The role of climate strategies and green infrastructure in the adaptation to climate change

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Abstract: Climate change is one of the greatest challenge for the economy, society and settlements. Today it is an expectation to mitigate the expected negative consequences and to make adaptation efforts. To achieve this, municipal climate strategies are needed which must include successfully used possibilities in adaptation. In our paper, we overview the specialities of the current Hungarian climate strategies, expectations for the future climate strategies and the role of green infrastructure as a possible method for adaptation. We investigated the climate strategies, and also conducted additional experts' interviews. To confirm the effectiveness of green infrastructure, we analysed the inside and outside temperatures in a green-walled building for a two-month period. As a result of the analysis and the comparison of Hungarian and international climate strategies, we can conclude that these documents put great emphasis on the use of renewable energy sources. Our suggestion is that the application of energy-saving green walls should get a greater role among adaptation possibilities in the future. First results of our measurement show that in the case of green-walled buildings the difference in the temperature between walls with and without shadow can reach 20 °C, and shading can reduce indoor minimum temperature with 4-5 °C. Besides that, application of green walls has a great importance from the perspective of reducing CO_2 emission, and improving of air quality thanks to the O_2 production.

Keywords: adaptation, climate change, climate strategies, green infrastructure

Introduction

Adaptation to the expected impacts of climate change becomes a central question which can be seen in different research projects, documents and institutions (Birch, 2014; EEA Report No 12/2016; Massona, et al. 2014; Rosenzweig et al., 2011). Similarly to many countries of the word, Hungary recognized the importance of mitigation and adaptation to climate change. The National Climate Change Strategy, or other documents and initiatives, like Climate Friendly Municipalities Association or Energy Efficient Settlements Association help to achieve this. In our research we focused on the local answers for the challenges of climate change with analyses of climate strategies of European and Hungarian cities.

Green infrastructure can play an important role in practical implementation on local level (Gill, et al. 2007). Adaptation and mitigation mean a challenge which can be approached from a regulatory aspect, where the focus is on energy savings and energy efficiency, or actions taken for example during heat waves.

Our aim was to explore the potential of a Hungarian medium sized town (Kecskemét) in green walls application.

Also our aim is to investigate the temperature inside green-walled buildings, which indicates the potential yearly energy savings. Above all, we try to estimate the amount of oxygen emitted by plants and the absorbed carbon dioxide, which can contribute to improve urban air quality.

We would like to draw attention for the potential in the application of green walls, which

could be important in the reduction of greenhouse effect and energy consumption, and can improve the life quality of urban population.

Materials and methods

In case of climate strategies, we reviewed the significant international results of climate protection, the main principles of climate policy in the European Union and Hungary. Besides these, we analysed the climate strategies of the Hungarian medium size cities. After that, we prepared experts interviews with the prominent persons who participated in the preparation of strategies or working in local climate associations. They have appropriate insight on the effectiveness of the local climate protection programs.

On the base of climate strategies green infrastructure is one of the successful practical solutions. In addition to „classic" green areas it is also worth to investigate other parts of green infrastructure because more green areas do not necessarily lead to local improvement in condition of settlements, and only constitute a part of the overall concept of urban climate (Gaffin, et al. 2012; Matthewsa, et al. 2015).

Ivy is one of the most popular plants in developing green walls because it tolerates urban conditions and its shielding ability is adequate. Researchers of Hochschule für Technik und Wirtschaft in Dresden investigated a 1000 m² ivy green wall with facing south. They calculated the oxygen emission and carbon sequestration, and the results for 1 m² green wall (Hedera helix) are 2,3 kg CO_2 sequestration and 1,7 kg O_2 emission per year (Schröder, 2009).

In our examination we focused on public buildings of Kecskemét. The list from Urban Development Ltd. of Kecskemét consists of 103 public buildings. We purified this database, so we assessed 62 buildings all together. It meant the estimation of front surface; the size of doors and windows were deducted from the wall surface. In relation to oxygen emission and carbon sequestration we made calculation on the base of ivy green walls.

We measured the temperature in order to monitor the impact of green walls on the buildings. This measurement has done in Clarion Hungary Kft., Nagykáta. This factory has a green wall by Zöldfalkert Horticultural Ltd., and it provided the suitable conditions for the measurement. The period of measurement was between 03. 08. 2015. – 23. 09. 2015.

