REGULATION FACILITIES AT THE SEWER NETWORK AS A TOOL IN REDUCING THE EFFECTS OF HEAT ISLANDS IN URBAN AREAS.

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ABSTRACT

The research work is focused on finding extremes in climate changes which are related to rainfall-runoff process at catchment area. Location of our research is set to urban area of Slovak town Levice. During the inspections process we have made necessary calibration measurements to correct the identified defects in the project documentation. The main part of the research is evaluating the impact of rainwater to the sewerage system using block rain with selected periodicity, taking into account impact of proposed solutions for management of rainwater in the area. Evaluation of existing sewerage network was handled at periodicity levels p = 0,5; p = 0,05. The results show that climate change has high level of impact on the rainfall runoff. Even with a rain with periodicity of p = 0,5; i.e. rain that occurs once in per 2 years, we have identified specific points in the sewerage network unable to fulfill its function without extensive stress.

Key words: *Storm water, sewerage network, UHI*

1 INTRODUCTION

In new urbanized areas, reinforced surfaces replace extensive areas of vegetation. This causes extreme changes in the hydrological nature of the city's catchment area. Paved surfaces are not restricted to the process of infiltration of water into the soil, thus increasing surface runoff. It is therefore necessary to build facilities and premises used for the complex management of rainwater. Currently in Central Europe is the most common method of rainwater management transport through the sewage network from where is water transported to the recipient. Using a decentralized method of management of rainwater, the water is seeped into the soil or the surface water will flow at higher time of runoff delay into the recipient. The flash floods occur in short torrential rain. These flash floods can occur where there is an area prone to the formation of extreme runoff (e.g. very Sloping terrain) or even in places where it prevents the possibility of infiltration or retention of rainwater (Gartland L. 2008,192 p.).

Analysis and evaluation of hydrogeological and hydrological modelling of catchment area is of high importance especially for the understanding of the hydro-ecological processes in different types of area.

In urbanized areas are green areas repressed urban and industrial expansion that implies the creation of specific climate typical heat islands in dense areas with high buildings. The UHI have stagnant air masses of photochemical smog, higher concentrations of solid and gaseous pollutants. The imbalance between the sunlight and artificial light have a bad effect on accumulation of pollutants which are thus accumulate in the soil (Martilli A., 2014, P. 433).

In complex analysis of urban areas was introduced the concept of "urban heat islands" - heat islands. This concept can be explained as a place of blazing heat to the surrounding landscape, which is in nature cooled by vegetation. Heat islands are unfavorable for the population they cause health problems and cause additional higher energy efficiency of buildings. The heat resulting from incident solar radiation accumulates in building materials emitted heat radiation is reflected into the surrounding buildings and a slow air circulation is kept heated air in the city. Heated zone is also supported by heating facilities, cooling facilities, vehicles heating, and not least the heat emanating from the population. The decisive factor is the thermal capacity of buildings and roads, which is directly related to changes in evaporation. Surface streets are paved and thus the infiltration of rainwater into the soil or evaporation from the soil unrealistic (Mcgranes. J., 2016, P. 2296).

By using rainwater sewerage networks (for rapid discharge of surface runoff) is the impact on the urban environment highly negatively, since the water without any benefit transported outside the urbanized area. Otherwise, the accumulation of rainwater allows its subsequent use, for example, to irrigate urban green, sprinkling the streets or use of this water for the needs of the population. Water detained at the beginning of surface runoff has several positive effects on the urban climate. One of the impacts is also the cooling of the roofs and surfaces on which the precipitation is captured. At the same time, urban water can be irrigated with accumulated water, which will provide the necessary nutrients for its growth and thus directly create better conditions for the population. Finally, thus used water cools the urban environment through evaporation of the green parts of the plants and therefore directly counteracts the formation of heat islands. The use of retention infiltration of objects is clear some positive impacts on the urbanized areas. The water is infiltrated into the upper layers of the soil horizon, making it easily accessible to plants, which then cools the air with their transpiration. The waters that we can infiltrate at the site of precipitation reduce the overflow of the sewer system. The disadvantages of these objects may include spatial complexity, because these are flat large objects.

