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SUSTAINABLE TOURISM THROUGH THE PROTECTION OF SWEET WATER RESOURCES IN MOUNTAIN AREA

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Abstract: *The evolution of tourism requires modern living standards with negative impact on the consumption of sweet water. In this context the article aims to analyse the possibilities to reduce the sweet water consumption by implementing solutions for exploiting rainwater in a mountain lodge with height P + 1. From the results of simulations performed on the monthly consumption of potable water, based on the amount of rain water that would have been possible to be collected in the years 2014 - 2015, it is found economies to approximately 61000 litres of sweet water, obtainable by using rainwater in some hygienic - sanitary activities.*

Key words: *Sustainable tourism, potable water, mountain are, lodge.*

1. Introduction

The tourism-environment relationship is particularly important in the protection and preservation of the environment which is a main condition of tourism development and any intervention that results in destruction or amendment of the natural environment of primary properties harm tourism potential by reducing, or even cancelling its resources [3].

For the tourism development, the environment has certain restraints. The modern tourism through his activities can have on the environment; positive effects, and negative effects, which often are irreversible, if it is practiced in an uncontrolled manner.

One aspect that must be considered to ensure natural balance is the appropriate sizing of the accommodation units, the rational resources consumption, the identification and the implementation of efficiently and environmentally friendly solutions. In this case the primary resources protection, and utilization of the alternative energy resources, constitutes environmental protection measures, and also economic measures, reducing the consumptions and costs.

The article has three main principles of sustainable development: ecological sustainability (reducing the consumption of sweet water), social sustainability (ensuring favourable economic development to the members of the community), economic sustainability (effective management of resources).

The concept of sustainable tourism obliges the accommodation units to the simultaneous adoption of energy efficiency solutions, saving natural resources, and therefore the resource of potable water, and increasing the comfort grade of accommodation.

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The energy efficiency measures for new constructions can be implemented from the design phase, using organic materials, and by designing systems that use alternative sources of electricity, energy for heating, cooling and air conditioning. A number of scientific works, may refer to these approaches [1], [2], [4], [6], [7], [9], [13] can be used as the solution to reduce energy consumption especially for isolated mountain accommodations units.

For existing accommodations units must find ways to reduce energy consumption through the modernization, and improvement of installations, and adoption of some ecological systems [10]. Water, as the main resource in the tourism industry contributes to the achievement of the comfort level. Accommodation units consume considerable potable water for cleaning the rooms, restaurant, filling swimming pools, taking care of green areas, and also for personal hygiene of tourists.

Used mainly for sanitary activities, water is a resource that is consumed entirely; generating proportional costs to the comfort degree offered by accommodation units.

In excessive usage of natural resources has determined the destruction of ecosystems with negative effects, mainly on consumers. The impact of environmental degradation through deforestation cause massive downstream floods, gas emissions of greenhouse effect, from highly industrialized countries causing devastating phenomena over long distances.

Thus, natural or artificial pollution, controlled or uncontrolled [8], [12], by altering the physical, chemical, and biological characteristics of the water, determine the increase of the potable water supply price, due to the complexity of the treatment process [5].

2. Materials and Methods

2.1. Study Location

The study was conducted for a mountain lodge, located in Predeal, at the highest altitude from Romania. The accommodation unit consists of four bedrooms, two bathrooms, a kitchen and a reception hall, and has a height regime of P + 1.

The construction's volumetry attempts to complete the urban landscape, and not to inhibit it. But as can be seen in Figure 1, the urban composition is not balanced.

Fig. 1. *Urban layout*

The roofs have a varied coloration, and it seems to compete with each other. The material used for the mountain lodge was meant to harmonize the space with the other constructions created with not profiled tile. The critical point of the site appeared at the time that, the other buildings were built with different colourful and volumetric roofs, so the area became unbalanced.

Nevertheless, it is trying to maintain a line, meant to remember the main colour created primarily from not profiled tile.

The exterior finishes (Figure 1) of the mountain lodge attempts to harmonize as possible the area. The exterior plasters, and washable painting: ceil (3) and white (2) creates a harmony with those constructs that have a blue roof structure.

2.2. Research Methodology

Consumption of potable water at points of use (sanitary) from accommodation units register high values, which vary depending on a number of factors (occupancy, season etc.).

The accommodation unit consumes potable water for equipment's

maintenance, cleaning the rooms, and restaurant, taking care of green spaces, and for personal hygiene of tourists.

One way to reduce water consumption in at least one of these categories uses mentioned above will be a significant decrease in costs. To this end it has conducted a simulation on monthly water consumption based on the amount of rainwater that would have collected in the years 2014-2015 (Figure 2).

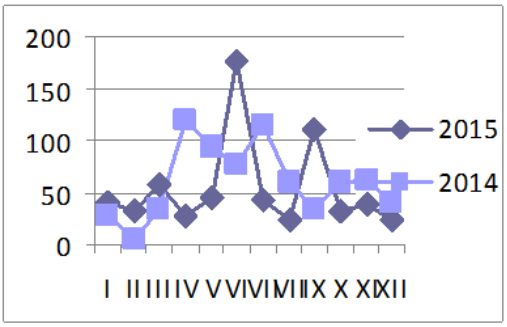


Fig. 2. *The chart of rainfall amounts recorded during 2014 – 2015, expressed by l/m²*

We also conducted an analysis, based on records from the years 2014-2015 on the possibilities of using rainwater for consumption.

