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# PARAMETERS OF RAINWATER COLLECTION AND STORAGE – MEASUREMENT AND EVALUATION

# PARAMETRY ZWIĄZANE Z GROMADZENIEM I PRZECHOWYWANIEM WODY OPADOWEJ – POMIARY I OCENA

A b s t r a c t

This paper describes the experimental evaluation of the effect of using different roofing materials affecting the quality and quantity of the amount of rainwater collected and stored in the Kosice city area. The two sites that were tested were located at the TUKE (Technical University of Kosice) campus site. Two models serving as data sources were located on the roof of the University library and a third source of data was an actual school building (PK6). The results obtained were then inputted to create a simulation. This article provides a detailed analysis of the factors at play in relation to the quality of rainwater collected and drained off from the PK6 building roof, and also an evaluation of an experimental model relating to a ceramic tiled roof. The results show that both roofing materials tested are suitable for systems collecting and storing rainwater. Ceramic tiles are suitable for the purpose without any complications concerning further treatment; Ceberit needs additional treatment and disinfection. The findings shall be used to inform the next step – modelling data.

*Keywords*: *rainwater*, *quality*, *quantity*

S t r e s z c z e n i e

Artykuł opisuje ocenę eksperymentalną efektu użyciu różnych materiałów dachowych wpływających na jakość i ilość ilości wody deszczowej gromadzonej i przechowywanej na terenie miasta Koszyce. Dwa testowane obiekty znajdowały się na terenie kampusu TUKE (Uniwersytet Techniczny w Koszycach). Dwa źródła danych znajdowały się na dachu Biblioteki Uniwersyteckiej, natomiast trzecim źródłem danych był rzeczywisty budynek szkoły (PK6). Otrzymane wyniki zostały następnie użyte do symulacji. Artykuł zawiera szczegółową analizę jakości wody deszczowej zebranej i odprowadzanej z dachu budynku PK6, a także ocenę modelu doświadczalnego opisującego dach pokryty dachówką ceramiczną. Wyniki pokazują, że oba badane materiały dachowe są odpowiednie dla systemów zbierania i przechowywania wody deszczowej. Płytki ceramiczne są odpowiednie do tego celu, bez żadnych dalszych działań; Ceberit wymaga dodatkowych zabiegów oraz odkażenia. Wyniki powinny zostać wykorzystane w kolejnym etapie – modelowaniu.

*Słowa kluczowe*: *woda deszczowa*, *jakość*, *ilość*

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## 1. Introduction

Stormwater management is a relatively new issue in Slovakia. There is no legal framework giving standards or guidelines as to how to apply sustainable stormwater management techniques. As a result of repeated flooding incidents, we are mindful of the need to adopt more effective stormwater handling procedures. There are numerous techniques and approaches applied worldwide to support sustainable stormwater management, especially in urban areas where stormwater can cause significant damage. Nowadays we are more open to these new approaches especially in cases where the issue concerns sustainability in stormwater management such as flood prevention / protection and pollution reduction measures. The aim is to manage stormwater as close to the source as possible (termed as source control) which encompasses a number of measures. The 'harvesting' (collection and storage) of rainwater within these source control measures may also contribute to stormwater management sustainability, by promoting portable water conservation measures and water management sustainability in general [1].

## 2. Measurements of the quality of rainwater run-off

This article describes the experimental evaluation of the effect of using different roofing materials affecting the amount of rainwater in the Kosice city area. The two sites that were tested were located on the TUKE (Technical University of Kosice) campus site. Two models serving as data sources were located on the roof of the University library and a third source of data was an actual school building PK6 (Fig.1). This article provides a detailed analysis of the factors in play in relation to the quality of rainwater draining off the PK6 building roof and also an evaluation of an experimental model with a ceramic tiled roof [2].

