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# WATER MANAGEMENT OF "SMART" BUILDINGS AND CITIES

Now is the time to take our future more seriously and start providing solutions for tomorrow´s world. The new notion or significant specification of the term "*BLUE to GREEN*" infrastructures in buildings in the modern information age is the expression of the sustainable development of a „smart city" society and beyond. We introduce our experimental platforms representing different types of green roofs, green and water walls as possible solutions. These experimental sites in the University Campus were created on the basis of researche dealing with green roofs and their retention qualities, as well as green walls and their impact on the microclimate and the possibility of using rain and gray water that could be filtrated through the media of these structures. The paper describes the world-wide conditions on the basis of which this issue is up to date and addressed. The outputs from the individual measurements will be related to water cycle issues, green walls and roofs constructions.

**Keywords:** green roof, green wall, water cycle, water management

## 1. Introduction

Reports of water scarcity and many draughts due to climate changes are becoming increasingly common. The costs of water infrastructure have risen in every country. These and other aspects lead us to use alternative water sources as primary for building water supply. Massive use of reused water for non-potable purposes in buildings promotes the conservation of natural resources, water, and thus the overall sustainability in water management.

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The replacement of natural permeable green areas with concrete constructions and hard surfaces will be noticed in last decades. The densification of existing built-up areas is responsible for the decreasing vegetation, which results in the lack of evapotranspiration and cooling the air. Such decreasing vegetation causes so called 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 or walls, 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 our research.

The vision of our team – to introduce into reality the term "BLUE to GREEN" in the modern information age is the expression of the sustainable development of a smart cities society and beyond. The grey infrastructure is an urban engineering infrastructure (roads, drains, sewerage). The red one is a human community. The green parallels the grey. This is a network of natural area and open spaces. The last one is the blue (water) infrastructure. We expect that using our models and measurements can become a suitable tool to improve the life quality of residents and environmental awareness of the society.

Green building gives sustainability for the earth and it can protect it from the climate change, but it costs a lot of money to put the green wall or green roofs so we have to create something not so costly. Our idea is that we can build the building and build the green wall with it like two things in the sametime, so the plants can grow up when we finish the building. [4], [6]

## 2. Vision of sustainable green and smart buildings

The act of building green dividers and green rooftops ought to be advanced in urban regions in order to enhance the occupants´ wellbeing and life quality. Its main aim is for aesthetic and energy saving in building. 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], [5], [7]. [9]. Water distress is an issue, which has brought an attention on the possibility using green roof/ walls 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/ walls 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].

The green architecture and sustainable buildings is not a luxury academically and not a trend in theory or the aspirations and dreams have no place in reality, but it represents a trend universally applied and exercise professional conscious began to make up her features and dimensions significantly among architects and engineers involved construction in the advanced industrial countries. These countries have come a long way in this area and there is a marked increase in the popularity of this trend by the public under the attention continued by the professionals themselves and engineers are as effective tools that can localize these techniques and establish it professional during the design of building projects and supervising its implementation. This all in turn requires the direction to education architectural and engineering in our university so that the laboratories of Architecture Engineering Institute went green architecture and sustainable buildings of professional perspective and to create environmental and economic solutions to the problems faced by the construction sector we urgently need to change traditional patterns followed in the design and implementation of our buildings more sustainable, and this change is needed to make them and must start from the main elements in it.

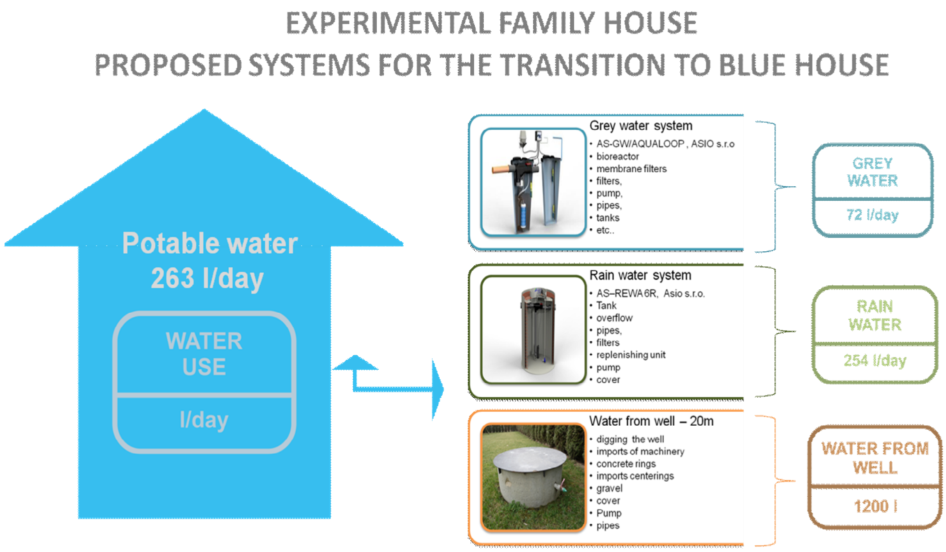


Fig. 1. Experimental house – proposed systems for transition from conventional to the blue one [4]

From the view point of grey water´s recycle treatment re-use in green and smart house, the feasibility and rationality is validated when it apply to buildings as an effective program of domestic water use which can both expand resource and reduce consumption. Whilst undertaking a water audit, it may be identified that rainwater and grey water are insufficient on their own to meet a part of the water demand in building. It may be possible to combine rainwater, grey water, water from well and potable water to provide a viable water source to cover the whole water demand at the building level (Fig. 1). [4], [6], [8], [9], [10].

