# O 19. RAINWATER HARVESTING AS A SUSTAINABLE SOLUTION FOR DOMESTIC USE

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**ABSTRACT:** Albania can be considered blessed for its water resources, well known for their clean and healthy water. On the other hand, water resources cannot be infinite. The main challenge of developing countries, such as Albania, is finding and managing water supplies.
Our study is focused on the city of Durres, which is located on the Adriatic coast, and is the most visited by local and foreign tourists. Today, Durres city suffers a difficult time of an urban chaos in center, as in suburb. Water supply has become very problematic. Considering the lack of water during summer days (in the city rains 116 days a year), it becomes important to well manage it.
This study is based on the management of rainwater through the construction of rainwater harvesting system and its implementation for domestic use.

*Keywords: Rainwater management, sustainable development, rainwater harvesting systems*

## 1. INTRODUCTION

The biggest environmental challenge facing mankind today is the lack of water (informazioneambiente.it, 2017). As drinking water decreases on the ground, other ways must be found to save it. In the last two decades the interest for collecting rainwater has increased. Rainwater is the main source of all the drinking water on the Planet.
Rainwater is not considered anymore as waste that is transported through underground sewers without using it. Rainwater can be collected to be filtered and then used for house cleaning, laundry, toiletries, irrigation.

## 2. OVERVIEW OF THE STUDY

During 28 years of democracy in Albania, even the city of Durres has been subject of massive social economic changes. Because of its characteristics, offering economic and social opportunities, after 1990, it has become one of the most attractive cities for massive population migration from rural areas. This has led to an urbanization process with the doubling of the population and as a result the design of low performance buildings in terms of hydropower consumption and environmental impact. The time when rainwater was treated as "waste" transported through underground sewers, without using it, is gone (Tataveshi et al., 2018). In Durres City, as a touristic city in the summer season, with continuously growing number of tourists, the water supply of the area has become quite problematic, reducing it to a timetable set by the municipality. For this reason, it is important to take potential measures for saving water to prevent this problem. During the autumn the number of rainy days increases (shije.al, 2016). Albania has a Mediterranean climate, where in the lowlands it is almost never cold. However, during the winter season, the rains are common and, in some cases, quite dense. Nowadays it is important to preserve drinking water as it is one of the main problems of the future.

### 2.1. Rainfall data

According to the data of the Meteorological Institute of Albania (IGjEUM, 2018), the amount of annual rainfall in the city of Durres is an average of 931.1 mm rain per year, for 116.1 days of the year (Monthly Climate Bulletin, 2018).
The highest rainfall months are November (132.9 mm), December (113.0 mm) and January (110.6 mm), while the lowest precipitation months are June (38.7 mm), July (23.9 mm) and August (34.8 mm). The

average amount of rainfall in one month is 77.6 mm. The seasonal rainfall distribution is presented in Table 1 (Braholli, 2016).

**Table 1.** Average monthly rainfall in the city of Durres (Braholli, 2016)

| Months (rainfall in mm) | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | |
| 110.6 | 91.4 | 95.2 | 76.2 | 50.8 | 38.7 | 23.9 | 34.8 | 62.5 | 101.1 | 132.9 | 113.0 | 931.1 |

Referring to the average amount of rainfall in Albania, between 800 - 1100 mm/year, it is clear that the city of Durres is included in the districts with relatively low average amount of rainfall (Muka, 2015).

## 2.2. Domestic water consumption

The idea presented in this study consists in the rainwater management. One of the main problems encountered is the use of drinking water without criteria, often when it is not indispensable. A loss of significant amount of drinking water and an economic cost follow. At a present, in Albania, as well in Durres, the public water distribution system is the main system that supplies with drinking water.

