THE INFLUENCE OF HYDROMETEOROLOGICAL PARAMETERS ON THE CONDITION OF THE GREEN ROOF OF KOMÍN KINDERGARTEN DURING THE YEAR

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Abstract

The article discusses the influence of hydrometeorological variables on the moisture status of the green roof at a kindergarten in the Brno-Komín district. Data on precipitation, temperature, relative humidity and wind speed were recorded for one year, and after a year of recording, an evaluation of the influence of these variables was processed. The correlation coefficient of the dependence of individual variables on the weight of the structure composition was determined.

Keywords

Extensive green roof, humidity, precipitation, temperature, humidity, correlation coefficient

1 INTRODUCTION

The aim of the article was to evaluate the condition of the green roof over a period of one year and to identify the influence of hydrometeorological influences on the processes taking place in the extensive green roof of a kindergarten building in Brno-Komín. For one year, variables such as relative humidity, precipitation, wind speed and temperature were measured on the green roof. A similar experiment was conducted by a team from the University of Wrocław [1], [2], [3]. The mention of the above research only serves to point out the methodology used and its relevance. To compare these variables with the condition of the roof, weekly weight gains were measured on an area of 0,25 m^2 of the green roof. The measurement was carried out using a control segment and a measuring tripod. Depending on the results, the author wanted to create an optimized maintenance plan for the extensive green roof. The impetus for this investigation and expertise was the identified insufficient maintenance of green roofs in the public and private sectors. During the research, several hypotheses gradually emerged from the investigation, which were verified or refuted.

2 METHODOLOGY

The research was carried out in several stages, which were linked to each other and refined the research results. First, the analysis of work procedures in the implementation of several types of green roofs was carried out. This was followed by the implementation of control segments and the introduction of a measurement methodology in order to achieve the most accurate result. During the research, the hydrometeorological variables were recorded and the mass values of the control segment on the green roof were measured. Furthermore, the condition of the green roof in the winter period was examined, and an experiment on runoff from the green roof structure with and without hydroaccumulation was carried out. A similar experiment was also the subject of a study of the influence of substrate and vegetation on the hydrological performance of roofs and evapotranspiration research in Germany. [4], [5]. During the experiment, an experimental calculation and determination of the retention capacity of the green roof was also carried out, similar to the article Retention capacity of extensive green roofs. [6] However, this experiment is not described in detail in this article and the author deals with them in other literature. In the final phase of the research, research was also carried out in the area of current maintenance of the implemented green roofs and, based on all these aspects, an optimized plan was created, which has the structure of

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a technological regulation. At the end of the research, the correlation coefficients of the dependence of individual hydrometeorological variables on the mass of the roofs were also determined. Before starting, the author established hypotheses that the measurement was supposed to disprove. These were hypotheses about the influence of humidity, temperature, wind speed and precipitation on the weight of the roof section.

Analysed green roof of kindergarten

Fig. 1 Green roof of kindergarten Brno-Komín.

The green roof on the kindergarten was implemented in 2021. An extensive green roof composition was installed on an area approximately 700 m^2, Fig.1). The traditional green roof composition was installed with a studded foil, geotextile, hydroaccumulation layer, substrate layer and sedum vegetation carpet.

Measurement methodology

Fig. 2 Control segment on tripod.

The measurement was carried out using a control segment inserted into the layers of the green roof. This segment was regularly removed from the roof, placed on a measuring tripod with a scale and the mass value was recorded (Fig. 2). This measurement was carried out at weekly intervals with the same procedure.

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Recorded quantities

During the measurement, various quantities were recorded that were essential for establishing various weather dependencies on the condition of the green roof:

1. Segment weight.
2. Total precipitation.
3. Relative air humidity.
4. Wind speed.
5. Daily temperature.

All the above were recorded in a clear table (Tab. 1). The temperature, humidity, wind speed and daily precipitation were supplied by the hydrometeorological office with daily values. Finally, a graph was created showing the individual quantities and their mutual characteristics with the mass of the segment.

Tab. 1 Preview of the control table.

Date	**Precipitation (mm)**	**Segment Weight (kg)**	**Wind speed (m/s)**	**Temp. (°C)**	**Rel. humidity (%)**
10.1.2023	0,00	25,42	1,2	5,8	74
11.1.2023	1,50		1	3,2	80
12.1.2023	0,60		0,6	5,4	89
13.1.2023	0,50		2	6,2	83
14.1.2023	0,60		1,6	5,5	73
15.1.2023	7,60		3,2	3,8	91
16.1.2023	2,60		2,4	2,8	90
17.1.2023	4,80	25,74	2,3	3,3	83
18.1.2023	0,20		0,8	1,4	92
19.1.2023	0,00		0,9	1	74
20.1.2023	1,30		1,8	-0,3	74
21.1.2023	0,00		1,9	0,1	81
22.1.2023	3,80		0,9	0,8	87
23.1.2023	0,00		2,4	3,2	81
24.1.2023	0,10	25,68	2,6	3,1	80

Winter check-up imaging

During the winter months, control imaging of the green roof was also carried out to analyse the impact of the segment on the thermal and technical properties of the roof (Fig. 3). Here, the inconsistent implementation by the implementing company had a major impact.