Climatic conditions in Romania, in terms of rainfall regime, are conducive for the realization of an investment in the utilisation of rainwater.

Mountain and hunting lodges situated at an altitude that water supply from the national water network is impossible, offers an opportunity to develop the comfort of tourists, creating a facility that can provide water for personal hygiene.

Precipitation regime in Brasov county denotes a favourable condition in this meaning. According Ghimbav Station, the quantity of rainfall has increased in 2014 than in 2015 (Table 1). There is a significant change in rainfall quantity in April, and July, while in 2014 were values of 118.5 mm/m² in April, respectively, 115.4 mm/m² in July (Table 1). And in 2015 were recorded values of 28 mm/m² in April, respectively, 42.4 mm/m² in July.

Table 1

Average annual values of rainfall amounts registered in the Ghimbav Meteorological Station (expressed by mm/m²)

MONTHLY AND ANNUAL AVERAGE RAINFALL (mm water/m²)													
GHIMBAV 534m													
Anul	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Suma
2014	27,4	3,4	34,9	118,5	94,4	76,0	115,4	60,6	34,4	59,8	60,8	41,3	726,9
2015	40,7	31,7	58,0	28,0	44,8	175,6	42,4	22,6	111,0	31,8	35,3	11,6	633,5
2016	33,5	11,0	26,0	98,4	100,4	121,4	28,8	85,8	38,0	96,4	38,4	23,0	701,1
1961 - 2014	26,2	25	30,6	46,8	73,8	85,9	90,5	74	51,1	38,9	30,7	29,6	602,8

Rainfall quality is affected by atmospheric impurities, and the material from which the roof is made.

The pH of rainwater is located usually between 3.5 and 5.5, and it doesn't change in contact with the roof made by tile.

The location of the mountain lodge is an advantage for the implementation of an installation who use rainwater; because water quality collected in this mountainous area is more pure than in large urban, or near industrial sites.

In mountain areas water can be considered relatively mild, though can sometimes have a slightly higher degree of hardness, which it is recommended to be used without additional

treatment (possibly a micro filter): to supply washing machines, WC rinsing, or sprinkling green areas.

Under unfavourable conditions, traffic, birds rooftop, rainwater can be used only to rinse the toilet because it may contain degradable hydrocarbons.

3. Results

The proposed installation can satisfy the need for replacement of potable water in some maintenance activities in the mountain lodge, and to increase the comfort degree of tourists.

The proposed system is composed of two storage tanks, and is created by the combination of the installation with rainwater collection, and an universal system for collecting rainwater, by coupling the container to a pressure boosting system (Figure 3).

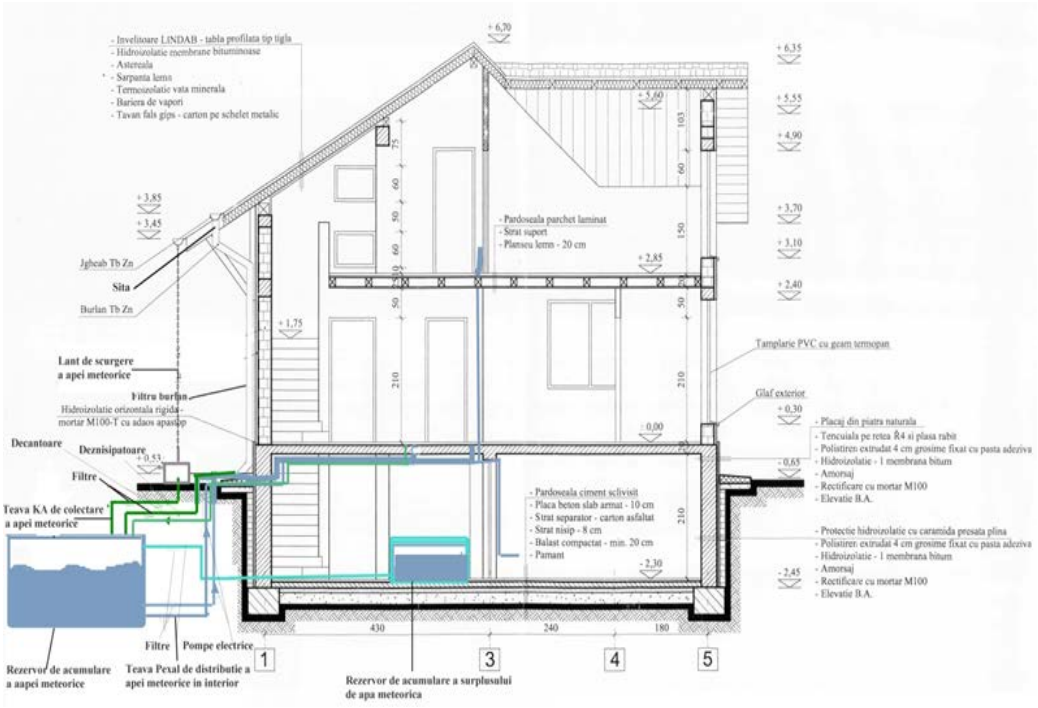


Fig. 3. *Capture, storage, and distribution installation of rainwater for the accommodation unit*

The main collector with a capacity of 11 m^3, located out of construction, is designed to supply with the meteoric water the installation for washing machine, and WC. Given a recording of more meteoric water needed, it can direct it to another collector to store this amount for dry and winter periods.