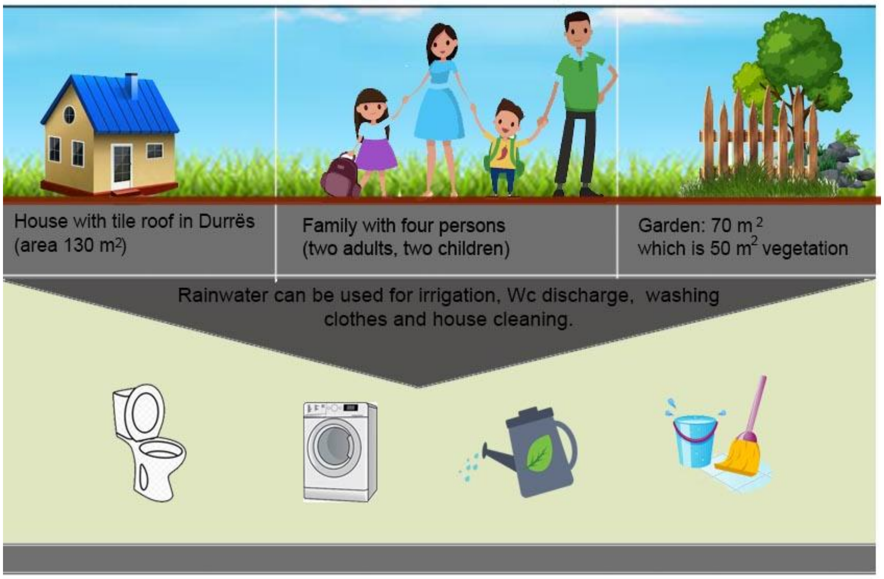


**Figure 1.** Examples where drinking water can be safely replaced by rainwater (Kessel Catalogue, 2019)

According to the rate applied in Albania from 2010 - 2017, the average annual water capacity was estimated to be 240 million $m^3$ per year, corresponding to a rate of 150 liters per day per person (MPWT, 2011 - 2017).

A brief list of consumption due to daily operations is shown in Table 2. It shows clearly that a considerable part of drinking water consumption can be saved by using rainwater, especially for secondary water needs (cleaning, irrigation, laundry, etc.). Following, the water consumption bills can be reduced.

**Table 2.** Table of daily household water consumption (Montalbano et al., 2009)

| Average daily water consumption | liters |
|---|---|
| Dishwashing | 10 |
| Cooking, drinking water | 20 |
| Self-care (shower or bath) | 45 |
| Cleaning | 3 |

| | |
|---|---|
| Irrigation | 12 |
| Laundry | 45 |
| Rinsing of sanitary hygiene equipment | 15 |
| **Total liters of water per day** | **150** |

### 2.3. Financial analysis

Water bills are continuously growing. In Table 3 are given the values in m³ for the drinking water and the polluted water including the 20% of VAT (Decision No. 31, 2017). The data show a continuous increase of water bills over the years.

**Table 3**. Annual price values (Regulatory Entity Annual Report, 2018)

| **Average price in years** | | | |
|---|---|---|---|
| **Years** | **Value in ALL/m³ for drinking water** | **Value in ALL/m³ for contaminated water** | **Total value in ALL/m³** |
| **2008** | 31 | 8 | 39 |
| **2009** | 38 | 8 | 46 |
| **2010** | 45 | 12 | 57 |
| **2011** | 36 | 11 | 47 |
| **2012** | 42 | 14 | 56 |
| **2013** | 58 | 35 | 93 |
| **2016** | 61 | 37 | 98 |
| **2017** | 70 | 50 | 120 |

This problem can be solved by harvesting the rainwater and using it instead of wasting it. It can be easily used to cover daily consumption and it can also be used on non-rainy days. But the question is: *Can the harvested rainwater cover all the needs*? The easiest and quickest way to harvest rainwater is to place buckets and containers of different sizes around the garden or on the balcony and the terraces. It's clear that this will lead to a small amount of water, but if we want a more organized home system, a plant that transports water from the gutters can be designed. For this a Rainwater Harvesting System (RWH) is needed (Centre for Science and Environment, 2019). This system stores rainwater that can be used when and where necessary. RWH can be installed in any space that has a “catching area” like the roof or another space to collect the rain.

## 3. CASE STUDY

In this study, we have considered a construction facility near the city of Durres. In the existing situation, it is a one-story building (Figure 2), built years ago with residential function. After reconstruction, it would be a two-story building as shown in figure 4.a, b. During the period under construction, residents were supplied with drinking water from the public network. With the new intervention, in addition to the increase in the volume of the building, a single plant for the management of rainwater has been proposed. The surface area of the rainfall is 130 m² (the roof plan is given in Figure 3), with an average annual rainfall in the city of Durres of 931.1 mm per year, for 116 days of the year (Braholli, 2016).

**Figure 2.** Existing view of the building

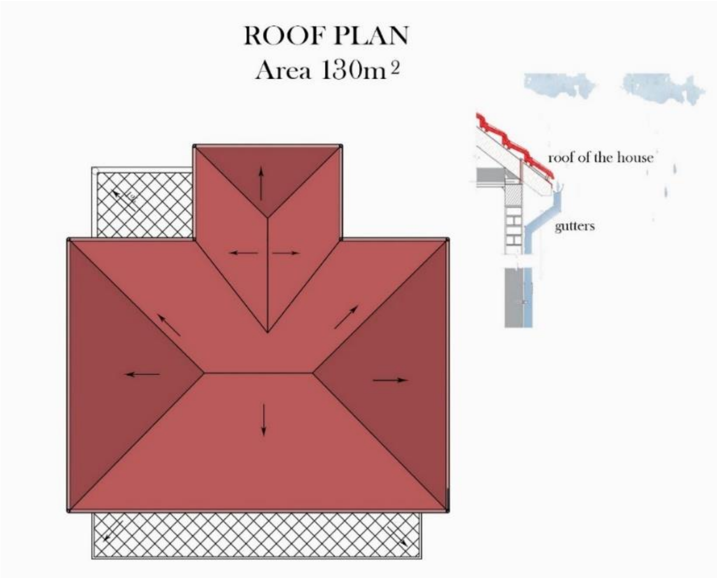


**Figure 3.** The roof plan

The family consists of 4 people and the house has a greenery surface of 70 m², with 20 m² of garden and 50 m² of vegetation. An important role in determining the amount of harvested rainwater plays the shape and the footprint of the roof, the orientation and the pendency. The maximum annual amount of the harvested rainwater is calculated by the following expression (Fanizzi and Misceo, 2008) and:

