43RD INTERNATIONAL SYMPOSIUM
CIB W062

RAINWATER HARVESTING SYSTEMS IN BUILDINGS WITH GREEN ROOFS

A STUDY ON RUNOFF COEFFICIENTS

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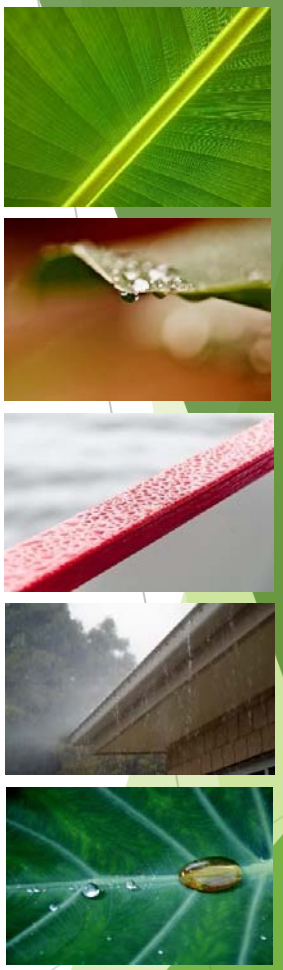
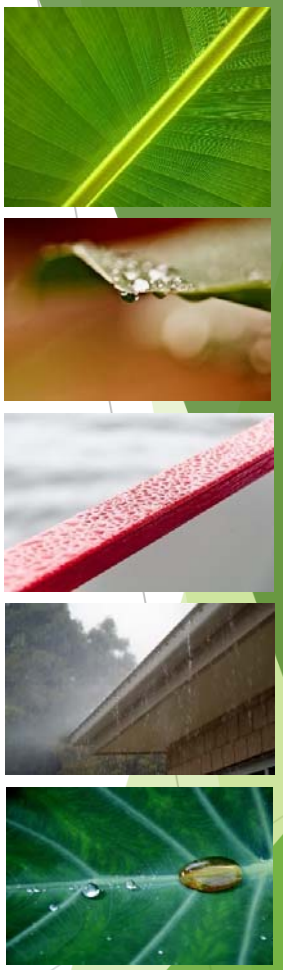
1. Introduction

- The hydric stress is increasing on a global scale (especially in the countries of the Mediterranean basin), as a result of the climate change.
- The use of rainwater harvesting systems (RHS) in buildings, allowing the use of an alternative source of fresh water, can be a good solution to increase the water efficiency in urban environment, and also contribute to reduce flood peaks on storm water drainage systems.



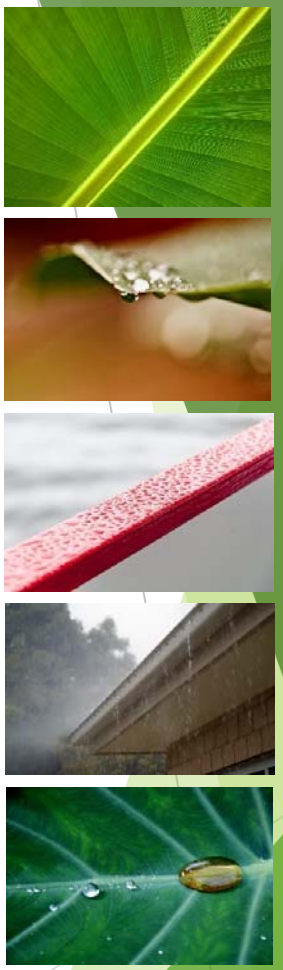
1. Introduction

- The construction of green roofs (GR) can also contribute to reduce the peaks of heavy precipitation (whose frequency and intensity will also be accentuated with the climate change).
- Thus, the construction of GR combined with rainwater harvesting systems are becoming particularly promising, given that it appears as an important solution to increase the sustainability and resilience of buildings and cities.