2 CALIBRATION MEASUREMENTS ON THE SEWAGE NETWORK

For solving research work it was intended urbanized part of the town of Levice. The highly populated area of the town of Vinohrady appears to be a very suitable area suitable for the accumulation of precipitation. Within accumulation and subsequent infiltration of rainwater is best optimization design of sewer network location regulatory objects directly in the area to which the actual runoff starts. Interest area belongs to the north-eastern part of the Slovakia Danube plain.

On selected areas are largely paved surfaces. Drainage of rainwater from this area is ensured by rain gullies on each street. The total urbanized area is 117 326 m^2, of which 74 055.7 m^2 (63.12%), constituting of paved areas including residential buildings. Rainwater from the roofs of nearby apartment buildings are transported into the sewer system via downpipes and connections. Waste water discharged sewage is disposed of in a waste water treatment plant in Levice -Géňa. Calibration parameters for assessing sewer network topography and the altimetry were areas which were targeted by GPS in the spring of 2017 and to an accuracy of 6 mm. Other parameter input to the assessment of the population figures, which were obtained from the Bureau of Statistics and data on rainfall totals.

3 RESULTS AND DISCUSSION

The aim of modeling is to highlight the impact of extreme rainfall to rainfall-runoff conditions. Due to ongoing climate change happens, it is becoming more widely occur during multi rains. One of the main reasons for which there is frequent but mostly to abundant precipitation over the last century is just above atmospheric temperature. Numerous are the extraordinary abundant rainfall, resulting in the remarkably high incidence of local or regional extensive flooding in the last two decades. (Leonhardt G., p. 885)

To assess the efficiency of the sewer network was made for 15-minute model block rains and these block rain was used by considering the rain curve for the Nový Tekov rainfall station. The intensity of the individual rainfall was calculated according to Urcikan, from the basic data on the local parameters for the Nový Tekov rainfall station, which reliably corresponds to the intensity and yield of the rainfall occurring in the area concerned.

The drainage area of the area of interest is 117 326 m^2 and the length of the sewerage network is 1492 m. In the assessment of the area they are worked out different scenarios burden on sewer network block rain with different periodicities. The input parameters for the assessment of the sewerage network were based on the number of inhabitants per dwelling unit, according to the available information in the public electronic administration of Levice. There were 2980 inhabitants from the streets Paláriková, Krátka, Južná, Severná, Pri tehelni, Školská a Hlboká (Žiaran J., 2015, p. 187-198).

3.1 Assessment of sewerage network with heavy rain for periodicity p 0,5

In our assessment of the existing sewer system was used SEWACAD software, which is used for modeling of surface runoff and software was also used to assess the effectiveness of static drains. The first condition was modeled runoff during rain with a periodicity p 0.5 represents the intensity of the rain occurring once every two years. Between manholes they were developed rainfall-runoff districts. On the ground surface they represent these districts area of rain runoff and underground these districts are representing the length of the pipe between manholes.

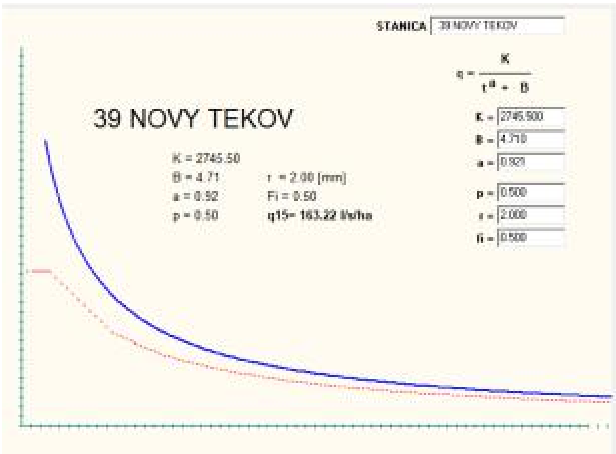

Fig. 1. The block rain curve – periodicity p 0,5

Overloaded districts [%]	Length [m]	Number of districts
0 - 100	1286	78
100 - 150	170	13
150 - 250	39	3
250 - 500	0	0
> 500	0	0

Tab. 1 Assessment of the sewerage system at rain with a periodicity of p 0.5

Assessment of the sewer network addressed area was found to be 83% collecting system meets the current state, and collecting system is capable of carrying the proposed run-off for rain, with a periodicity p = 0.5.

