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OPTIMIZING RAINWATER COLLECTION IN SMALL TOWNS

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Abstract: **In recent years, increased attention has been paid to the collection of meteoric water, which can then be reused. All this is due to climate change in which long periods of drought occur, followed by torrential rains. The water from these rains sometimes generates floods due to the fact that green spaces have been reduced in large cities, their place being taken by concrete surfaces. In this situation, the sewerage of meteoric water, which in most cities is the unitary system, does not cope. Due to the fact that the green spaces have been replaced with concrete constructions and, in most situations, the minimum impact methodology has not been respected, these unwanted effects appear, especially in the case of highly urbanized cities, so that, even in the case of a short-term torrential rain floods may occur with negative effects on the population. Even if the collection of rainwater and its reuse by every citizen who has yards and gardens does not seem important, in this paper we will refer to the collection of rainwater from a household, the collection carried out by the author himself, and will be presented at the scale of a locality the advantages of collecting this meteoric water. This work aims to make an analysis to demonstrate that in any household, regardless of the investment potential available, the collection of meteoric water is advantageous and contributes substantially, on the one hand, to the reduction of expenses in terms of the evacuation of water from the owned space of this household. Also, by using meteoric water collected during periods of drought, the economy is double, less water is consumed from the drinking water network. Last but not least, the great advantage of collecting rainwater will be that the whole community, with minimal effort, can contribute to reducing the risk of flooding.**

Keywords: rainwater collection, meteoric water, torrential rains, rainwater harvesting, household, pollutants, collection systems

1. INTRODUCTION

Even in smaller cities where houses with gardens and courtyards predominate, in the event of torrential rains, the land does not have the capacity to absorb all the water so quickly, the water from the roofs enters the sewers at a very high rate, so the same appears the situation as in big cities, the sewage treatment plant is suffocated and cannot cope. The same thing happens with the sewer system, which is designed for a certain flow rate, in the event of torrential rains, especially if they are of long duration, they do not cope and this results in floods, which sometimes generate significant damage.

The lack of water in periods of drought will lead to its price, so watering gardens in villages, even in small towns, will be a real luxury for their residents. That is why the interest of collecting meteoric water is becoming more and more obvious, water that can become the cheapest and best method for the population in drought situations. That is why there is a growing interest in collecting this water and reusing it to irrigate gardens or even for domestic and household purposes such as washing clothes (of course this involves filtering rainwater), washing cars and even the hygiene of the inhabitants .

Meteoric water, regardless of whether it comes from rain or snowmelt, has special characteristics, it has a low hardness and a neutral pH, so it is a good and cheap alternative from several points of view. That is why, instead of being wasted, meteoric water can be collected, its collection is an effective method so that it can be reused later. This collection can be done according to the possibility of each household, even with a minimal investment, part of this rainwater can be reused.

2. THE ADVANTAGES OF RAINWATER COLLECTION

Rainwater harvesting has many advantages. One of these is that, by collecting rainwater, soil erosion is reduced, thus reducing the possibility of landslides and also reducing the risk of flooding. Thus, those who choose to collect meteoric water significantly contribute to the protection of the environment by avoiding soil erosion, which in some places has led to the occurrence of disastrous landslides with material and even human damage.

Another advantage of collecting rainwater is that of reducing the cost of water, reducing bills from the respective household.

Last but not least, the collection of rainwater and its reuse is a great advantage and due to the fact that, by using this water, it is no longer necessary to use the water from drilled wells, which are still poorer anyway, the water from these wells is still reduced. Due to the misuse of water from bore wells in certain arid areas, groundwater reserves have decreased considerably, which has a negative effect on the environment.

It is found that, on a global level, the flow of underground water is continuously decreasing, and, therefore, one way in which we can restore the underground water reserve is to collect meteoric water, which can later be used for the desired purposes.

The meteoric water discharged into the sewerage network is paid for, the related costs in the next period

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will not decrease due to the fact that alternate periods of drought, rain are more frequent, which will require the modernization of the sewerage in the localities. All these costs will be borne by the citizens through the increase in the price of drinking water and the price of water discharged into the centralized sewage system. On the other hand, water from precipitation that enters the natural water circuit without entering the network is not taxable. So a double advantage, the reduced cost of drinking water that will be paid by the citizens who use rainwater and the reduction of the cost coming from meteoric water discharged into the sewage network.

The daily consumption of water is very high, regardless of whether it is drinking water, and especially meteoric water. The water used for the daily hygiene of each person represents an important amount of the total treated water consumed that can be significantly reduced through this collection and reuse process. Thus, instead of using water from the mains treated at the sewage treatment plant for washing clothes, showering, the toilet bowl, even for washing clothes, we can successfully use the water collected from precipitation.