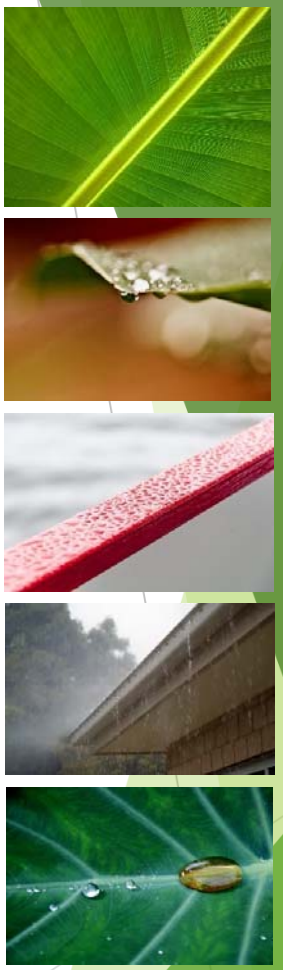
1. Introduction

- A project focused on the conception and study of innovative green roofs made with expanded cork agglomerate (ICB) are being developed in Portugal.
- In order to combine this innovative GR with rainwater harvesting systems, it is necessary to determine the runoff coefficients of these GRs.
- In countries with a Mediterranean climate, the design of rainwater harvesting systems is based on **monthly runoff coefficients.**



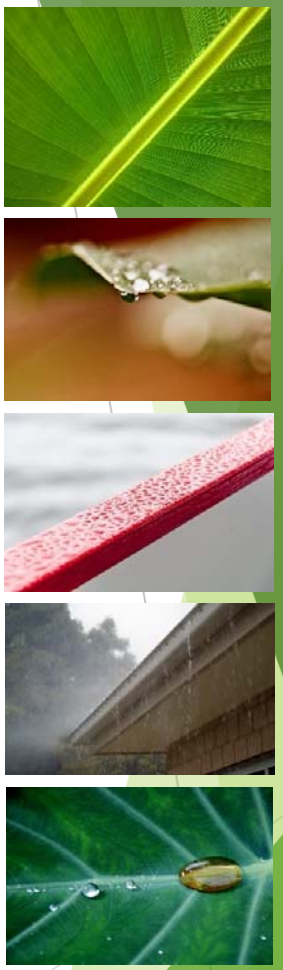
1. Introduction

- Experimental studies carried out for an extensive green roof pilot system (in Oporto city, Portugal), with a traditional structure, have allowed the development of an general expression for the monthly runoff coefficient in this type of green roofs.



2. Purpose of this study

- The purpose of the ongoing research is generalize and validate for the innovative type of GR the expression deduced for the pilot GR (with traditional structure), considering different locations with different climatic characteristics.



3. Methodology

GREEN ROOF SYSTEM WITH ICB

Conception and study of innovative GR made with expanded cork agglomerate

Compatibility of this system with rainwater harvesting systems in buildings:

MONTHLY RUNOFF COEFFICIENT (C_M) = ?

Current knowledge – **ETA 0701** ANQIP

THEORETICAL STUDIES

Theoretical results obtained by the application of the expression in diferente zones in Portugal.

PREVIEW STUDIES

PILOT GREEN ROOF SYSTEM

Experimental tests for a period of 12 months (Mar 2013-Feb 2014)

Extensive GR.

Development of the expression for monthly runoff coefficient (C_M):

$$C_M = \frac{k_1(P_M - R_M)}{(k_2 T_M - T_{M-1})^{k_3}}$$

With k_1 = 0.016; k_2 = 2 and k_3 = 1.2

ONGOING STUDIES

EXPERIMENTAL TESTS

The experimental tests with new GR are in progress to evaluate the runoff coefficient value ad validate the expression previously defined.

Period: 1 year.

k_1, k_2 and k_3 = ?

