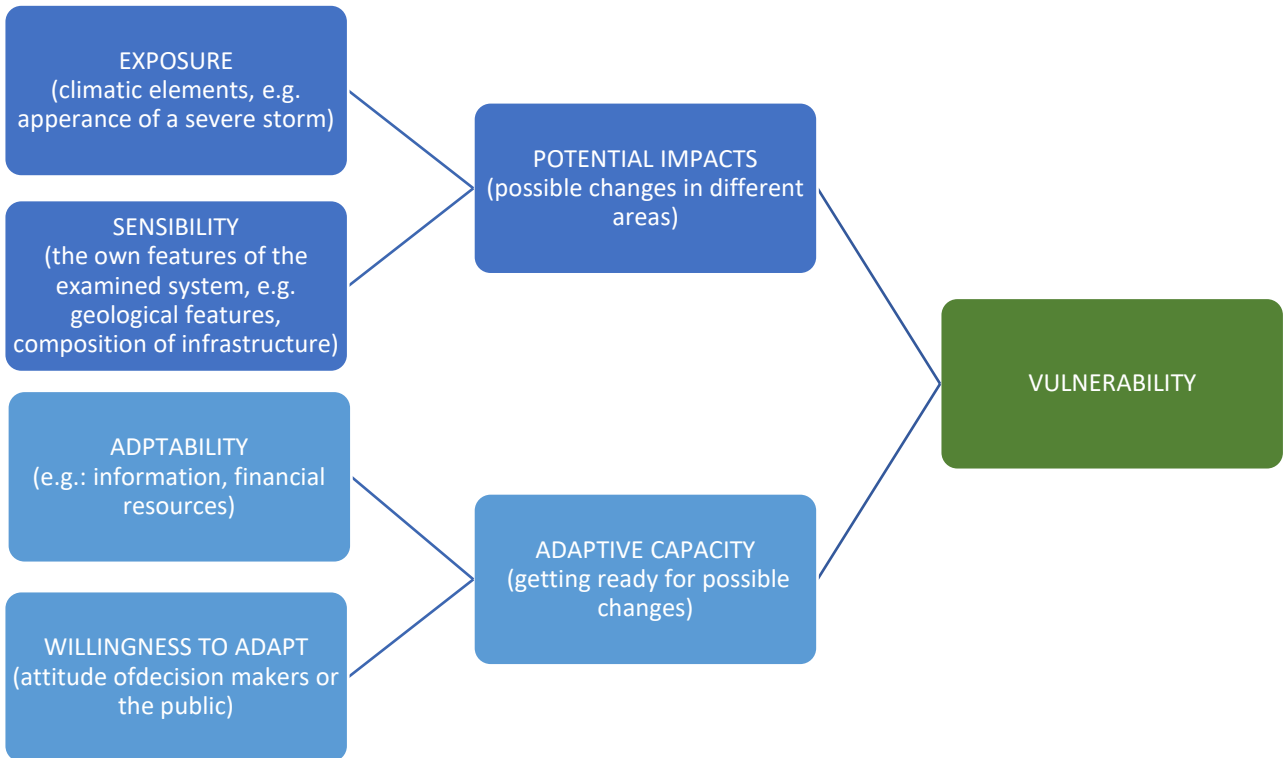


Figure 6: Factors influencing vulnerability
(own edition, based on the 'Adaptation to Climate Change at the Municipal Level' publication by Energiaklub, 2016)

Of the two components of vulnerability, “Potential impacts” cover the methodology of the top-down approach, while “Adaptive capacity” covers the methodology of the bottom-up approach to vulnerability analysis. (See Methods for setting up a vulnerability analysis chapter.)

Consequently, the data requirements can be grouped as follows:

	Data requirements	Data source
Basic information identifying potential impacts	Geographical features	Hungarian Mining and Geological Service - NATÉR database
	Local climatic conditions (temperature, sunlight, rainfall distribution, etc.)	National Meteorological Service
	Climate change trends and forecasts	National Meteorological Service
	Impacts of climate change on agriculture	National Climate Change Strategy
	Impacts of climate change on the built environment	National Climate Change Strategy
	Land cover	Lechner Knowledge Center spatial data
Basic information determining adaptive capacity	Territorial distribution of the local population by age groups.	Central Statistics Office census data, constituency data, local surveys
	Territorial distribution of the local population by income situation	Central Statistics Office census data, constituency data, local surveys
	Territorial distribution of green areas and their condition	Lechner Knowledge Center spatial data, local government GIS systems
	The most common climate effects recognised by the local population	qualitative surveys, (for example: webmapping-klimapanasz.online)
	Information on the condition of the local built environment.	population survey, database of insurance companies, spatial data of the Lechner Knowledge Center, local government GIS systems,
	Microclimatological modelling	local GIS database, digital maps, plans, meteorological measurements for example: National Meteorological Service

Table 4: Overview of data requirements



In Hungary, the primary source of data related to adaptation is the National Adaptation GIS System (Natér). The system can be used without registration. An unfavourable feature is that most of the data are available at a broader level and there is no detailed data for each settlement or at district level.

