WATER IS LIFE

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Contents

Introduction 3

Our Plan 4

Filtering the rainwater 5
What is the most convenient way of filtering rainwater? 5

Energy 6
Is it possible to generate energy with a water wheel in a rain pipe? 6

Groundwater 7
What kind of soil do we have in our neighbourhood? 7
How fast does water sink into the ground? 8
On average, how much rainwater does Drunen get? 9
Where are we going to store the fallen rainwater? 10

In the neighbourhood 11
Where are we going to store the collected water? 11
Can the collected rainwater be reused? 11
Is it possible to wash cars in the neighbourhood? 11

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Introduction

Our names are Romy van Oorschot, Sahre van Ooijen and Emma Brandts. We are students at the d'Oultremontcollege in Drunen, the Netherlands.
In this essay, we will introduce our innovative idea of how to cope with the problems that rainwater causes. The main purpose of our project is to find a more efficient way of collecting and re-using rainwater.

Our idea is to collect the rainwater in a container on top of the garage. Because the rainwater is caught so close to the house, the amount of energy used for transporting the water into the house is almost negligible. The collected water can be used for tasks in and around the house. By using a waterwheel in the container, we can regenerate sustainable energy.

Moreover, we will place an infiltration crate underground in the garden so that the rainwater which has fallen onto it will flow into the container. This implies that all the rainwater in your territory will become useable.

In this project, we hope to fulfil our goal and we hope to contribute a little bit to a better environment.

Our Plan

Our plan is to store the fallen rainwater in a container. These containers will be placed on top of the garage in the first place, so that the pumping of the water doesn't consume too much energy. If there is no garage, the container will be placed in the attic, because from here the water can be easily guided to the toilet. If people want to, they can place solar panels against the container on top of the garage.

Filtering the rainwater

What is the most convenient way of filtering the rainwater?

Rainwater can be filtered in many ways, but there are a few things you need to take into account. The main priority is public health. The rainwater should not be damaging public health, so the things that could damage it should be removed. When we examined the rainwater that we had collected (by collecting the water at the end of a rain pipe or right out of the sky) under a microscope, we saw lots of tiny parts of plants. These parts need to be removed. We also saw that some of the rainwater we had collected, had a very light brown colour. It is understandable that people, for example, don't want to flush their toilets with brown water, because it looks very dirty. Rainwater can also begin to smell when you save it, so that is something that should be worked on too.

We tested different ways of filtering the rainwater. First of all, we ran tests using Norit powder. We put the powder in the rainwater and shook it. After that, we filtered the rainwater by using filtering paper. The brown colour disappeared and the smell was gone, but the disadvantage is that it took a lot of time to filter the water, we would like to filter the water more quickly. Also, the water got a bit darker, because the powder is black and tiny particles of the powder were still in the filtered water. People wouldn't want that colour of water and it could affect the toilet itself.

We also tried using old tights. This method can be very efficient, because a lot of women have old tights that have holes in it and instead of throwing them away, they could use it to filter rainwater. Filtering the water with this method turned out really well. It filtered very quickly and also caught all the bits of plant matter.

Furthermore, we did a test with filtering paper. The plant matter was removed by the filtering paper, but it went very slowly. If there is a lot of rainfall, it would take a lot of time to filter the water with this method. It's more convenient when the water gets filtered more quickly, because a lot of water needs to be filtered and people in the house need to use it.

To conclude, the best method we found was using old tights. It's a very practical, convenient and really cheap way of filtering the water, because a lot of people have tights and lots of people get holes in it quickly. The only problem is that you need to change or clean the tights every now and then, because it will get full of plant matter et cetera. The best tights you can use are between 20 and 40 deniers. When you use tights with a higher number it will probably filter pieces that don't necessarily need to be filtered and it would take more time for the water to go through it. When you use tights with a lower number, there is a possibility of some plant matter of plant going through the tights, so the water won't be filtered enough and you will get little bits of plant matter in the filtered water.

Of course, we are not going to use an actual pair of tights. Our plan is to only utilize the structure of the tights, because tights itself are not strong enough to be used as a filter.

Still, the smell is present when you filter the water with tights. The filter, namely the tights, should be put somewhere before the water is stored, so the water that is being stored has already been filtered. This can prevent a big part of the smelling, because the plant material that causes the smell has already been filtered. However, there will still be a slight smell. The most convenient way is to use air fresheners. You can place them in your toilet or in your bathroom and you won't smell it anymore.

Energy

Is it possible to generate energy with a water wheel in a rain pipe?

On a rainy Sunday, the solar panels generate 20 Watt electricity with a lot of difficulty. But would the solar panels be able to generate energy with all that rain? To illustrate our idea, we will use a fictional house. We are going to catch all the rainwater and we are going to lead this into our recovery tank on the roof of the garage or the flat roof of your house. Then we will examine how much energy it will produce if we lead the rainwater through a water wheel. Will the quantity of the energy be worth the effort?