The measurement was made simultaneously at four points:

- outdoor surface of bare building wall
- indoor room behind the bare building wall
- green walls wrapped wall
- indoor room behind green walls (periods with and without air condition)

Results and discussion

Until this time, only 10 medium size cities prepared publicly available climate strategy, but some of these documents are only „water management climate strategies" (such as in the case of Vác and Pomáz). These documents only focus on water management issues like flood protection and rainwater management. Some of the other strategies put the focus on energy management and efficiency.

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Nowadays we have found several background materials, scientific and policy documents – like the Climate-guide edited by Fülöp (2009) – that can be useful for the Hungarian settlements to prepare an elaborate climate strategy. According to this Climate-guide, the first (and most important) steps are revolving around energy, like founding local energy committees, creating an energetic database and preparing local energy-conceptions. Almost all of the climate concepts contain the land-, water-, and forest-management, flood protection, heat and UV action plans, but the recommendations of the Climate-guide also point out that in Hungary, local energy management and the increased use of renewable energy is considered as the most effective way to mitigate the effects of climate change. We carried out an analysis which shows the targets of these documents (Fig. 1.):

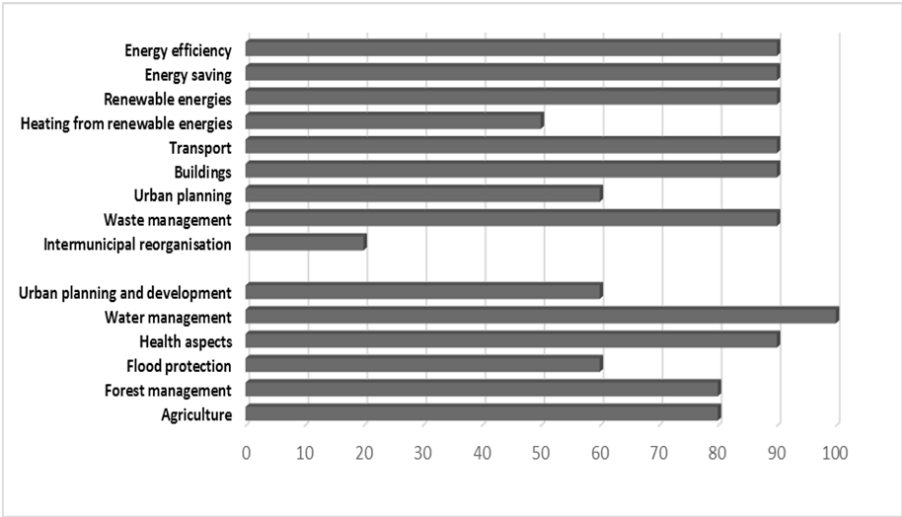

Figure 1.: Topics of mitigation and adaptation (%) in the examined Hungarian climate strategies

It can be concluded that most of the local climate strategies contain almost every topics with the exception of the need for restructuring of the public services (inter-municipal reorganization). It shows, domestic strategies consider every topics important in theory, but the realization is weak in practice in many cases. The analysed climate strategies pay particular attention to the question of energetics which supports our hypothesis that energy management is one of the most important topics for the settlements.

We have selected six settlements, where we analysed the local climate strategies and conducted interviews with the prominent experts on the subject. The experts also agreed on that energetics will have the most important role in climate protection in the future. Despite some disagreements all experts agree on that „not used energy is the safest, cheapest and most environmentally friendly energy".

In addition to mitigation topics in European cities (Reckien et al., 2014), Hungarian possibilities mentioned in the city strategies are the following:

- reducing emissions, CO_2 sequestration
- development of monitoring network (e.g. air pollution)
- increasing green areas and green roofs
- landscape rehabilitation
- awareness for mitigation

Based on the above mentioned topics, two things are worth highlighting: importance of energy savings and increasing of green areas. These two themes can go hand in hand; green areas play a role in reducing emissions and CO_2 sequestration, furthermore green roofs or green walls have an insulating role which may help in energy savings. It means, green infrastructure can be a central element in climate strategies.

In order to examine this issue we analysed 62 public buildings in Kecskemét from the point of view of green wall application, possible energy savings and oxygen emission/ carbon sequestration. The estimated area of walls without windows are approximately 32 000 m^2. If these walls were all wrapped with green walls – for simplicity it could happen with ivy – the oxygen emission approximately would be 54 400 kg, carbon sequestration would be 73 600 kg per year. On the base of literature data we can calculate a 15 000 kg O_2 emission and 13 500 kg CO_2 sequestration for 1 hectare per year in case of forests. On the basis of this values oxygen emission are similar to results of urban green walls, but CO_2 sequestration is less than our calculation. It is clear from the comparison that the green walls on public buildings of Kecskemét could greatly contribute to improving urban air quality or reduction the amount of greenhouse gas emission.