Natér* provides data on following topics:

- Demography
- Climate
- Forestry
- Land cover
- Groundwater management
- Geological hazards
- Economy
- Heat waves
- Drinking water resources
- Change in attitudes of the population
- Ecology
- Ecosystem service indicator
- Field crop production
- Tourism
- risk due to flash flood
- Vulnerability of buildings

The application of the National Land-use Planning and Development GIS (TEIR) supporting Integrated City Development Strategies can also help to collect the data necessary for the vulnerability analysis. The application provides a number of socio-economic data by settlements, but also by districts within Budapest, such as demographic indicators, economic sectors, transport, built and natural environment. The data is collected by the Lechner Knowledge Center, operator of TEIR. The system is favourable because it currently provides data from 2011 census data up to the latest data from 1-2 years ago.

* Natér subscriptions are available under: <https://nater.mbfisz.gov.hu/hu/node/120>

4.3 Microclimatic modelling

Different climate models and their results are already available, presenting the expected trends in larger areas e.g., globally, or for a given continent or country. In Hungary, the National Meteorological Service carried out related analyses. From this data only rough conclusions to a smaller unit of area can be made, for example how a (part of a) settlement or public area reacts, how the existing natural and artificial spatial elements amplify or mitigate the climate effects. Microclimatological models are suitable for presenting and analysing this. Modelling is able to show heat effects, thermal comfort, wind movement, humidity and parameters which can present e.g., the flow of air pollutants at street level or even at apartment levels.

Microclimatological modelling is a practical tool that helps us to present and analyse the conditions of a given area, part of a settlement, or even a selected public area. Furthermore, it can help to analyse the effects of planned measures for example tree planting, setting up fountains, or changing the pavement. It also helps to analyse improvements and spatial changes (e.g., placing a new building on an empty plot). Thus, it can be an important additional tool for both vulnerability assessment and climate-adaptive settlement planning, as well as development preparation processes.

Its significance lies in the fact that the modelling enables to quantify characteristics that can otherwise only be interpreted subjectively (e.g., feeling of heat). In this way, local planning can be much better tuned to real needs, and negative effects can be eliminated more effectively.

There are now several types of modelling software available on the market, but it is important to note that both their use and the evaluation of the results require experts' help. Otherwise, its interpretation can lead to false conclusions based on planned investment decisions.

4.3.1 The main steps of microclimatological modelling:

i. Careful selection of the model area

When choosing the area to be modelled, the parameters and changes that are to be analysed have to be considered. When testing air movements or the flow of pollutants, for example in the case of a densely built-up part of the city only using one or two street areas as a basis can lead to deceptive results. In this case, it is better to think in an entire residential area, or to choose area borders which has the greatest influence on the given parameter. The following example shows Valéria Square in Budapest IX. district. The model area was not narrowed down to the immediate surroundings of the square., Instead, it has been examined it in a broader perspective, considering the surrounding streets and building blocks forming the air ducts, as well as the intermediate green areas.

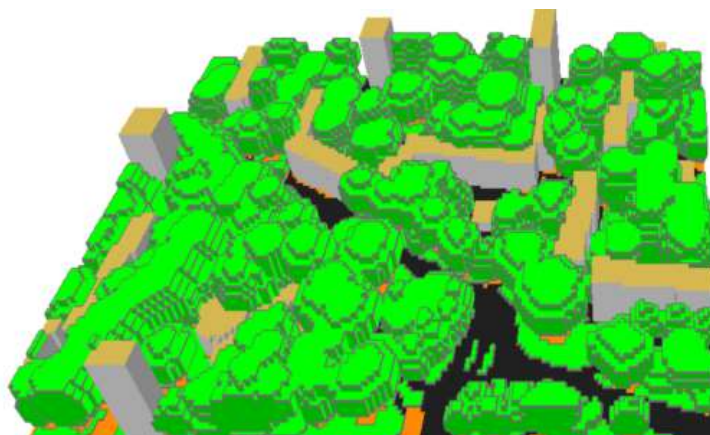


Figure 7: Budapest. IX. district, Valéria Square

From the point of view of thermal comfort, or for modelling the humidity influenced by a plant cover, a fountain placement, or a pavement selection, it is useful to choose a smaller modelling unit: a park or a public square. The modelling can be represented well on these areas. (See Bakáts Square - Budapest IX. District.)

