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Modeling Košice Green Roofs Maps

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Abstract

The need to house population in urban areas is expected to rise to 66% in 2050, according to United Nations. The replacement of natural permeable green areas with concrete constructions and hard surfaces will be noticed. The densification of existing built-up areas is responsible for the decreasing vegetation, which results in the lack of evapotranspiration cooling the air. Such decreasing vegetation causes urban heat islands. Since roofs and pavements have a very low albedo, they absorb a lot of sunlight. Several studies have shown that natural and permeable surfaces, as in the case of green roofs, can play crucial role in mitigating this negative climate phenomenon and providing higher efficiency for the building, leading to savings. Such as water saving, what is the main idea of this research.

Key words: green roof allocation, maximum temperature, minimum humidity, modeling map of Košice

1 Introduction

Green roof advantages concerning water management include the attenuation of flood peaks in extreme rain events due to stormwater runoff delay, acting like a meanders of the river through water storage in the layers of the green roof, and reduction into the public drainage system [1]. Water distress is an issue, which has brought an attention on the possibility using green roof structures to manage stormwater and allow their storage for later reuse. In Portugal, ANQIP (Associação Nacional para a Qualidade nas Instalações Prediais) has developed a Technical Specification ETA 701 [2] for rainwater harvesting in buildings, being a valuable tool to couple with the green roof technology [3].
Green roofs have the potential to be the most common type of green structures in the city due to their characteristics, low maintenance and low weight to the buildings [3].

2 Data

According to 5 year analysis, World Meteorological Organization (WMO) stated that the period between 2011 and 2015 was the warmest period of a 5 years long period in the history of observations. During this period there have been many cases of extreme weather, particularly heat waves. Situation of the global climate in 2015 was historic for many reasons. The level of greenhouse gases in the atmosphere has reached new highs in the northern hemisphere during spring 2015. For the first time it exceeded 3 month average of global concentrations of CO_2. 2015 was the warmest year in the history records in terms of the surface temperature of the oceans since the beginning of observations [4].

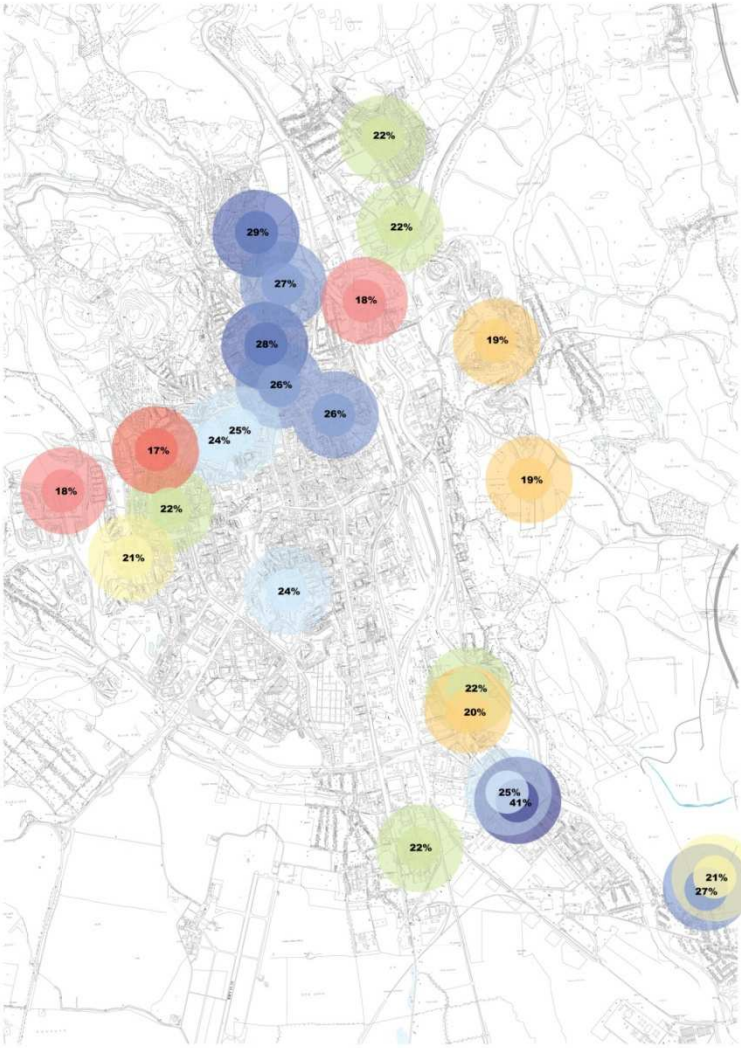

Figure 1 Spatial distribution of humidity trends in July 2015 in Košice

In 2016 there were 2-7 more days of summer than in extremely warm year 2015. On the other hand, we have experienced significantly fewer tropical days than in the previous year 2015, approximately 15 to 30 days less [5, 6].