Adjustment of k_i values, through the experimental results

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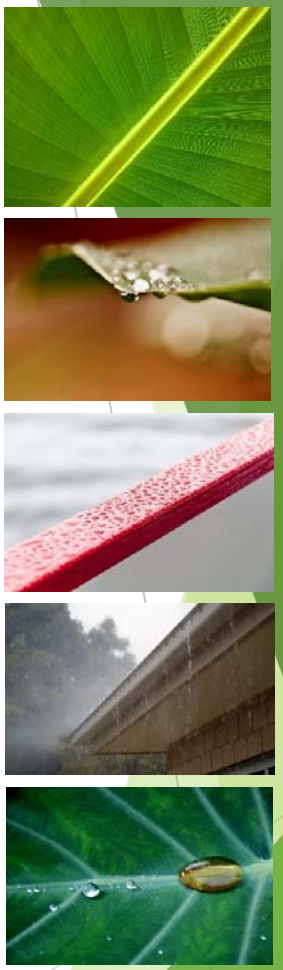
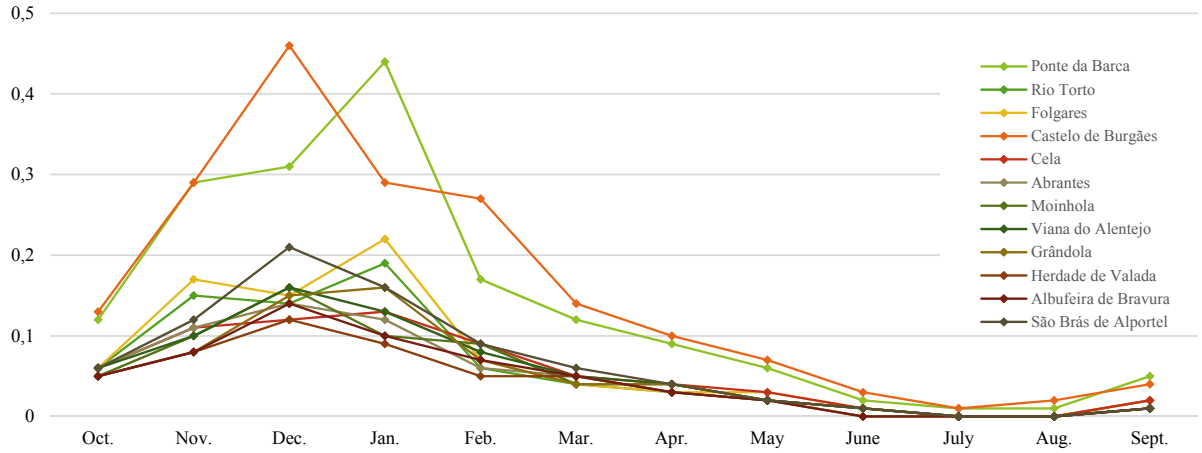
3. Methodology

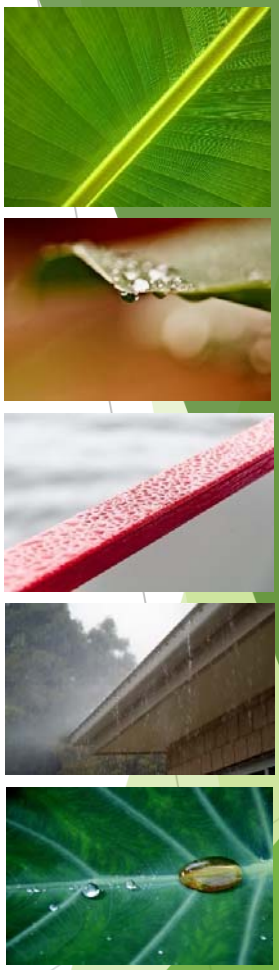
- The expression to predict the ‘monthly runoff coefficient’ of the GR, depends of:
  - C_M = Runoff coefficient of the month M;
  - P_M = Precipitation of the month M (mm)
  - R_M = Watering of the month M (mm)
  - T_M = Mean air temperature of the month M (ºC)
  - $T\_(M-1)$ = Mean air temperature of the month M-1 (ºC)



4. Results

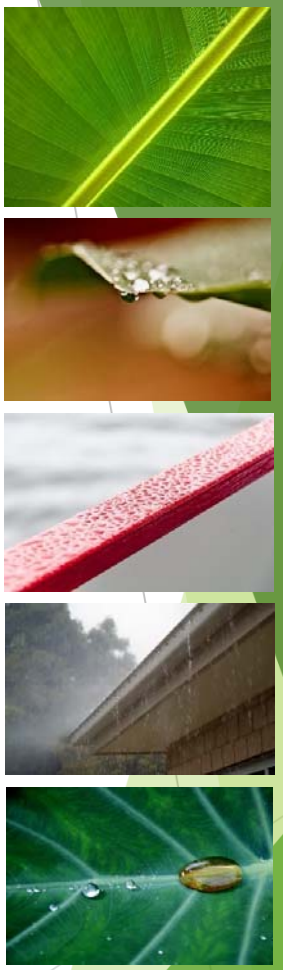
- In a first phase, the general expression to determine the monthly runoff coefficients was applied to 12 stations of Portugal where it is possible to get temperature and precipitation values.