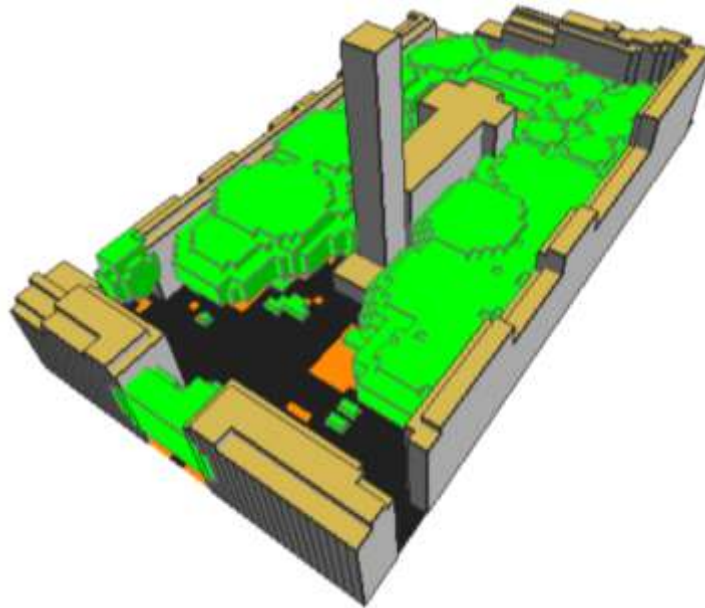


Figure 8: Budapest. IX. district, Bakáts Square

The definition of a model area can also be influenced by the amount and quality of data and information available. In the absence of data or by entering fictitious data, it does not make much sense to perform software modelling. Such analyses can only serve demonstration purposes, but they are not usable for drawing real conclusions.

ii. Collecting data

The quality and usability of the modelling is greatly influenced by the detail of the input data. In general, it is true that the more complex our database is, the more reliable the results of the modelling are, reflecting closely the real processes.

For microclimatological modelling, some centrally available data may be needed but the significant amount will be available from local databases and / or even based on self-conducted surveys.

<i>Type</i>	<i>Possible data source</i>
<ul style="list-style-type: none"> current temperature and precipitation data sets modelled data on future temperature and precipitation conditions 	NATÉR, National Meteorological Service
<ul style="list-style-type: none"> digital base map 	NATÉR, municipal architectural office, OpenStreetMap.
<ul style="list-style-type: none"> materials, area, and height data of buildings material of pavements, green surfaces 	municipal architect's office, digital base maps if they contain such data, or own survey
<ul style="list-style-type: none"> planned measures, parameters of territorial interventions 	municipal architect's office, plans for future condition and / or parameters of fictitious ideas to be modelled

Table 5: Data collection – types and possible data sources



iii. Data entry, digitization

Once we have collected the necessary data, it has to be uploaded in the appropriate form to the model area. This can be done up to the depth described above, i.e., after the geolocation and geometrical characteristics, the parameters of the built and natural environment have to be uploaded. The more detailed, the more reliable results about the factors that can influence the microclimatological conditions of a given area can be acquired. For example: when studying heat effects in an area, it is not only influenced by the extent of buildings and pavements, but also by the characteristics of the materials used (brick, basalt paving, concrete, etc.) and the plant composition of green areas (bushes, tree types, canopy size, etc.).

iv. Modelling process

After the data is properly fed, the computer runs the software analysis to calculate models. It has to be taken into account that each model run requires a high-capacity computer, and the time required depends on the computer's capacity. Depending on the level of detail of the data entered and the capacity of the computer performing the calculations, a model calculation may take several days or even a week or two to complete. Modelling can be especially useful if different variations can be compared with each other, so a single model will not be enough. It is a good idea to run a model for at least one current state situation and one or more future versions so that information with the appropriate variables is available to support your decisions. This means, in the design processes, sufficient time has to be appointed to the modelling process.

v. Evaluation of results

Evaluating the results is at least as sensitive a point of modelling as the steps outlined earlier. At this point, it is decided what results are published based on the model calculations and in what depth they are defined. Accordingly, **the evaluation inevitably requires the involvement of experts from several disciplines** to avoid misinterpretations.

Experts should at least be involved in the following areas:

- architecture
- landscape architecture
- meteorology
- regional development
- settlement operation
- transport engineer
- public health

Results of microclimatological modelling in the IX. district in Budapest:

In Ferencváros, modelling has been performed in 2019-2020 by using the Envi-met software to support the forthcoming adaptation concept and action plan.