Also, let's not forget that rainwater is not contaminated with anthropogenic pollutants, so when it is used to water gardens, it can contribute to the elimination of salt accumulation in the soil and plants. By watering with this meteoric water, the flora in the gardens grows healthy due to the fact that this water does not contain chlorine.

Even in households that do not benefit from high material resources, collecting this rainwater is not expensive, it is within the reach of any citizen to do so with a minimal financial effort, this fact being detailed in detail in what follows.

Therefore, rainwater is beneficial to agricultural crops, it is water that can be used for other household purposes, so every household can take advantage of the many advantages of collecting this rainwater. Let's not forget the financial advantage, considering the fact that, due to the alternation of periods of drought with those of torrential rains which lately have a longer duration of action, the water will have an increasingly high cost of treatment and purification, so that , its price will be higher and higher.

Frequent use of rainwater in irrigation has been found to result in faster and healthier growth of household plants.

3. RAINWATER COLLECTION METHODS

The rainwater collection methods are various, their collection is done through systems

for the collection of rainwater systems that allow the successful reuse of this water with a low content of salts, pollutants, etc. These collection systems can be from the simplest to the most complex, depending on the financial potential of each family and according to the way and place of its use. These collection systems can be above ground and underground.

3.1 Underground collection

This type of collection does not make the study of this work, it is only mentioned as an acquisition, but no

means it is less effective. Some use this option in order not to spoil the aesthetic appearance of the garden and the space where these systems are located.

The cost of this method of collection is higher than in the case of above-ground collection, but it is more efficient because it allows the use of filter systems called filter troughs. Water distribution can be done after collection directly by connecting to pumps or irrigation facilities.

3.2 Above ground collection

The above-ground collector system is the easiest and can be realized with the help of cisterns

different capacities according to the possibilities of each household. This cistern must be installed under the rainwater gutter so that the rainwater reaches the cistern.

Several cisterns can also be provided, connected to each other on the principle of communicating vessels, at one of the ends a valve will be provided, provided at the end with a hose. It is preferable that these tanks are located as close as possible to the garden that needs to be watered. Thus the use of water can be done in a controlled way depending on the time and the need of that household.

Another method of distributing water collected by the above-ground method is to use a pump, followed by directing the water to the places that need irrigation, or to the places that need this non-potable water.

4. THE WAYS IN WHICH RAINWATER CAN BE USED. HOUSEHOLD EXAMPLES AND COLLECTION METHOD

The most common way in which rainwater is used is forirrigating crops in gardens, washing driveways, yards and personal cars of that household.

If one wants to use meteor water for personal car washing, this is a good way to save water, considering that washing a car requires a large amount of water that is consumed for this purpose.

Due to the fact that it is a soft water, its use is indicated for washing carpets or even for the clothes washing machine. However, to use rainwater for the clothes washing machine, this water cannot be used directly, it is necessary to filter it beforehand. These filters are placed either directly at the pump that distributes the water, or at the collection tanks.

If these filters are efficient, the filtered water can even be used for washing dishes, preparing food or for personal hygiene.

In any household where these tanks can be placed, costs can be optimized by using this water where a significant amount of water is consumed (toilets, washing yards, watering flowers, watering gardens, showers).

The reason why any resident pays for the meteoric water coming from the public household is, or should be, very clear. Water from households ends up in the city's public sewer system and needs the same purification and treatment procedures as household water. All these treatment and purification processes

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require costs, costs that must be borne by each individual citizen. Also, the costs of operating and maintaining the pipeline networks, the treatment plant and all the ancillary constructions that are necessary to obtain the final product, to obtain water within the limits provided by STAS, must be covered.

If we consider a household where the surface of the roofs is 500 m2, the slope of the roof is on average 45, which means that the horizontal sequence of these roofs collecting the rain would be 500:√2, so about 350 m2(Figure 1 a), b),c), d). These 350 m2 in the case of a rain that has a flow rate of 20 l/m2 lead somewhere to 7000 l of meteoric water in an hour, rainwater that flows partly inside the yard of that household, another part inside the garden and the other side in the sewerage network of the respective locality.

With a rain of such intensity there can be significant damage, damage due to torrents of water that wash everything away, that produce soil erosion and that can even affect the walls of buildings.

The following figures show a rainwater collection system executed in a rural locality. Water is collected in this example from four sources (4 roofs), all this water is sent to the garden, where it will be used to water the garden during periods of drought.

The area that is required for a roof to collect rainwater represents about 80% of its total area. To calculate the approximate volume of meteoric water that we can collect, one of the following formulas can be applied:

W (m3) = S x H x k sau W (m3) = H x k / 1000, where:

S - useful surface of the roof (m²)

H - the average annual amount of precipitation (mm)

K - 0.8 - rainwater collection coefficient









Figure 1. Example of rainwater collection by a household

An effective and easy-to-implement method, which does not require much knowledge in the field of rainwater collection, is to place a tank or container of the highest capacity directly under the downspout.