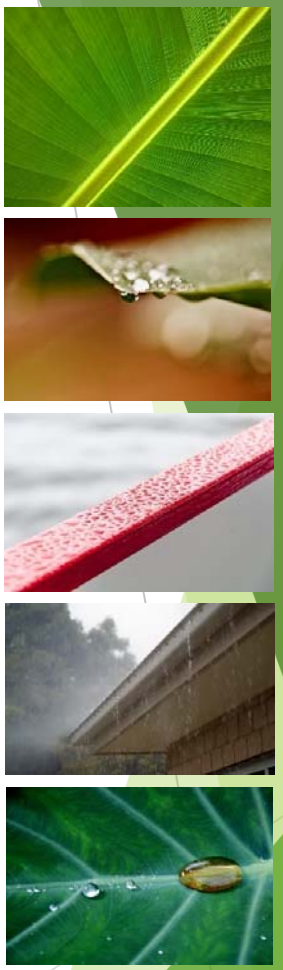
4. Results

- In a second phase, the validation of this expression for the new type of GR (with ICB) is done (adjustment of the coefficients k_1, k_2 and k_3).
- At the moment, experimental studies are under way for one of the stations (Coimbra area).



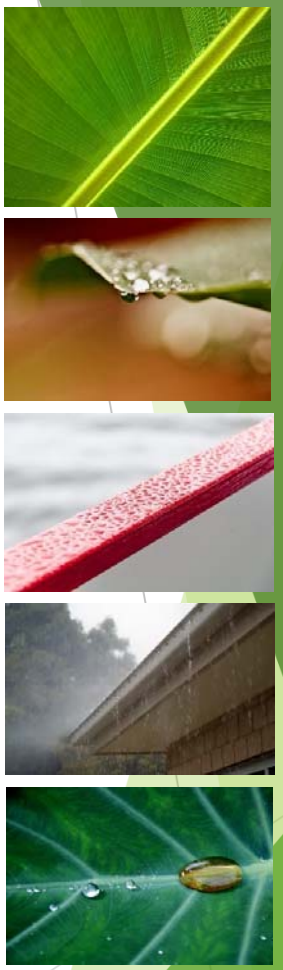
5. Conclusions

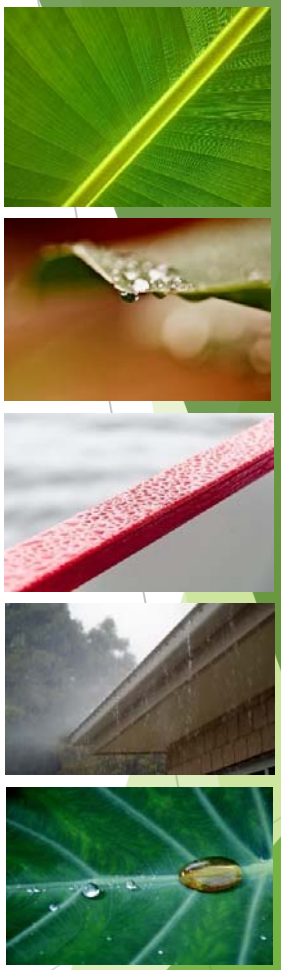
- The combination of green roofs (GR) with rainwater harvesting systems (RHS) seems a promising solution that can contribute greatly to an appropriate response to the impacts of climate change, increasing the resilience of buildings and cities
- These solutions should be widely generalized in the future. However, the design of these combined solutions has a great dependence of the type of GR and particularities of the local or regional climate.



5. Conclusions

- Experimental studies carried out for a traditional extensive GR (in Porto city, Portugal), aiming the design of RHS in buildings with GR, have led to the development of a general expression to predict the 'monthly runoff coefficients'.
- In this context, the main objective of this work was to generalize and validate in different locations, for the innovative GR (with ICB) in development, the expression previous deduced for the extensive traditional GR.





Thank you very much for your attention!

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