The choice of the model area was determined by two factors: renovation was planned in the given area in the near future and it could well represent the different types of residential areas in the district. Based on this, the following three public areas provided the basis for modelling:

1. Bakáts Square: Inner-Ferencváros, a densely built - up, multifunctional public space
2. Boráros Square: Central Ferencváros as a busy hub marked with lots of roads and intense public transport
3. Valéria Square: Outskirt of Ferencváros, green area, less frequently built residential area

The data on the current and future conditions were available in the most detailed way for Bakáts Square, therefore the analyses are also the most complex for this area.

Representatives from several disciplines and decision-makers of the municipality took part in both the selection of the areas and the modelling process, as well as in the evaluation of the results. The different phases were also discussed in workshops. For each model area, several calculations were made for the current climatological conditions and for an expected future condition with a higher average temperature. The study combined all this data with the facts such as any climate adaptive interventions or developments planned in the given area, or the area left unchanged.

The study calculated the following hypothesized interventions in the modelling compared to the original states:

Subject of model area modification	Bakáts Square	Boráros Square	Valéria Square
<i>Modified pavement</i>	✓	✓	unchanged*
<i>Modified sidewalk pavement</i>	✓	✓	
<i>Modified ground cover</i>	✓	✓	
<i>Increased green area</i>	✓	✓	
<i>Increasing the number of canopy trees</i>	✓	✓	
<i>Construction of fountains and wet areas</i>	✓	✓	

Figure 9: Overview of changes in exemplary models after hypothesized interventions

Based on the results of the modelling, it became clear that by increasing the proportion of green spaces in public spaces and replacing coverings, spectacular results can be achieved both in the current and warming climatic conditions.

Microclimatological modelling results at Bakáts Square:

The most critical part of the square is the paved area in front of the church entrance, which heats up extremely in summer. Heat stress can be reduced by greening and breaking the cladding, but other aspects must also be taken into account: the space must be able to retain its "parade" character and remain suitable for holding various events. Therefore, instead of large-scale afforestation, the modelling was performed with the replacement of the pavement and a fountain built at ground level. Figures 5.1 and 5.2 illustrate well that the renovation can significantly decrease the feeling of heat at the square.

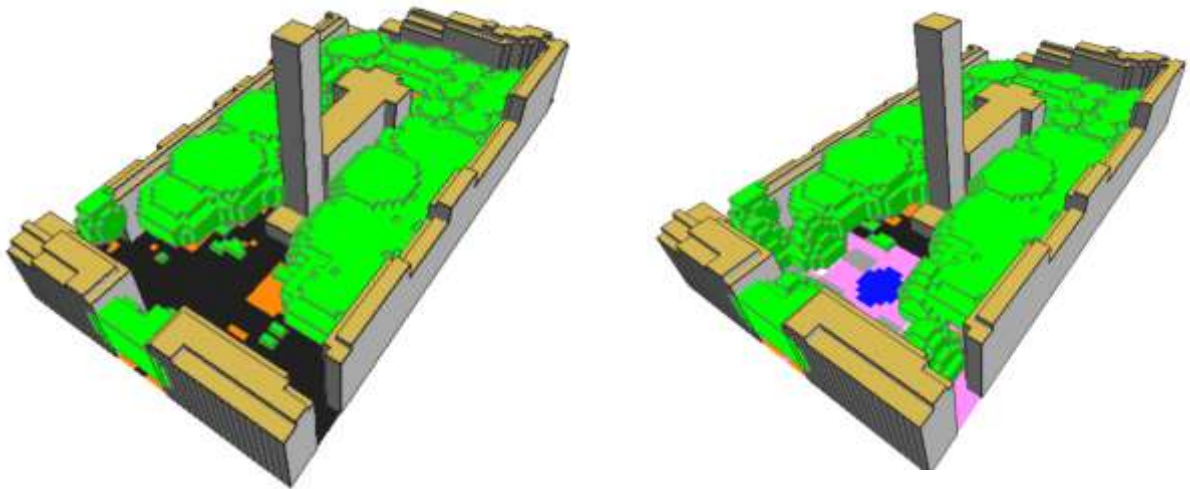


Figure 10.1: modelling results of Bakáts Square: condition without renovation (left) and model area after renovation (right)

PMV

	below 0.50	<i>moderate</i>
	0.50 to 1.00	<i>warm</i>
	1.00 to 1.50	<i>warm</i>
	1.50 to 2.00	
	2.00 to 2.50	<i>cold</i>
	2.50 to 3.00	
	3.00 to 3.50	<i>extremely</i>
	3.50 to 4.00	
	4.00 to 4.50	
	above 4.50	