Summer of 2016 was in all the main features quite different than the summer of 2015. While the year 2015 was extremely warm at the same time it was also very dry. Summer 2016 was much wetter than summer 2015. This resulted in a high number of days and nights, when a people feel stuffy. It also resulted in intense thunderstorms. An essential feature of summer 2016 was also part of the transition significant cold front, which also initiated a significant convective systems that brought abundant rainfall. That is why in 2016 we did not observe similar long periods of high daily maximum air temperatures exceeding 35 °C as in summer 2015. Characteristic features of the summer 2016 were extremely high temperatures and high frequency of intense storms and torrential rainfalls that are associated with them [5,6].
Following above mentioned information, July 01-31, 2015 data from this period was used to create map of green roofs of Košice city.

3 Fixed stations in Košice

The studies on green roofs and their retention qualities in other cities in world are focusing on humidity as a factor. Online data from period July 01-31, 2015 (**bold text**) were supplemented with calculated data (regular text) caused by gaps in measurement, using data from period July 01-31, 2016, mathematic calculation and taking into account the location of weather station.

Table 1 List of weather stations and minimum humidity of period July 01-31, 2015

address	Košice housing estate	min. humidity [%]
Berlínska 3	**Sídisko Ťahanovce**	**22**
Branisková 25	**Staré mesto**	**25**
Brnenská 41	Západ	21
Bukovecká 43	Sídlisko nad Jazerom	20
Bukovecká 68	Sídlisko nad Jazerom	22
Cesta pod Hradovou 6	**Sever**	**29**
Čingovská 15	**Sídlisko nad Jazerom**	**41**
Čingovská 72	Sídlisko nad Jazerom	25
Magnezitárska 2	**Sever**	**22**
Fatranská 39	Staré mesto	24
Hrabová 8	**Vyšné Opátske**	**19**
Kmeťova 51	Staré mesto	26
Komenského 56	Sever	28
Obrody 63	Západ	22
Park angelium 58	Staré mesto	26
Park mládeže 4	Sever	27
Severné Nábrežie 30	Džungľa	18
Sokolovská 23	**Západ**	**17**
Starozagorská 5	KVP	18
Šuhajova 49	Krásna	27
Šuhajova 70	Krásna	21
Turgenevova 66	Juh	24
Zinková 9	**Barca**	**22**
Zupkova 7	**Furča**	**19**

Spatial distribution of humidity trends in July 2015 in Košice is pictured in Figure 1. The distribution of humidity trends used only data (min. humidity [%]) listed in Table 1. Table 2

represents the distribution of humidity of each weather station. The study uses minimum humidity because it takes the worst case scenario into account. The first radius of minimum humidity of each weather station represents 250 meters, minimal distance between weather stations used for this research. The second radius represents 500 meters.

4 Map of minimum humidity in June, 2015 in Košice

The detail of spatial distribution of humidity trends in July 2015 in Košice focusing on city centre and surrounding housing estates is pictured in Figure 1. The distribution used only data listed in Table 1. 22 self-governing neighborhoods have more than just one humidity zone. The biggest extremes are observed in Nad Jazerom and Krásna housing estates. The differences are due to presence of heat station, lake and park near weather stations used for this research. Important is that these measurement results are related to the temperature measurements. The weather stations with higher temperatures have lower humidity and the weather stations with lower temperatures have higher humidity. In Košice during summer 2015 up to 24% humidity differences (minimum 17%, maximum 41%) occurred in comparison one housing estate to another housing estate.

Table 2 Range of humidity of period July 01-31, 2015 [%]

address	41	29	28	27	26	25	24	23	22	21	20	19	18	17
Berlínska 3														
Branisková 25														
Brnenská 41														
Bukovecká 43														
Bukovecká 68														
Cesta pod Hradovou 6														
Čingovská 15														
Čingovská 72														
Magnezitárska 2														
Fatranská 39														
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Kmeťova 51														
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Park angelium 58														
Park mládeže 4														
Severné Nábrežie 30														
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Šuhajova 70														
Turgenevova 66														
Zinková 9														
Zupkova 7														

5 Green roofs beating low humidity in Košice

Košice was chosen as a study area to demonstrate the possibility to mitigate low humidity and therefore heat island in the city center and housing estates implementing green roofs. The dissertation, one of its parts is this paper, deals with the possibility to use green roof structures to manage stormwater runoff delay, its reduction into the public drainage system and its storage for later reuse.