$$V = \varphi \text{ x } S \text{ x } P \text{ x } \eta \quad (1)$$
$$= 0.9 \times 130 \times 931.1 \times 0.95$$
$$=103\,492 \text{ liters/year}$$

where:

- V: the maximum volume of the accumulated rainwater (liters/year),
- φ: the runoff coefficient is a dimensionless coefficient relating the amount of runoff to the amount of precipitation received. DIN 1989-1: 2002-04 sets the coefficients for each type of coverage. In Table 4 are shown the runoff coefficients for two types of exposed areas (Fanizzi and Misceo, 2008),
- S: the total rainwater capture surface (m²),
- P: the average annual rainfall data. For the year 2018, in the city of Durres, the data are given in Table 1,
- η: the filter efficiency (Torlai, 2012) is a dimensionless number giving the ratio between the amount of water entering the filter and the amount of water exiting it. The performance values depend on filter characteristics and for two types of filters are listed in Table 5 (Fanizzi and Misceo, 2008).

**Table 4.** Runoff coefficient based on the type of the capture areas (Fanizzi and Misceo, 2008)

| **Type of the exposed areas** | **Runoff coefficient (φ)** |
|---|---|
| Corrugated plastic roof | 0.90 |
| Tiled roof | 0.90 |

**Table 5.** Type of rainwater filters and their indicative average efficiency values (Fanizzi and Misceo, 2008)

| **Type of rain water filter** | **Average efficiency η [-]** |
|---|---|
| Centrifugal filter | 0.7 ÷ 0.9 |
| Auto clear filter | 0.8 ÷ 0.9 |


**Figure 4.a, b** The proposed Rainwater Harvesting System

Following the data given above for the number of people that live in the building, the equipment types, and their annual consumption, the annual rainwater needs can be calculated as given in Table 6 and 7.

**Table 6.** Calculation of rainwater annual consumption for secondary needs

| Use | Water needs (liters/person per day) | No. of persons | Annual period | Water needs (liters/family per year) |
|---|---|---|---|---|
| **Toilet** | 15 | 4 | 365 | 21 900 |
| **Washing** | 45 | | 365 | 16 425 |
| **Cleaning** | 3 | 4 | 365 | 4 380 |
| **Amount of annual needs (liters/year)** | | | | 42 705 |

**Table 7.** Amount of annual rainwater needs for irrigation

| For irrigation | Annual needs (liters/m$^2$) | Surface (m$^2$) | Water needs (liters / per year) |
|---|---|---|---|
| **Park** | 60 | 20 | 1 200 |
| **Green surface** | 200 | 50 | 10 000 |
| **Amount of annual needs (liters/year)** | | | 11 200 |

Annual rainwater harvested is 103 941 liters/year (following expression 1). Based in Table 6 and 7, the total annual rainwater needs are 53 905 liters/year. So, this family can get more rainwater than it's needed (103 491 l/year > 53 905 l/year) (Graf water, 2019).

If the harvested rainwater is well managed it will cover all the needs of the family, without need to use in addition the public water distribution system. In this case of study, the building has a considerable surface of the yard that gives us the possibility to collect this amount of water in tanks. Underground types of tanks can be considered. The tanks selection must meet certain technical characteristics: ability to face weather, thermal changes, corrosion and oxidation. The system is independent of the public water distribution system. The basic elements are:

- gutters that serve to transport it to the water tanks,
- 2 filters, one in the inlet and one in the outlet (main function of the filters is the collection of the impurities and the prevention of their entry into the tanks),
- water tanks,
- collection pump.

Since the building is being completely reconstructed, the cost of installing an RWH is insignificant, because it does not need additional pipes, once they are integrated into the construction project.

## 4. CONCLUSIONS

Rainwater Harvesting System (RWH) is a sustainable system to obtain water in addition to the public distribution system.

In our case of study, the harvested rainwater fully covers the needs of the family.

The cost of installing an RWH is insignificant, being it integrated into the reconstruction project.

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Veprımtarıa e entıt rregullator të sektorıt të furnızımıt me ujë dhe largımıt e përpunımıt të ujërave të ndotura dhe gjendja në sektorın ujësjellës kanalızıme (Alb) - Regulatory entity of the water supply and wastewater leaving and processing sectors and the situation in the water supply sector (Eng), Annual Report 2018.

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