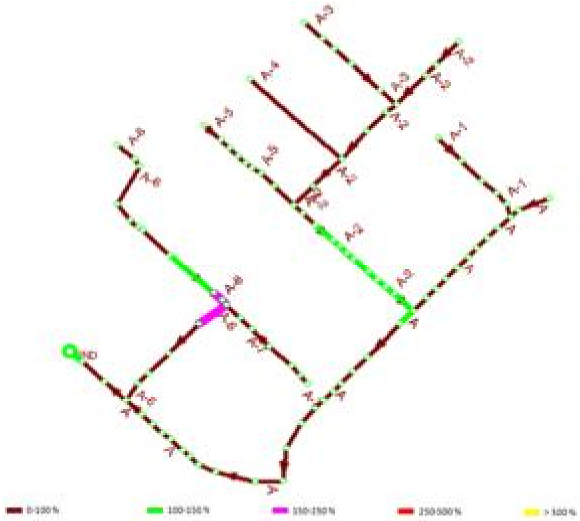

Fig. 2. Assessment of the sewerage system at rain with a periodicity of p 0.5 -hydraulic overload in %

3.2 Assessment of sewerage network with heavy rain for periodicity p 0,05

The second condition was modeled runoff during rain with a periodicity p 0.05 represents the intensity of the rain occurring once every twenty years.

Fig. 3. Assessment of the sewerage system at rain with a periodicity of p 0.05 -hydraulic overload in %

Overloaded districts [%]	Length [m]	Number of districts
0 - 100	1162	71
100 - 150	79	4
150 - 250	212	16
250 - 500	39	3
> 500	0	0

Tab. 2. Assessment of the sewerage system at rain with a periodicity of p 0.05

In the second assessment of the sewerage area, the sewer network is not suitable for discharging the surface drain to 75.5% for the proposed rain with periodicity p = 0.05.

3.3 Assessment of sewer network in the use of infiltration facilities

After the flooded objects were placed on the treated area, seamless operation of the sewerage system would be ensured even during intense rains up to P 0.05. Designed infiltration objects were designed according to the German standard in a total of 6 objects. (DWA-A 138 En 2005) The assessment considered the existing profiles DN 400-800. The proposed variant of the pipe profile is oversized for only sewage water itself. For a given area, in the event of wastewater was suitable variant DN 300 for population in 2980 and with a flow rate in the final profile Q_V = 25.87 l/ s.

Fig. 4. Assessment of sewer network in the use of infiltration facilities

4 CONCLUSION

Aim of this paper was to analyze the rainfall runoff in urban area of Levice and then assess the functionality and efficiency of the sewer network in the area of interest. When assessing been processed scenarios assessment at Block rains of varying periodicity of rain. The results can be clearly seen that the impact of climate change has a significant impact on drainage conditions. Even a rain with a frequency p = 0.5 is shown regions which failed to convert flow rates without significant load. Part of the assessment is also the design of the DWA-A 138 standard-intake objects in the area of interest. The results of simulations on real territory is seen up to 500% overload some parts of the sewer network. With the proposed infiltration objects, the sewer system could be relieved by 100% of the rainwater and thus ensuring safer operation of the sewerage network. These findings serve as a basis for solving the project of the Excellent Young Teams STU under the title "Analysis of Impact of Green Infrastructure on Qualitative and Quantitative Indicators of Surface and Groundwater in Urban Areas", which analyzes the impact of rainwater retention on their quality and quantity in the under-terrain environment which is solved in these days.

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