Kecskemét Municipality assessed the expected savings from energetic modernisation in case of the owned buildings. On the basis of three different possible modernized fields the total savings would be 620 777 Euro in 62 buildings we surveyed. The majority – 509 677 Euro – of this saving comes from architectural modernization, which means wall insulation mainly. The amount needed for architectural modernization – based on the calculation of government data – is approximately 8 926 000 Euro. A significant part of this considerable amount could be reserved with the application of green walls besides wall insulation.

On the basis of the temperature measurement we can conclude that the difference in air temperature between a wall without shadow and a shaded wall is significant. Temperature in front of the wall without shadow was more than 60 °C in many times in August (Fig. 2.), meanwhile maximum temperature in front of the wall with shadow (green wall) was

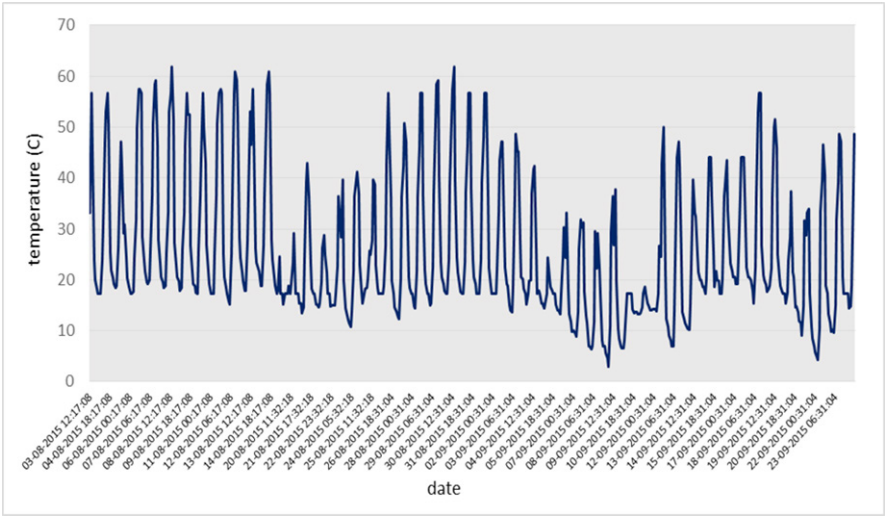

Figure 2.: Outside air temperature in front of the building without green wall (°C)

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about 40 °C (Fig. 3.). Temperature of the room without shadow is about the same with the outdoor air temperature in shadow. Temperature of the room with shadow in the period without air condition is similar with the other room's temperature but there was a 4 days difference between indoor and outdoor values.

Conclusions

Sustainability, climate protection, energy management, renewable energy sources and

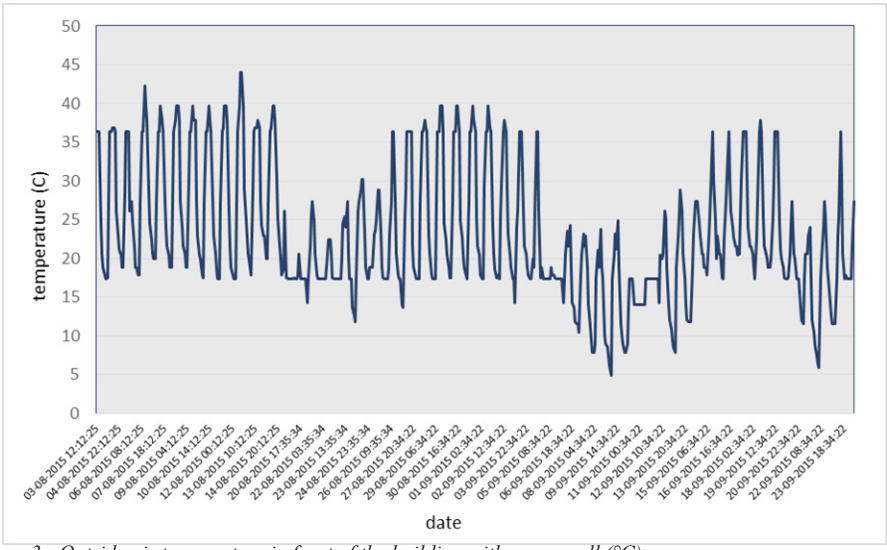

Figure 3.: Outside air temperature in front of the building with green wall (°C)

green infrastructure are closely related concepts. Renewable energies have an important role in climate strategies. But the current reality is that renewable energy use is ranked behind energy savings and efficiency in the examined settlements (and in the similar cities). Renewables require significant investments which hinders their spread. If we concentrate to energy savings and efficiency, green infrastructure – such as green walls – could come into the front.