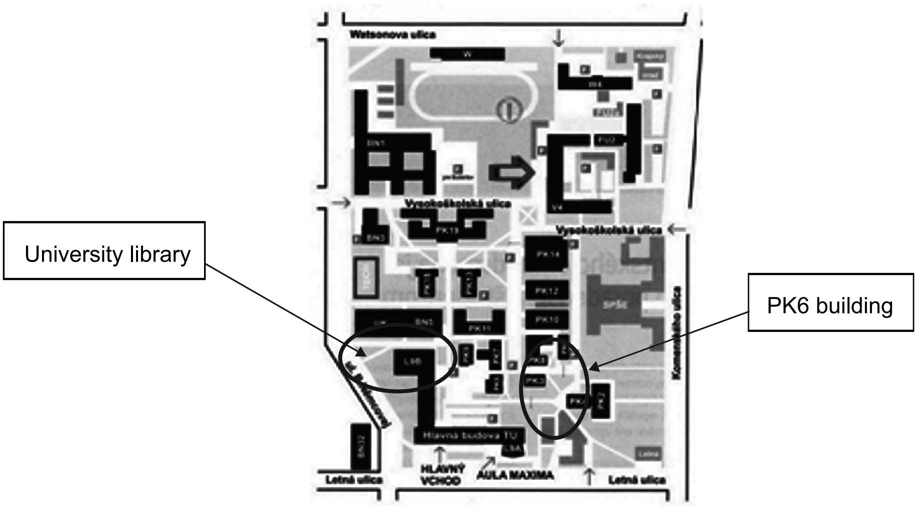


Fig. 1. Location of the research points at the TUKE campus site

### 2.1. Models located on the library roof

Two identical roofing models were placed on the University library rooftop (Fig. 2). The design allows for the pitch angle to be adjusted and also for the model roofing material to be exchanged for other materials. All components required to collect RHSR data may be fastened to the models (Figs. 3, 4). Ceramic tiles, lakoplastic, and concrete roof tiles have been used. X marks the angle of slope at which readings are first taken. The objective

Fig. 2. Models located on the roof of the University library

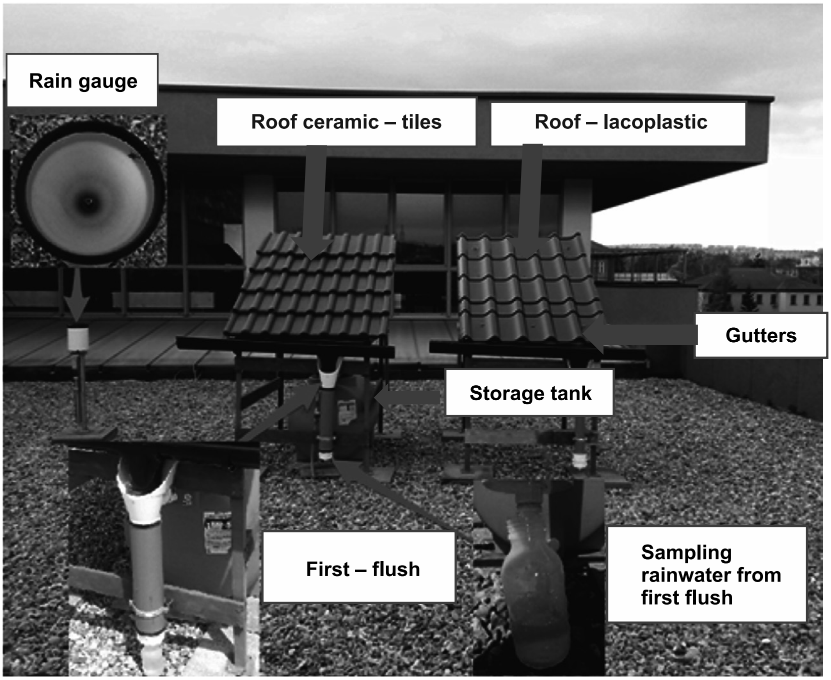


Fig. 3. The model's components

of the exercise is to identify the material best suited for the collection of RHSR in the Kosice city area. This is done by using a simple flow meter, a precipitation measuring station, and by conducting rain water quality analysis. Models are still being constructed. At present, one model with a ceramic tiled surface continues in operation.

Fig. 4. The model's components

Roofing materials are chosen according to the most commonly used roofing materials in Slovakia, but the choice also depends on suitability of use for of the collection and storage of RHSR.