## 3. Experimental green and smart building

The main challenge of the 3rd millenium is to reduce water consumption and to introduce the water-saving culture in the context of climate change. There are no studies taken about the influence of buildings transformation to green living system.

For this reason our aim is to explore the green design that is blending of four co-operating infrastructure strands into a seamless system. In this paper we introduce our experimental platforms representing different types of green roofs and green/ water walls. These experimental sites in the University Campus were created on the basis of different research in the frame of doctoral thesis as well as grant project dealing with green roofs and their retention qualities, as well as green or water walls and their impact on the microclimate and the possibility of using rain and gray water that could be filtrated through the media of these structures. (see Fig. 2 and 3).

Fig. 2. Models of green roofs prepared for experimental study

Fig. 3. Models of green walls and water wall prepared for experimental study

### 3.1. Methods of study

This paragraph deals with our vision with proceeding on the topic future water management of the sustainable building in the smart cities. We would like to introduce our conception. This shows four most important parts of the work (past and mostly future). We called it MAMA conception because of the four main steps [7]:

- Monitoring,
- Analysing,
- Modelling,
- Assessment.

These main steps should divide our research work into four working blocks with each step having its own objectives and outputs.

Monitoring and analsing parts consist more or less of data collection and according to the topic (green roof/ green or water walls), on the base of studying background documents, developing own methodology and preparing experiments. The most important part of this step includes are on site measurements.

The next point of the MAMA conception is the analysis which provides all necessary documents and information about the place of interest. This step include not only studying all background documents but on site, questionnaires and own measurements. The objectives of analysis provide a complex overview and input data necessary for the modelling phase.

For modelling part is important to know what kind of data do we need for the model. One of our aims is reusing rain/ gray water. That means that modelling part in this specific case will be concerned to the rainwater harvesting as a part of source control measure in stormwater management. Our target is to observe what the necessary equipment will be and at the same time effectiveness of potable water saving. Reliable combination of source control measures require to know what the total runoff will be.

Final step is evaluation and environmental assessment. For green constructions the topic target is to observe water retention, discharge coefficient and water storage features of walls used in research. Last part of this step is an assessment of all obtained results from previous parts of research. Evaluation of retention, possible improving of the water and air parameters, etc. as well as design prototypes for future work. For the society is very useful to perform return of investment assessment and also environmental assessment with all advantages and disadvantages of designed system.

### 3.2. Experimental tools

For our study we will practically use following equipments (Fig. 2):

- 4 green exterior platforms / roofs,
- 3 x 300 l tanks for rainwater accumulation,
- 6 x 60 l small tanks for water samples.

In the close future we start with monitoring of following parameters:

  - ✓ Rainwater quality,
  - ✓ Quality of rainwater accumulated in the green roof,
  - ✓ Quality of rainwater filtered by exterior green walls,
  - ✓ Water amount catched by the green roof,
  - ✓ Water amount catched in the green walls,

- 2 interior green walls (Fig. 3):
  - ✓ Indoor environment quality improvement,
  - ✓ Treatment and recycle of grey waters,
- Grey waster source – appliances in Laboratory of Institute,
- Green wall layers – test of effect of different substrates/ greens for treatment process effectiveness.

Monitoring:

  - ✓ Grey water quality on the input to the green wall and following effect on its parameters,
  - ✓ Water quality after filtration by individual substrates,
  - ✓ Water amount catched by substrate and necessary for green development,
  - ✓ Filterd water amount suitable for next using,
  - ✓ Effect on the indoor environment quality–humidity, temperature, $CO_2$,

- 1 type of substrate,
- 5 type of plants.

## 4. Conclusions

Potable water consumption of the Slovak households isn't above average at all but we use it in inappropriate ways. It is well known that around 60% of drinking water may be replaced by alternative water sources. This fact gives credit to reuse of potable water in building watercycle and better percentage weight in building environmental assessment.

In Slovakia, the results of questionnaire shows that most of our citizens are pro water saving oriented and open to new water ideas - as in building water cycle. There is a gap for water regulation and water supply of grey and rainwater systems. On the basis of the scientific, policy, economic and social impacts, our study pointed out challenges and recommendations to strengthen and enhance future of alternative water sources.

Our partial studies have shown that natural and permeable surfaces can play crucial role in mitigating this negative phenomenon and providing higher efficiency for the building.

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