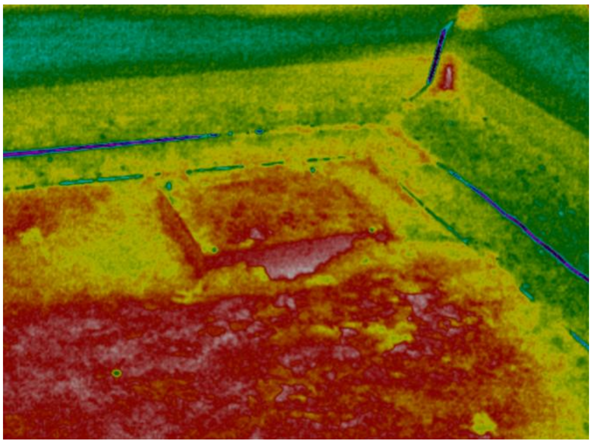

Fig. 3 Control segment in winter.

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The image shows an increased heat flow in the area where the segment is not sufficiently covered with substrate. The other material of the segment freezes more than the surrounding layers, and the space around it transmits more heat.

3 RESULTS

Verification of input hypotheses was carried out from individual graphs of annual values for individual hydrometeorological variables.

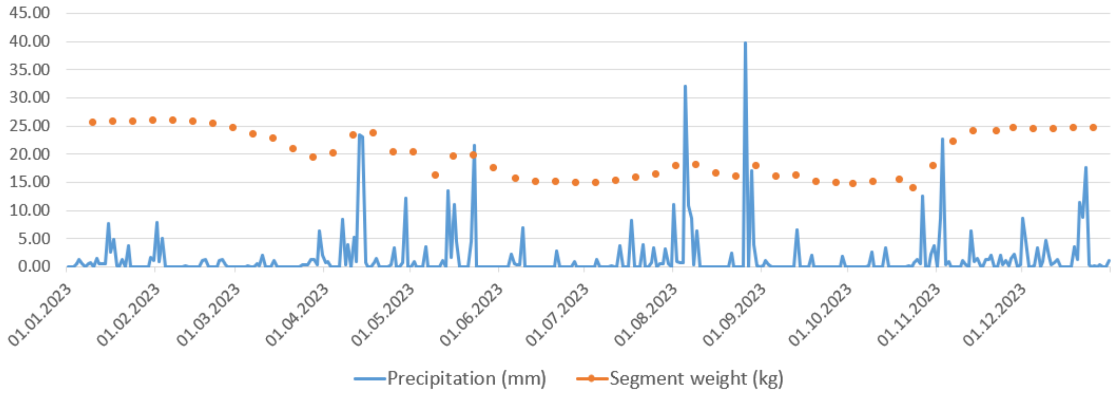

Fig. 4 Precipitation and segment weights.

In the case of recorded rainfall data, the individual daily measurements differed greatly from each other (Fig. 4). In order to obtain the most accurate correlation between the deviations of rainfall and segment weight, weekly averages of rainfall were calculated and subsequently compared with the weekly weight measurements.

The correlation coefficient in this case was k = 0.26.

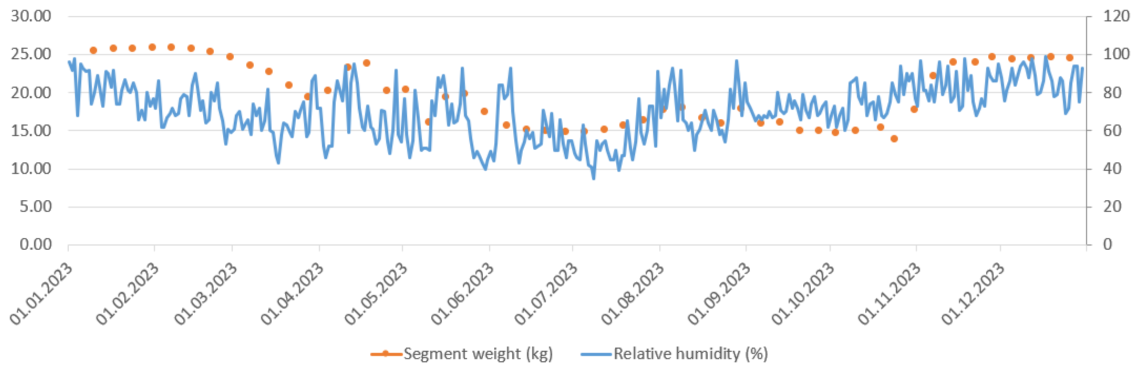

Fig. 5 Relative humidity and segment weights.

The dependence of air humidity and segment weight is higher (Fig. 5). Individual humidity does not differ from each other as significantly as for precipitation, and therefore the correlation coefficient is equal to k = 0.52.