The qualitative indicator results for RHSR collected from a model fitted with ceramic tiling are presented in Figs. 5, 6. The RHSR quality was monitored between June and December in 2012. Water samples were taken regularly on the 3rd, 15th and 30th days of the month from a 100 litre tank. Two parameters were examined: pH and conductivity.

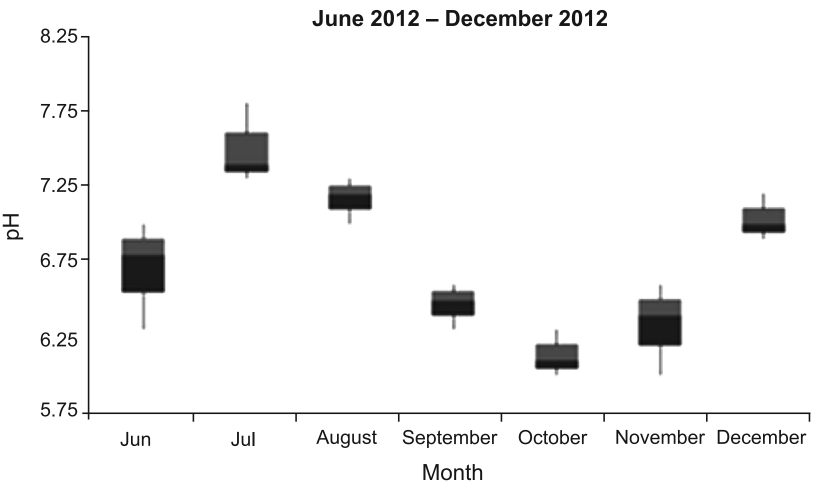


Fig. 5. pH values of the model with ceramic roof tiling

These values were obtained through the collection and subsequent chemical analysis of rainwater samples. The pH values of the water during the 2012 sample period are shown in Fig. 5. The mean pH value, at 25°C, was 6.7, the maximum pH was 7.8 and the minimumwas 6.1. According to the NV SR regulation (number 269/2010 Z.z.), the pH value should be in the range of 6 to 8.5. In fact, the pH values obtained during the June to December observation period were at a standard level.

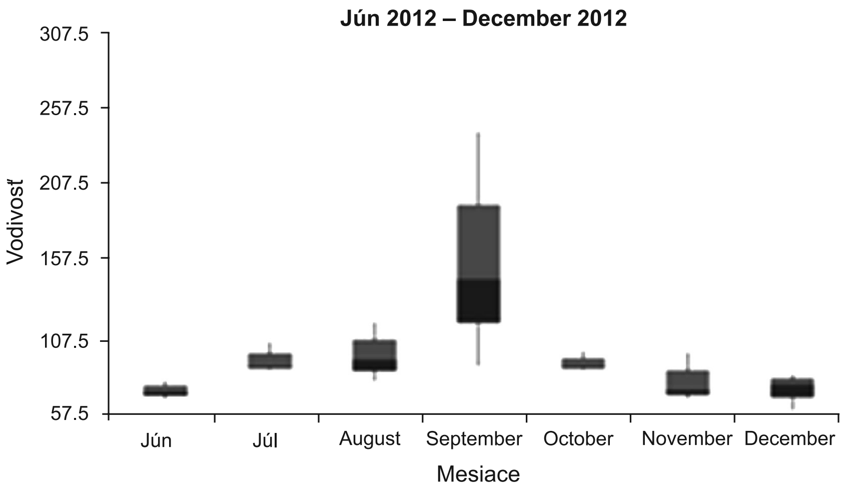


Fig. 6. Conductivity values of the model fitted with ceramic roof tiling

The water conductivity values during the 2012 survey period are shown in Fig. 6. According to the NV SR regulation (number 269/2010 Z. Z), the conductivity limit for water in portable storage represents 100 mS/m which is equal to 1000 mg/l. In optimum conditions, portable water supplies should be less soluble in substance, i.e. 200–400 mg/l (about 25–50 mS/m). In most cases, the conductivity values did not exceed the standard value of 100 mS/m [14]. September was an exception with higher conductivity values recorded. The average conductivity value of is 96 mS/m.