The potential in the application of green walls in Kecskemét is significant, with approximately 32 000 m^2 walls of public buildings. Green infrastructure in cities can largely contribute to the reduction of CO_2 emission (which is important from the point of view of climate protection) and improving of air quality thanks to the O_2 production.

Reduction in energy consumption is imaginable with the replace estimated costs of insulation to green walls in case of public buildings, and reduction of heating and cooling costs during operation of buildings. We have data about costs of insulation at this moment. On the basis of this, it can be seen that the possible financial savings can reach hundred thousand Euro.

Our results show that in the case of greenwalled buildings the difference in the temperature between walls with and without shadow can reach 20 °C, and shading can reduce indoor minimum temperature with 4-5 °C.

One of the main challenge of urban ecology nowadays, how it can contribute to the liveable urban environment with own researches, by extension, to the reduction of negative effects of climate change. One of the obvious answer for it is application of plants (green infrastructure), as part of climate strategies of the cities. Urban vegetation means not only parks, roadside alleys or green roofs, but also vertical greens– with increasing number of greenwalled buildings.

References

Birch, E.L. (2014): A Review of "Climate Change 2014: Impacts, Adaptation, and Vulnerability" and "Climate Change 2014: Mitigation of Climate Change" Journal of the American Planning Association Volume **80**, Issue 2, DOI: https://doi.org/10.1080/01944363.2014.954464

EEA Report No 12/2016: Urban adaptation to climate change in Europe 2016 — Transforming cities in a changing climate Luxembourg: Publications Office of the European Union, 2016 ISBN 978-92-9213-742-7 ISSN 1977-8449 DOI: https://doi.org/10.1007/978-3-319-28591-7_14

Fülöp O. (szerk.) (2009): Klímakalauz – első lépések a települési éghajlatvédelmi stratégiához (Climateguide – First steps for municipal climate strategies) Energia Klub, Bp., p. 56.

Gaffin, S.R., Rosenzweig, C., Kong, A.Y.Y. (2012): Adapting to climate change through urban green infrastructure. Nature Climate Change, Volume **2**, 704. DOI: https://doi.org/10.1038/nclimate1685

Gill, S.E., Handley, J.F., Ennos, A.R., Pauleit, S. (2007): Adapting Cities for Climate Change: The Role of the Green Infrastructure. Built Environment, Volume **33**. Issue 1. 115-133. DOI: https://doi.org/10.2148/benv.33.1.115

Massona, V. et al. (2014): Adapting cities to climate change: A systemic modelling approach. Urban Climate. Volume 10, Part 2, 407–429. ICUC8: The 8th International Conference on Urban Climate and the 10th Symposium on the Urban Environment. DOI: https://doi.org/10.1016/j.uclim.2014.03.004

Matthewsa, T., Lob, A.Y., Byrnec, J.A. (2015): Reconceptualizing green infrastructure for climate change adaptation: Barriers to adoption and drivers for uptake by spatial planners. Landscape and Urban Planning, Volume **138**, 155–163. DOI: http://dx.doi.org/10.1016/j.landurbplan.2015.02.010

Reckien, D., Flacke, J., Dawson, R.J., Heidrich, O., Olazabal, M., Foley, A., Hamann, J.J.P., Orru, H., Salvia, M., De Gregorio Hurtado, S., Geneletti, D., Pietrapertosa, F. (2014): Climate change response in Europe: what's the reality? Analysis of adaptation and mitigation plans from 200 urban areas in 11 countries. In: Climatic change, Volume **122**. 331-340. DOI: https://doi.org/10.1007/s10584-013-0989-8

Rosenzweig, C., Solecki, W.D., Blake, R. et al. (2011): Developing coastal adaptation to climate change in the New York City infrastructure-shed: process, approach, tools, and strategies Climate Change, Volume **106**, 93–127. DOI: https://doi.org/10.1007/s10584-010-0002-8

Schröder, F.G. (2009): Automatizált, biológiai, függőleges városi zöldhomlokzat kialakítása dekoratív, célirányos jellemzőkkel; Zárójelentés az együttműködési projekthez a PRO INNO II keretében; Hochschule für Technik und Wirtschaft Dresden, 2009.

 DOI: 10.18380/SZIE.COLUM.2017.4.1.suppl