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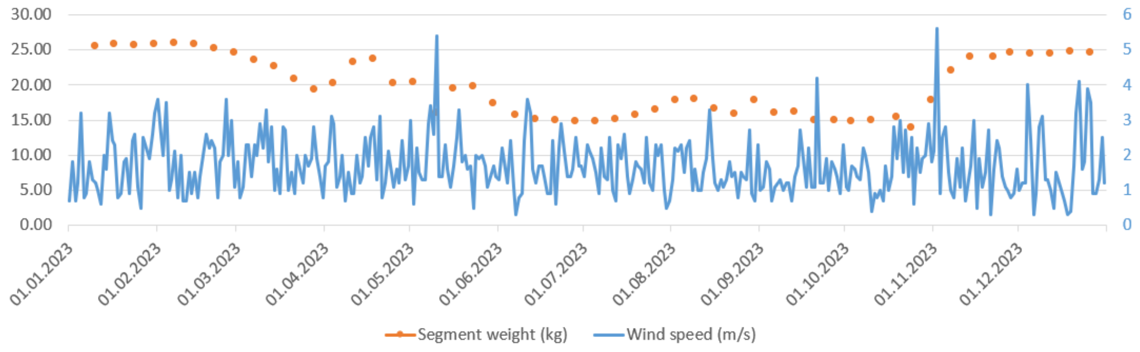

Fig. 6 Wind speed and segment weights.

Wind speed values, as in the case of precipitation volumes, are highly variable and therefore their dependence on segment mass did not show any similarity or dependence (Fig. 6). The correlation coefficient is equal to k = 0.07.

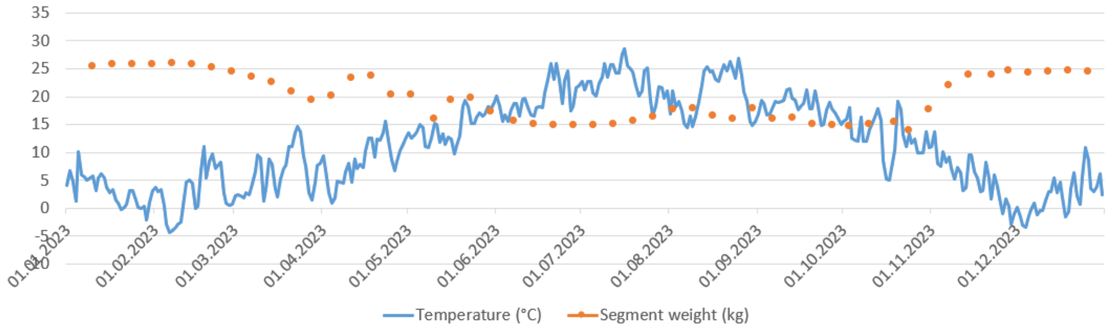

Fig. 7 Temperature and segment weights.

The opposite trend is shown by the daily temperature value (Fig. 7). Here the values are gradually increasing or decreasing, as with the weight values, but with the opposite trend. The correlation coefficient is k = -0.87.

Correlation coefficients are summarised in Tab. 2.

Tab. 2 Correlation coefficients.

	Precipitation	**Humidity**	**Wind speed**	**Temperature**
Correlation	0.26	0.52	0.07	-0.87

4 DISCUSSION

After evaluating all measured values, we concluded that although the precipitation graph shows a similar trend, the low correlation coefficient for the amount of precipitation is caused by a high dispersion of consecutive values. An increase in the coefficient would be noticeable in the case of daily measurement of weight values. Zero precipitation values also contribute to the decrease in the coefficient during the year.

A similar consideration can be applied to humidity. There are no values with a large difference here, but the frequency of weight measurements would also significantly increase the coefficient.

The smallest dependence is that of wind speed, which has a negligible effect on weight. The roof structure is built behind the attic to minimise wind effects, therefore we can use the effect of the wind as almost zero.

A clear dependence is shown in particular by the temperature value, which does not fluctuate during the year, and, therefore its coefficient is the highest of all measured.

In conclusion, we can exclude the hypothesis of the dependence of wind speed on the weight of the roof, in the case of precipitation it must be stated that the frequency of measurements significantly influenced the degree of dependence and therefore the hypothesis is refuted. Assuming a higher frequency of measurements, the hypothesis would most likely be verified. The highest degree of dependence is shown by the temperature value, so the hypothesis of this quantity is confirmed.

5 CONCLUSION

The highest temperature dependence was found on the body weight segment. This confirms the fundamental dependence of selected quantities on the condition of the green roof. The dependence was quantified using correlation coefficients. The hypotheses regarding the dependence of temperature, humidity and precipitation on the roof structure were confirmed, while those concerning were refuted. Optimal maintenance period according to the condition of the structure was determined. The research contributes to the development and optimization of light green roofs and their optimization based on the collected data. This study continues as part of doctoral research.

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