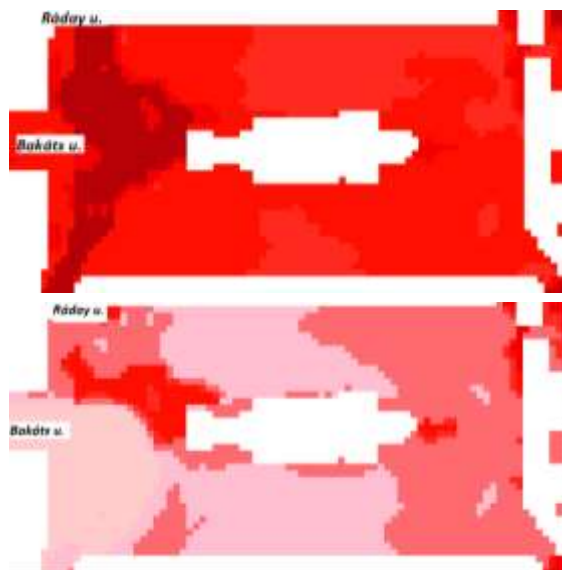


Figure 10.2: modelling results of Bakáts Square: perceived temperature without renovation (top) and after renovation (bottom) both under current climatic conditions

It has to be considered that measures, for example the planting of trees, can reduce heat stress, but it can also block the ventilation of the area or increase the humidity in an extreme way. Further, regulations must also be taken into account for instance when replacing pavements, as barrier-free areas for fire trucks could be a legal requirement.

4.3.2 Choosing the right measures for effective adaptation

There are a number of options for increasing adaptive capacity, thereby reducing vulnerability. These may differ in many aspects in themselves and related to the given local conditions. For this reason, it is important to choose the areas of intervention with utmost consideration at the strategic planning stage to provide an effective response to the problems identified during the vulnerability assessment.

However, not only vulnerability, but also the financial possibilities and capacities of the municipality are an important aspect in the selection of measures, as it is of public interest to devote the tight resources to adaptation-related tasks in an efficient way.

First, it is recommended to select the impacts and / or affected systems (see table below) which require the most improvement/ intervention/ response to achieve the goals.

Possible effects	Vulnerable systems which may need to be developed
Extremely high temperatures	Healthcare
Heatwaves	Local economy
Extremely low temperatures	Buildings and construction sites
Low summer precipitation, drought	Green and blue spaces
Intense rainfall and flashflood	Biodiversity
Flooding	Food supply
Inland inundation	Water supply
Mass movements, landslides	Sewage drainage
Storms (extreme wind and lightning)	Rainwater drainage
Snowstroms	Gas supply
Hail	Electricity supply
Fire caused by droughts	Transport
	Infocommunication
	Waste management
	Cultural heritage
	Tourism
	Education

Table 6: Overview of possible effects and vulnerable systems which potentially require improvements

The next step is to list possible measures to reduce the risk of damage from a given impact or to increase the resilience of the affected systems, followed by the evaluation of the listed measures and narrowing down the list accordingly. It is worth continuing to narrow the list down until a package of measures is in place which ensures that goals are met and to which all the needed resources are available or easily attainable.

Examples of selection criteria and associated evaluation methods:

- Contribution to increase resilience
 - High
 - Medium
 - Low
 - None
- Effectiveness of vulnerability and risk reduction
 - Strong
 - Medium
 - Low
 - None
- Investment and maintenance costs
 - high (max. HUF 5 million)
 - medium (HUF 5-100 million)
 - low (more than HUF 100 million)
- Positive externalities, additional benefits
 - social
 - environmental
 - none
 - both
- Impact on emission reductions
 - negative
 - positive
 - no effect
- Implementation period
 - short term (1-4 years)
 - medium term (5-10 years)
 - long term (more than 10 years)
- Regular maintenance required (e.g., time, HR capacities, financial resources)
 - minimal
 - occasional
 - medium
 - significant

Political and legal aspects should also be taken into account, and in case of measures requiring significant financial resources, it is inevitable to carry out a more detailed assessment.

This can be carried out by a feasibility study including a cost-benefit analysis. Preference should be given to measures that address several risks, such as green space improvements, which are effective in terms of both heat and water management, as well as having a positive impact on air quality.



Involvement of an adaptation expert with experience is absolutely necessary to evaluate the measures. It is also recommended to involve experts from the affected sectors or systems which measures are intended to improve. It is also advisable to check if the measures selected are consistent with each other and with the measures set out in other development or strategic plans. There should be no inconsistencies and if the selected measures can resolve all targeted problems can be deemed serious.