### 2.2. Building PK6

The PK6 building at the Technical University of Kosice campus was selected for research into the quality and volume of rainwater draining into existing underground drainage shafts. Two vertical shafts are located next to the PK6 building. All of the run-off rainwater falling onto the roof flows into these underground pipes (Fig. 7).

A multiparameter water sensor took qualitative measurements of pH and conductivity readings from late 2011 onwards. The sensor was installed in a measurement flume inserted in one of the drainage shafts (Fig. 8). Values for pH and conductivity were recorded on a continuous basis.

The Box-Plot graph shown in Fig. 9 depicts the pH values of the rainwater from the PK6 building throughout 2012. Figure 9 shows that the average pH value varied each month. The pH values in June and October indicated RHSR levels of acidity.

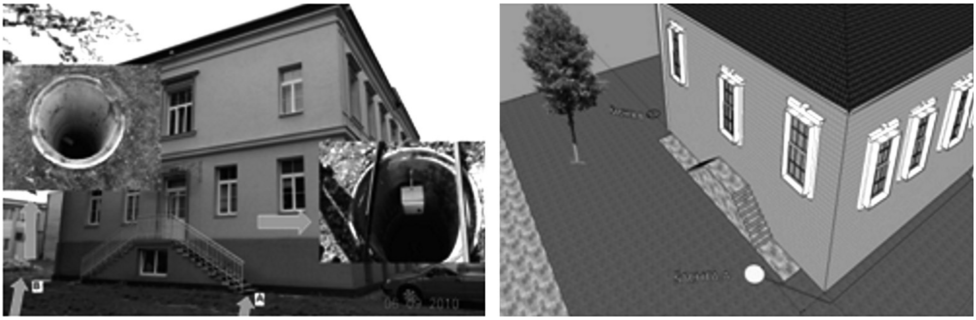

Fig. 7. Location of drainage shafts near the PK6 building [3]

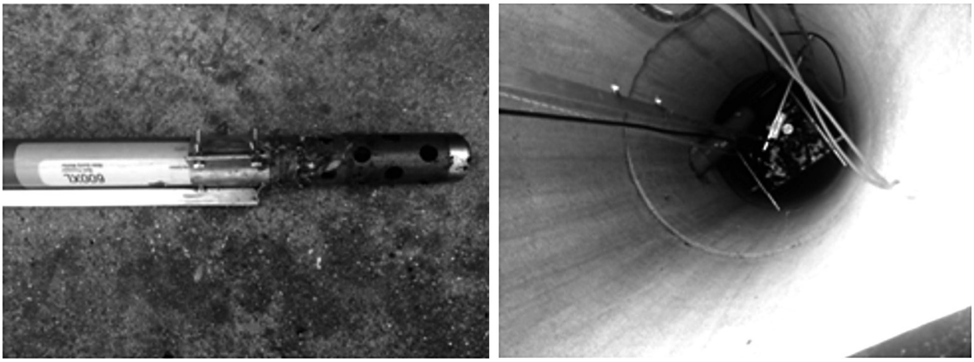

Fig. 8. The multi-parameter water sensor in the drainage shaft near the PK6 building