We appreciated an average consumption of 35 litres/person at the toilet utilisation/day and about 24 litres/day for washing machines. Anticipating a maximum occupancy, the mountain lodge will consume an amount of 5250 litres/month for the toilet and 720 litres/month for the washing machine, resulting a total consumption of 5970 litres/month.

Knowing that the total collection of rainwater is 90.4 m^2 the simulation shows

the replacement degree of meteoric water each month (according to the average annual values of rainfall registered in the Meteorological Ghimbav in Table 1).

In Figure 4 and Figure 5 were represented the average monthly rainfall amount, and the estimated amounts to be collected from the roof surface o\of the mountain lodge.

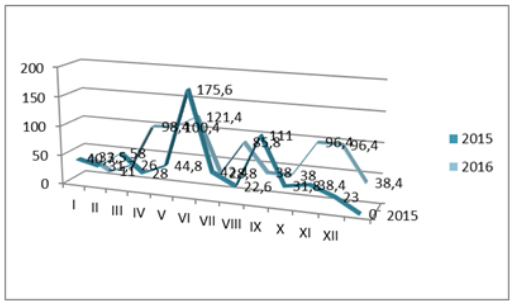
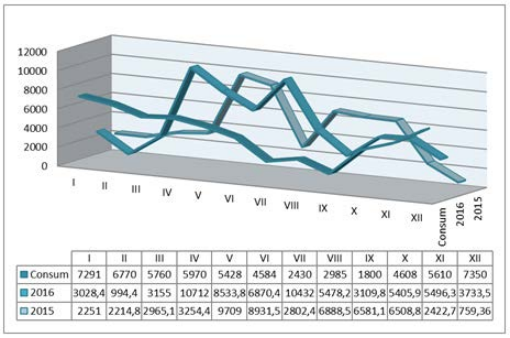


Fig. 4. *Average monthly rainfall recorded in the years 2015 – 2016 according to the Ghimbav Meteorological Station*



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Consum	7291	6770	5760	5970	5428	4584	2430	2985	1800	4608	5610	7350
2016	3028,4	994,4	3155	10712	8533,8	6870,4	10432	5478,2	3109,8	5405,9	5496,3	3733,5
2015	2251	2214,8	2965,1	3254,4	9709	8931,5	2802,4	6888,5	6581,1	6508,8	2422,7	759,36

Fig. 5. *Estimated amounts to be collected from the roof surface, and consumption regime of potable water*

4. Discussion

The amount of rainfall can vary from month to month, and it is difficult to predict. Due the fact that the operation of the installation is based on meteoric water as raw material, it is difficult to estimate revenue and a profit in the future because it is not a source of purchase. For this reason we imagined an estimate of revenue exercise based on meteorological information in 2016.

According to the data presented above (Figure 5) we calculated in Table 2, the ratio of consumption, and the amount of water that can be replaced by the meteoric water:

Annual amount in 2016 Table 2

Tip	Amount [l].
C	60786
S	66949.5
R	6163.5

**C – Potable water consumption; S – The amount of meteoric water collected; R – Remnant amount of meteoric water remaining after one year of use.*

Considering that 1 m^3 water costs 7.8 RON and sewerage price is 5 RON/m^3, the proposed installation would bring savings of 856.95 RON minimum, covering the entire volume of water consumed.

Besides all this time it was a remnant of meteoric water, totalling 78.89 RON which can be used for maintenance of green areas and other amenities.

5. Conclusions

As the tourism industry is a major consumer of potable water, each accommodation unit must make their own environment protection policies.

In Romania achieving a system for collecting rainwater implies a beneficial policy, on the environment, with a positive, and economically impact. The rainfall regime offers the advantage of realizing such an investment, especially in Predeal. In this area the pollution is in the lowest level in the country (due to the altitude of the town is). The annual quantities of rainfall ranges between 600 and 700 mm/m^2. So, an installation for

capturing, storing and exploitation of rainwater will generate a major impact on freshwater management resources while providing extra comfort to tourists.

The total investment cost is 18207.9 RON, and will be pay off over a flexible period of 10 years. In the exercise of estimating income was a profit of 1488.83 U.M./2016 only for saving potable water, and a total profit of 48679.83 U.M./ 2016.

It concludes that the installation requires a sustainable investment with beneficial impact on the environment.

The chalets situated at a high altitude that have no way to benefit from a regimen of potable water from the national water network can use this solution, which is beneficial, in this sense, and efficient in cost reduction.

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