The development and implementation of measures requires both financial and human resources. A given measure can determine the operation of settlements for decades. Therefore, in terms of human resources, it is especially important to have expertise and be familiar with current professional guidelines related to climate change, in order to avoid counterproductive measures and effects.

Selection process of measures in Ferencváros

Following the vulnerability analysis, the focus of the experts working on the adaptation action plan was to address the risks posed by heat, extreme precipitation and storms. The measures picked for the action plan were selected from a database of about 200 climate adaptation measures compiled by Energiaklub. Based on the vulnerability of the district, measures for three key areas were examined, namely:

- Human health
- Urban planning / land management
- Water management

Based on the criteria listed above, the project experts examined and assessed the extent to which each measure was in line with the IX. district conditions. As next step the measurements which were able to reduce the vulnerability of the district at least moderately were selected.

The list was narrowed to roughly 30 measures in this way. In order to further abbreviate the list, a workshop was held with the employees of the municipality and external experts already involved in the project. The 30 selected and evaluated measures were presented at the event, after which the participants nominated the measures, they considered most important with 4-4 votes per topic area. Tables with the measures were available on a large poster, and participants also received them in smaller sizes for better visibility and to make their own notes. Before the vote, the evaluators briefly presented the measures and their evaluation in the thematic areas and answered the questions that arose.

Based on the votes, the list was narrowed to 10 measures, and then in consultation with the international experts of the project, the three measures (some of them jointly handled from that point on; coloured in the list) were selected. These were then developed in detail within the framework of the "Dialogue Climate Adaptation: Berlin-Budapest" project.



CATEGORY	Type of measure	Concrete action
Human Health	Development of alarm and information systems	Municipal UV and heat plan and heat alarm system development; including a system of connection with hospitals and general practitioners to maintain adequate capacity
	Direct reduction of exposure of social groups	Create a database of air-conditioned / cool public buildings, with free access. Selection of suitable buildings (health facilities, cultural centres, shopping centres, churches)
	Conscious coordination of the planning and operational tasks of the municipality	Cooperation with district / capital municipalities to prevent the reduction of green spaces
	Transforming indoor lifestyles	Passive cooling of municipal facilities and public buildings and air humidification, if necessary supplemented by renewable active e-cooling
City Infrastructure	Building environment / legislation	Developing/amending local regulations for increasing adaptive capacity of built environment, e.g.: Requiring high-albedo surfaces, roofs and green roofs: supplementing local building codes to make it compulsory to install green roofs and / or green walls in designated construction zones (at least in residential areas) during building renovations and new constructions, Improving precipitation absorption and water permeability by defining the usable covering materials, regulating them, formulating expectations, Defining afforestation requirements that help both the cooling of the urban atmosphere and the thermal protection and thermal insulation of certain buildings, Tightening of local wood protection regulations, requiring expert examination before felling, During road renovations, mandatory utility reorganisation and maximize timber planting / green space establishment, Validation of adaptation aspects when reviewing spatial planning and development documents
	Biodiversity / sustainable green area and forest management	Increasing the area and intensity of green areas and forests, plant stock reconstruction; establishment of deciduous rows of trees, shrub strips, green areas, water surfaces; Increasing the extent of extensively managed biodiversity green areas
	Storms and floods / adaptation of building structures	Guidance for climate adaptive planning of new buildings, put into practice the recommendations by the municipality (at own developments)
Water Management	Legislation / planning / monitoring	Preparing detailed map and strategy by modelling to highlight the risky areas of drainage and showing the potential areas of storage facilities.
	Increasing efficiency of water usage	Initiating water saving solutions and using them in municipal buildings/institutions (rainwater)
	Increasing efficiency of water usage	Collecting and reuse of rainwater on lands (legislation for new buildings, support for existing ones)

Table 7: Selected actions by topic

4.4 Involving stakeholders

The success of the development and implementation of adaptation strategies and action plans depends on a large extent on the way how information is communicated and the ability to involve stakeholders in the process. Therefore, it is important to have long-term, well-structured communication planning and a consequent use of appropriate forms of participation (for example online communication, webinars, workshops) suitable for knowledge sharing and team building.

i. Who should be involved in the process?

As the first step in planning, it is worth summarizing the range of key persons and organizations by categories. It is important to find a competent contact person within the selected organizations. It is recommended to collect key actors and their contact details in a database which should be updated if necessary.