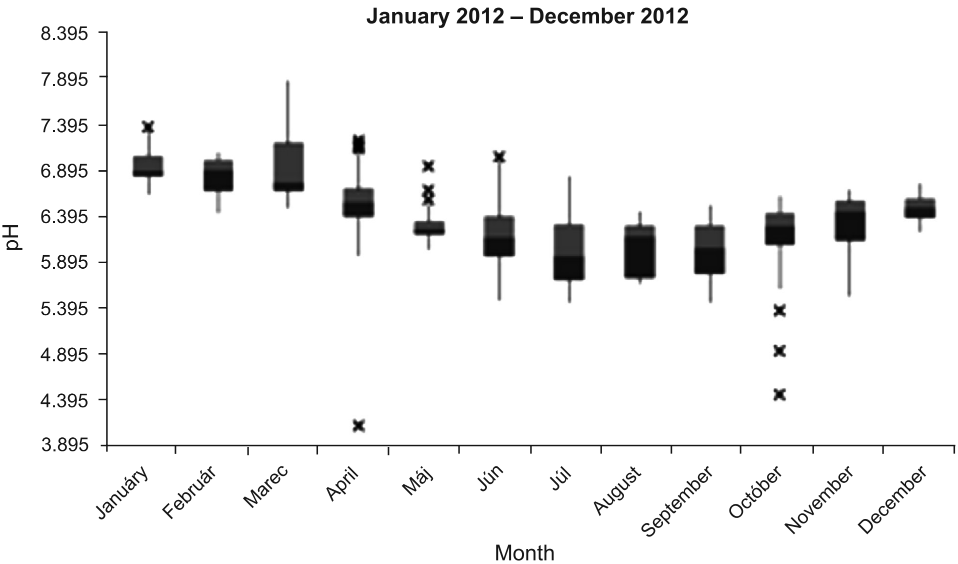


Fig. 9. pH values of rainwater collected from the PK6 building during 2012

Another water quality indicator is the conductivity of the water collected from the PK6 building. As with the pH values, the conductivity levels were also measured on a continuous basis using the same multi-parameter sensor (Fig. 8).

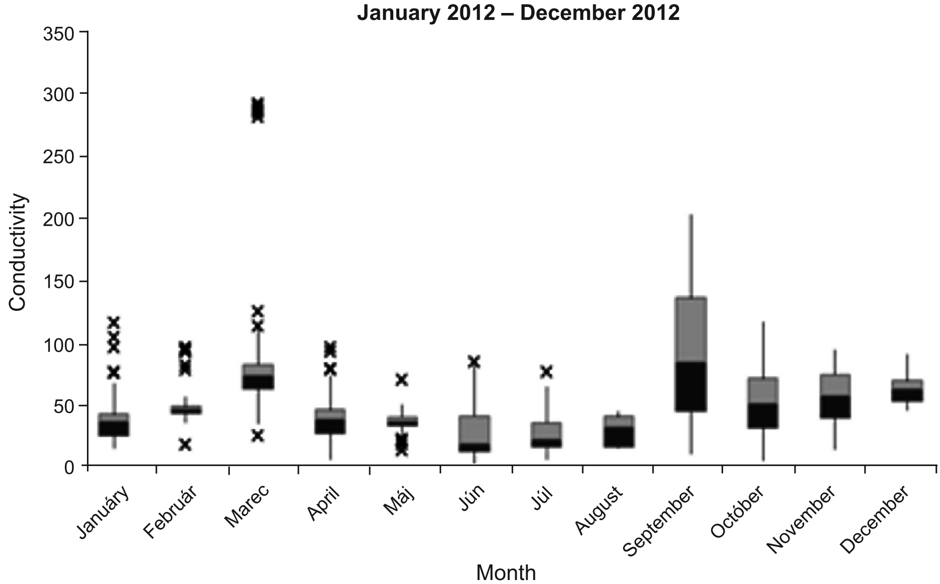


Fig. 10. Conductivity values of the rainwater from the PK6 building during 2012

Conductivity refers to the approximate rate of the concentration of electrolytes in water. Conductivity values of rainwater during the 2012 period are shown in the Box-Plot graph in Fig. 10. From this graph, we can see that the average value for each month varied, but in most months the values were satisfactory. Limits were exceeded during periods of rainfall, howeveron most occasions the conductivity levels were within acceptable standards and were occasionally satisfactory. September was an exception, when the limit was exceeded [2].

## 3. Conclusions

The storage and re-use of rainwater collected from rooftops of buildings in the Slovak Republic is not so commonplace as it is in the USA, Western Europe, Australia etc. The limiting factors are lower prices of drinking water and high initial investment costs of technological equipment required to turn rainwater into a re-usable resource.

The rainwater quality measurements taken from the PK6 building roof, and from the roofing models sited on top of the university library, demonstrate that the rainwater meets quality standards for the purposes of collection, storage and re-use, as well as for the purposes of rainwater infiltration.

Clearly, it is necessary to take each project on a case-by-case basis, because rainwater collection and storage systems are sensitive to, and dependant on, local site and building design conditions [6].

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*VEGA 1/0450/12*
*Rainwater management and energy balance research in the cities of the future.*

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