Green roofs in urban areas are significant due to their capacity of water storage in the layers of the roof. This capacity, retention quality, allows minimizing the effect of extreme rainfall in short period. Retaining water in the layers of the green roof means reducing the flood peak in the urban drainage system and reducing the risk of water distress.

The dissertation, one of its parts is this paper, uses 6 typical types of different green roof construction: 001, 002, 003, 004, 005 and 006. The research focusing on this topic is ongoing.

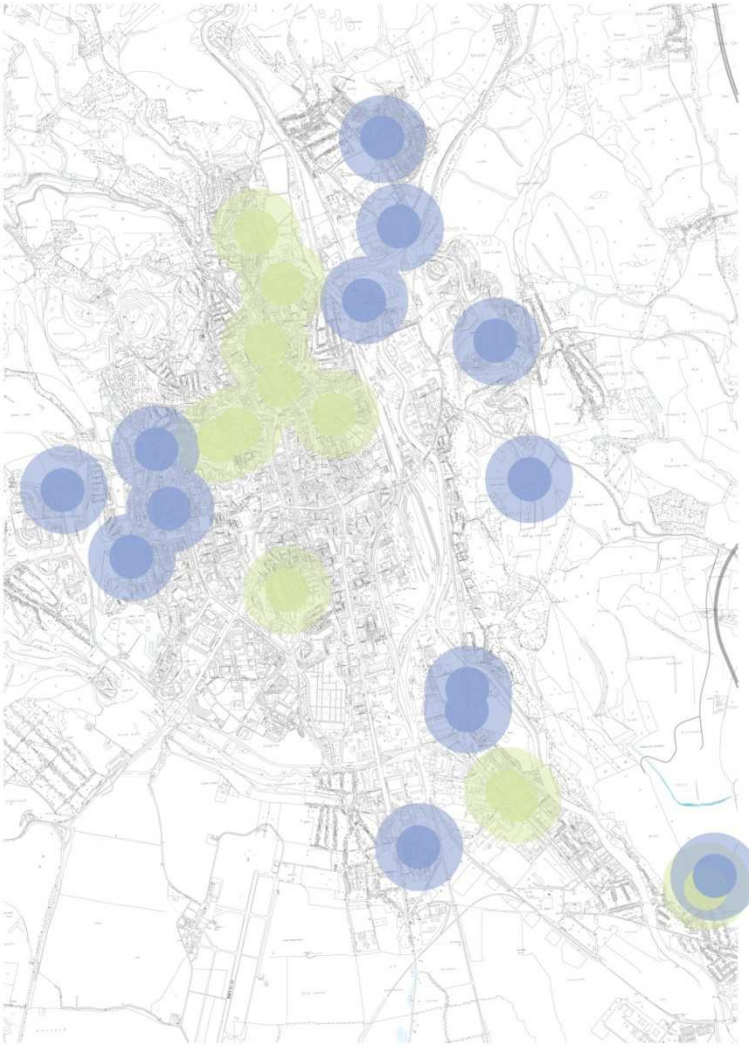

Figure 2 Allocation of green roofs in Košice following spatial distribution of humidity trends

The area with low humidity (17-22%) needs green roof construction (type 004, 005 or 006) with higher retention qualities (Fig. 2, blue color). The city area with higher humidity (24-

41%) needs green roof construction (type 001, 002 or 003) with lower retention qualities (Fig. 2 green color). Using list of typical green roof constructions used for this research. The first radius of suggested green roof construction represents 250 meters. The radius represents minimal distance between weather stations used for this research. The second radius of suggested green roof construction represents 500 meters.
The map of green roofs in Košice (Fig. 2) is modeled using data in Tab. 1. Allocation of two different major types (001 002 003) and (004 005 006) of green roofs follows these data. More input data is needed to complete more precise and more accurate map of green roofs of Košice city.

6 Conclusion

The paper is a part of the dissertation focusing on green roofs and their retention qualities. In this part of this research, modeling the map of the Košice city based on minimum humidity is the mail goal. Following data from 07/2015 the map is created based on the key that the area with low humidity needs green roof construction with higher retention qualities and the city area with higher humidity needs green roof construction with lower retention qualities. The aim of this research is to continue and provide 6 types of the green roof constructions as a choice for the user / citizen of the city based on picking the best one according to the city district, where it should be built.

Acknowledgements

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