Checklist to determine the key actors to be involved:

(the list may vary from municipality to municipality)

- Professional stakeholders
(a group of only a few members, their role is mainly to contribute with their professional inputs and points of view):
 - local municipality experts (for example colleagues dealing with settlement operation, settlement development, environmental protection, built environment, social affairs)
 - urban planners, landscape architects
 - professionals representing local infrastructure maintainers
 - representatives of local / nearby higher education or research institutes dealing with climate change or climate adaptation
 - interested civil sector (from community development, environmental protection, village / urban development, or social fields)
- Stakeholders representing the citizens:
 - representations of condominiums
 - building owners
 - church, social institutions
 - educational institutions
 - health network
 - other civil communities
 - interested, (larger) businesses
 - interested local citizens, experts, influencers (for example leaders of FB groups)

The group above is a much wider circle as the one of the professionals. Their role is usually emphasized primarily during implementation, but if they are left out during the planning steps, they might support implementation with less enthusiasm. They can also play an important role in communication, as they usually reach people who are difficult or impossible to reach through municipal channels.

ii. When should key stakeholders be involved in the process?

Finally, a question to which a general, always applicable answer can be given. At least those named as “key stakeholders” should be involved at the very beginning of the planning process!

The involvement of the wider circle must be started at the latest in the strategy preparation phase, already during the situation analysis (vulnerability analysis). The bottom-up method described in the “Methods for setting up a vulnerability analysis” chapter is suitable for this process.

General advice is that for each major step of the planning process a method of involvement for both the narrower and the wider circle is used. Remember to always include the narrower circle first and then inform the wider circle. Methods of communication are usually different, at least in their scale. Such main points of involvement, as described in the chapter on “Planning for adaptation to climate change” are:

- situation analysis, data collection
- setting goals
- identification of areas for intervention
- planning specific measures and actions
- implementation
- examining the effectiveness of implementation

iii. How to involve stakeholders?

The first step of the process is to select the key actors who can contribute to the success of the action to be implemented. Communication which focuses on problem solving and mutual understanding can result in intensive teamwork. In addition to the facilitator-host role, the municipality should set up a “green / climate protection working group” within its own organization, which should inform and involve its individual departments, as necessary.

The urban planning department and / or the green representative may have the key role in the process.

The first meeting should be held in the form of a workshop, where the cause and background of the changes in the local climate and the need for an action plan should be presented. At this meeting, professionals from different fields will be able to outline the problems and possible suggestions for solutions, which will be noted. Next steps of the work are characterized by accurate project management, which communicates with the group on a regular basis and follows the milestones set.

Communication tools for the planning process:

- compiling and presenting information materials on the situation
- establishment of workshops / working groups, documentation of results, compilation of objectives and assigned activities, establishment of a timetable with the necessary milestones
- professional study trips, events
- online consultations (mailings, meetings)

Communication tools for implementation:

- involvement of stakeholders representing the citizens
- setting up working groups
- round table discussions
- presentation of good national / international examples
- flyers, website, articles, and press releases to inform the public

Excellent guides in Hungarian are already available on the various possibilities of community involvement, see: „Useful literature, links”.

Example of Ferencváros: a detailed communication plan for a measure

For the implementation and communication of the given measure, first of all it is necessary to involve the participants according to the table below:

First phase:	Identifying key actors and involving them.
Second phase:	Compiling working groups, information, and a summary of possible professional resources. Sensitizing actors to the topic.
Third phase:	Creating smaller subgroups as needed to work effectively. Regular communication between groups is essential!
Fourth phase:	Expanding the professional circle with the further stakeholders required for the implementation.

Table 8: The four phases of a communication plan (overview)

Further, detailing the example presented in the „Action Planning“ chapter, you can review the communication plan for the measure “Development of an Action Plan for Heat Waves with the Process of the Public Information System”.

The implementation process is divided into four phases, the tasks and their resource needs are gathered in a structured way.



Phases	Resource requirements	Topic	Activity/outputs
I. phase	2 person days	Mapping and inviting / selecting potential group members to participate (civil sector, social institutions, medical network, private sector)	<ul style="list-style-type: none"> ✓ Determining the ideal distribution of climate shelter points ✓ Setting up a database of potential actors ✓ Sending invitation letters
	5 person days	Creating an online communication interface for the group (recommended: a social media or other closed online group for interaction)	<ul style="list-style-type: none"> ✓ Setting up groups based on feedback of the invited ✓ Finding and adding new members to the group for missing points ✓ Announcing the date of the first information event
II. phase	4 person days	First workshop on the map of planned climate shelter points.	<ul style="list-style-type: none"> ✓ Compiling information needed to create a map (address, contact details, opening hours, providing local contact details) ✓ Informing participants about their basic tasks
	7 person days	Creating the maps' content, reviewing it with the group	<ul style="list-style-type: none"> ✓ Creating map content ✓ Online consultation in two rounds: 1. sending out, 2. submission and approval of a revised, improved version
III. phase	4 person days	Phase for graphic design: This activity can be fitted to the budget. At least printable online versions are worth making.	<ul style="list-style-type: none"> ✓ Creating the map ✓ Prepararingsigns for climate shelters, which can be placed in traffic junctions and busy streets in case of danger ✓ Making climate shelter stickers for institutional entrances ✓ Creating poster designs
IV. phase	10 person days	Compiling communication material for a public campaign. Informing members of the group about the communication campaign of climate shelters within a workshop.	<ul style="list-style-type: none"> ✓ Internal communication tools for the group: <ul style="list-style-type: none"> ○ Q/A for public communication ○ Event calendar (description of relevant events and communication plan) ○ Creating a volunteer calendar of climate shelters: marking information days, events in which the climate shelter points voluntarily give information about their role
	1-1,5 working hours occasionally	Continuously communicating in the online group	<ul style="list-style-type: none"> ✓ Weather forecast, preparing for the activation of climate refuge points in time ✓ Continuously informing about the events and appearances of the campaign