According to the KNMI (meteorological institute), The Netherlands has an average rainfall of 800 mm of precipitation a year, which is 0,8 meters. Our fictional house has a roof of 50 square meters (5 x 10). So, there is room for 42 cubic meters of water in a year (this is the same as 42000 litres). One litre of water weighs one kilo. This means that all the rain that falls in an entire year has the weight of 42000 kilograms.
The potential energy of a mass at a certain height is:

$$E_{pot} = m \cdot g \cdot h$$

Where *h* is the height (6 meters in our case) and *g* is the acceleration of gravity (9,8 m/s^2).
Calculated: 42000 x 9,8 x 6 = 2,5 million joules.
This concludes the potential energy of all the rain in a year.

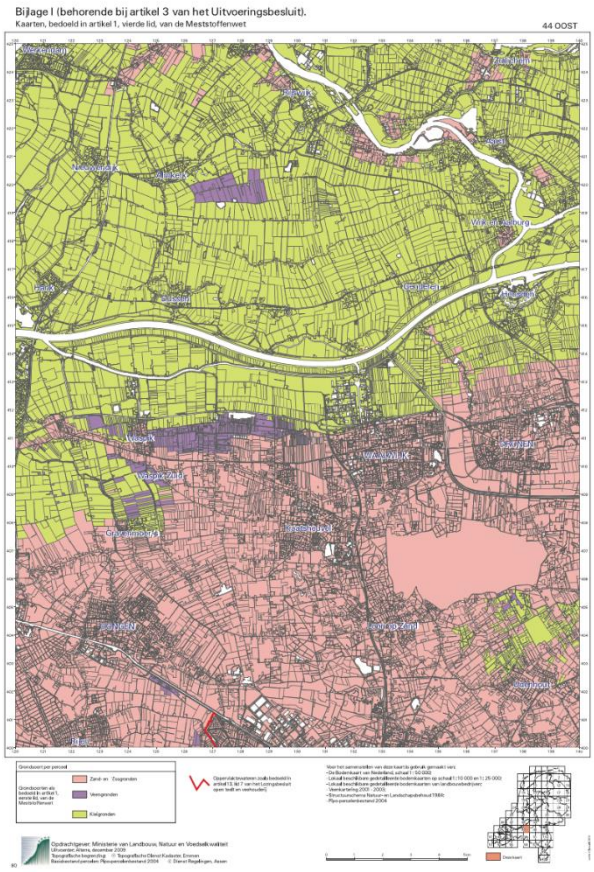
A big number, but to find out how much energy this is, we have to convert this to kilowatt hours (1 kWh = 3,6 million joules). The potential energy of the rainwater for a whole year is 0,7 kWh. The average electricity consumption of a household in the Netherlands is approximately 3500 kWh a year. With all the rainwater on the roof of the house, we can generate 0,02% of the average power consumption of a household. This is not a lot, but even a small contribution will help. A water wheel with a simple alternator costs little, so you will have a quick return on your investment.

Our idea was to place the water wheel in the rain pipe to the underground storage tank or in the pipe that goes from the roof to a storage tank in the attic. Now the water will go into the water wheel and by this hydropower the water wheel will be activated. By the use of a dynamo, energy will be generated.

Groundwater

What kind of ground do we have in our neighbourhood?

In our research, we mainly focused on this area in Drunen, near our school. The soil type we have here is sandy soil.



In the image above, you can see that the area in and around Drunen is marked pink. This indicates that the soil type in Drunen is indeed sandy soil.

How quickly does water sink into the ground?

In the soil, there is groundwater. That's water that has sunk into the soil through ditches, lakes and rivers. Rainwater also infiltrates into the soil until it can't sink any further, caused by a soil that doesn't let water through. Above this layer of soil, the ground gets saturated. This indicates that the soil can't take in more water. The height at which this saturation begins, is called the groundwater level. The water beneath that, is being called groundwater. Everywhere in the Netherlands there are different groundwater levels. We will only look at the groundwater level at our school in Noord-Brabant. Like there was said before, here we have to do with sandy soils.

Soil type	**Permeability (m/day)**
Heavy clay	0.0001
Moderately heavy clay	0.01
Sandy clay	0,05
Peat	0.001 - 0.1
Loam	0,05
Soil	5
Fine sand	1 – 10
Coarse sand	30
Very coarse sand	80
Coarse gravel	10.000 - 100.000

This means that the water sinks relatively fast here. The groundwater in Drunen sinks with 1 up to 10 meters a day.
This means that when we assume 1 meter a day, the groundwater sinks with 1,16 * 10-5 meters per second. When we assume 10 meters a day, the groundwater winks with 1,16 * 10^{-4} meters per second.