From here, the water is distributed by means of a pipe or hose, preferably, if the terrain allows, this distribution of the collected meteoric water to be done by gravity (Figure 2 a,b,c).





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Figure 2. Collecting meteoric water in a household in a small town

The collection of water in these barrels is done by the capillarity method, the water passes from one barrel to another, so the following figure shows a top view of the connections between the barrels.

In the figures below, the connection between these tanks is shown, which is a simple one, with the help of hoses and small pipes and some clamps that have the role of supporting these hoses.



Figure 3. Example of connection of several tanks

One of the big disadvantages of this method, we can say rudimentary, is that when the water enters the first tank, those holes get clogged quite quickly, water no longer enters the barrel. There is also the risk that, after a certain period, the pipes that connect these tanks will also clog, so that the passage of water from one barrel to another is no longer allowed.



Figure 4. Mode of collection

A solution found in this sense is that, directly under the downspout, a barrel with a large capacity is provided, so that, when all the barrels are full, the water flows directly from the poplar into the tank.



Figure 5. Collecting water in barrels and large plastic containers

Afterwards, the water is taken out of the barrel and used to water the garden in periods of drought. Also, during the rain, water was also collected from other eaves and collected in buckets, then used in periods of drought. The images below reflect these statements.

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Figure 6. Small capacity tanks

The garden that is the subject of this study is located in the immediate vicinity of this collection system. In the immediate vicinity of these collection tanks is a greenhouse, and here the solution was found to evacuate the water from the gutter directly onto the vegetable rows inside.

Thus, during the rainy season the interior of this small greenhouse is also watered, and during periods of drought the watering is done manually with those buckets in which the rainwater has accumulated or directly from the tanks through a hose. This is illustrated in the images below. (Figure 7 a,b,c).



Figure 7. Images from the studied garden

In the figure below, the rudimentary collection of water from another eaves in the respective household is shown, the collection being done directly from the eaves. A big disadvantage here is the presence of man, who should stay during the period of torrential rain to collect this water. This, of course, is not possible.



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Figure 8. The rudimentary collection of rainwater

In the future, two more tanks with triple the capacity of these barrels will be attached to this household, with the aim of collecting this rainwater and using it to water the garden. Also, the owner of the garden does not have sufficient funds, so, after collecting this water, the cost of meteoric water is reduced by half and also the price paid for water is reduced by 70% during periods of drought. These tanks to be attached to the sewage system are shown in the figure below.



Figure 9. Larger capacity tanks provided for rainwater collection

One of the big disadvantages of this collection system is its unsightly appearance, but it does not compare with the benefits brought to the owner, the environment and last but not least the plants in this household whose production has increased by 30% since the installation of this collection system.

Another disadvantage is that the amount of water collected is not very large, therefore, in the future those tanks shown in the previous images will be attached. An overview of the household for which rainwater was collected and for which this study was done is shown in the figure below (Figure 10 a,b)



Figure 10. a,b Overview of the garden where the study was done

In winter this method may not work, especially if the temperatures are very low, the water in these tanks freezes and it is not possible to distribute it.

Another method of rainwater collection and storage would be that in which the water is taken directly from the downspouts and transported through a pipe to an artificial pool or pond, where it can be stored for periods of drought. At that time, with a hydrophore, water can be used when and where it is needed. And this method has its disadvantages, one of

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them would be that a large area is required to build this pond. During periods of drought, due to the fact that the evaporation surface is large, the water can become biologically and chemically contaminated.

Another solution, considered to be the most effective, is to make an underground concrete pool and build a well. In this case, large amounts of water can be stored, it is kept underground in almost ideal conditions, in any case much better than in the other cases presented. From the point of view of costs, the investment is higher, it is necessary to purchase concrete pipes, to dig a concrete basin, but let's not forget that this construction is durable, it lasts for decades and does not require additional costs for maintenance and for repairs.

5. CONCLUSIONS

Optimizing water costs in a household can be done by using rainwater in all activities that consume a lot of water (washing toilets, carpets, personal cars, yards, daily hygiene, washing machines, watering gardens, flowers, etc.)

There are many factors that make rainwater conservation an important goal that rests with the population. We can't stop urban sprawl, we can't, or we don't want to change climate change, but we must act where we can. And we must act on the redevelopment of storm sewer systems. This is where the role of each household comes into play, and this role, even if it does not seem to be very important in this regard. The more every householder, every citizen understands the importance of saving water by any means, the more he contributes to avoiding floods in his community thanks to the fact that he manages to free the treatment plant and so suffocated by the large amount of water during periods of torrential rains.

In conclusion, regardless of how complex the factors are that determine the reduction of the volume of meteoric water, its discharge to the treatment plant, it is necessary to implement a so-called rainwater management station in each household, a solution which, taken as a whole of a locality can significantly reduce the overloading of the pipes that carry water to the treatment plant, thus floods can be avoide.

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