Table 9: The four phases of a communication plan - the process of implementation

4.5 Financial resources for implementing adaptation measures

In terms of raising funds, the costs for adaptation measures do not considerably differ from the measures that arise during the operation of a settlement, so they may include the following types of measures:

- investment
- regulatory
- awareness-raising.

A productive way is to create a so-called “source map” and to differentiate according to managers of the funds and financing possibilities, available on the given topic. These are of different nature, e.g., application, loan, donation, etc. A source map can also be created for a specific project, but it is worth to detail it into project elements within the given project, as usually it is not possible to find a single source according to the ideas to be implemented.

The basic steps for creating a source map are following:



Figure 11: Process of creating a source map (own edition)

Keep in mind, there are indirect tools which can be used to save time and money in addition to funding sources, such as guides developed for municipalities, or toolkits which can be used for attitude formation and education.

The table below shows the most appropriate financial sources for climate change adaptation and some alternative solutions.

	Direct EU applications	Regional funds	Domestic EU funds	Municipal budget	Corporate responsibility	Local initiatives
Notifier / initiator	European Commission	EU member states/ associate members	Designated managing authorities	Local municipality	company	citizens, non- governmental organizations
Funding programs	Horizon Europe Interreg LIFE ERASMUS	Visegrad Fund EEA Grants Norwegian Fund EUKI	Operational Programs	Tender and other resources allocated in the annual budget of the municipality for environmental and climate adaptation purposes (attitude formation, energy modernization, green roofs, rainwater collecting, etc.)	At the expense of their CSR frameworks, companies can be a potential opportunity to fund local initiatives.	In many cases, bottom-up civil initiatives can help to achieve the municipality's climate adaptation goals. By involving civils, some of the municipality's capacity can be freed up and can help to shape attitudes or implement initiatives such as tree planting in public spaces, community gardens, green transport, and so on.
Other conditions	Projects requiring international cooperation.		Support varies from region to region	Board approval	Clear goals, mutually beneficial program offering	Participatory planning, involvement of local population and NGOs in planning processes

Table 10: Overview of potential financing options

5. Useful literature, a collection of links

Climate change in Hungary

- Second national climate change strategy
- climate action plan
- Report on the scientific assessment of the possible effects of climate change on the Carpathian Basin: <http://www.zoldbusz.hu/files/jelentes.pdf>
- www.klimavalasz.hu
- http://owwww.met.hu/pages/idegenek_az_uveghazban.php
- <https://www.met.hu/eghajlat/eghajlatvaltozas/hatasok-alkalmazkodas/>

Preparation of municipal strategy documents on climate change

- <http://klimabarát.hu/tudastar>
- <https://www.polgarmestereksovetsege.eu/>
- <https://klimavalasz.hu/tudastar/tovabbi>

Adaptation

- <https://www.polgarmestereksovetsege.eu/support-mainmenu-hu/adaptation-res-hu.html>
- <https://naturvation.eu/>
- <https://life-local-adapt.eu/en/>

Stakeholder involvement, community planning

- Participatory planning in settlement development and planning activities: http://www.okosvaros.lechnerkozpont.hu/sites/default/files/2018-12/2018-03-22_reszveteli_kezikonyv.pdf
- Community development - methodological guide: https://cskwiki.hu/wp-content/uploads/2017/09/csk_utmutato_kozossegefejlesztés_online_20170331-1.pdf
- Community involvement and public participation in urban renewal - policy recommendations: http://www.terport.hu/webfm_send/549
- Example of Tér Köz: Good practices for involving society: http://terkoz.budapest.hu/wp-content/uploads/2018/07/kiadvany_proba_20180723_online.pdf
- <https://www.umweltbundesamt.de/publikationen/adapting-to-climate-change-good-participation>

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