1 m/day	10 m/day
1,16 * 10^{-5} m/s	1,16 * 10^{-4} m/s

But because nowadays everything gets more asphalted, like gardens and streets, the surface in which the groundwater would normally sink, decreases enormously. If the fallen rainwater can't sink into the ground, caused by too little space, it will cause problems such as flooding. We will discuss the possible solutions for this in **'Where do we store the groundwater?'.**

On average, how much rainwater falls in Drunen?

The data in the table beneath includes information about the average rainfall in Drunen and the surrounding area.

	gemiddelde maximum temperatuur (°C)	gemiddelde minimum temperatuur (°C)	gemiddeld aantal uren zon per dag	gemiddeld aantal dagen neerslag per maand	gemiddeld aantal mm neerslag per maand	gemiddelde water temperatuur (°C)
januari	5	0	2	20	💧💧💧	n.v.t.
februari	6	0	3	15	💧💧	n.v.t.
maart	10	2	4	20	💧💧💧	n.v.t.
april	13	4	5	18	💧💧	n.v.t.
mei	18	8	7	18	💧💧💧	n.v.t.
juni	20	10	6	19	💧💧💧	n.v.t.
juli	22	12	7	17	💧💧💧	n.v.t.
augustus	23	12	7	17	💧💧💧	n.v.t.
september	19	10	5	18	💧💧💧	n.v.t.
oktober	15	6	4	19	💧💧💧	n.v.t.
november	9	3	2	21	💧💧💧	n.v.t.
december	6	1	2	21	💧💧💧	n.v.t.

nihil = 0-5 mm • 💧 = 6-30 mm • 💧💧 = 31-60 mm • 💧💧💧 = 61-100 mm • 💧💧💧💧 = 101-200 mm • 💧💧💧💧💧 = meer dan 200 mm

In the table, you can see that mainly 61mm – 100mm rainfall falls per month.
This means that there falls 0,061 m – 0,1 m rainfall per month.
When we compare this data with the data of the sinking of the groundwater, it would mean that, relatively seen, there falls less rain than there can sink into the ground, but these calculations do not take asphalted pieces of land into account. This also leads back to the aforementioned problem, the lack of places where water can sink into the ground.

Where do we store the fallen rainwater?

We are going to focus on the new houses that are going to be built next to our school. Here are terraced and corner houses, semi-detached houses and detached houses.
Because we are partly going to focus on the plot, we chose to use a detached house in our example.
The living area of a detached house is approximately 151 m^2.
The plot of a detached house is approximately 472 m^2.
In the house, there is room for about 4 persons.
Furthermore, the house includes 2 toilets.

By flushing the toilet, you use approximately 8 litres of water. On average one goes to the toilet 5 times a day. When we assume that 4 people live in the house, it implies that 160 litres of water is being used per day just by flashing the toilet.

In the neighbourhood

Where do we store the collected water?

Obviously, rainwater doesn't only fall on houses and plots. It also falls a lot in the district, for example on the streets. This water should also be led somewhere.
At the moment, rainwater that has fallen onto the street is led to the sewer. But the sewer gets too full, because too much water is being led into it. This causes flooding. It's also unnecessary to let all the clean rainwater go through the water treatment systems. This cost a lot of money and time, while it could be saved. A possible solution for this is to separate the relatively clean rainwater and the dirty wastewater. The rainwater will not be led to the sewer anymore, but to a place in the neighbourhood where the water will be stored. 'De Baardwijkse Overlaat' is an area in our neighbourhood that could be used to store the water. This area now functions as a place to collect the overflow from 'de Maas', a river that flows in the neighbourhood, when it floods.
The rainwater that falls on the street, will not be led into the sewer anymore, but into the 'Baardwijkse Overlaat'. The water will be led through pipes. Furthermore, the excess water from the houses in the neighbourhood will be led through the same pipes to the 'Baardwijkse Overlaat'. This excess water will come out of the collecting trays of the houses. The excess water will be led through a pipe to the central main pipe and from there it will be led to the 'Baardwijkse Overlaat'.
We believe the almost clean rainwater should be led there. It would be a lot cheaper to separate the rainwater from the wastewater, because wastewater needs extensive treatment.

Can the collected rainwater be reused?

The fallen rainwater will be led to the 'Baardwijkse Overlaat, as explained in the question above. The water from the 'Baardwijkse Overlaat' could be led back to the houses, when necessary. That water could also be used in and around the house.

Is it possible to wash cars in the neighbourhood?

At this moment, it isn't possible to wash cars in the new neighbourhoods. This is because various cleaning products are used while washing a car. These cleaning products can get mixed up with the 'clean' rainwater and then it can't be re-used. The dirty water should go into the sewer, because it's wastewater. But it is very difficult to separately collect the dirty water from the 'clean' rainwater. So, washing the car can't be done in your own neighbourhood, but only in the car wash.