

Abstract:

Due to climate change rivers have to carry more water in the direction of the North Sea. Heavier more inconsistent rains and the melting of glaciers in Central Europe are the main causes for this surplus in water in the Netherlands. Sea level rise makes it hard for our rivers to get rid of all this water. Action is necessary.

The goal of the Dutch Room for the River Program is to give the river more room to be able to manage higher water levels. At more than 30 locations, measures will be taken that give the river space to flood safely. Moreover, the measures will be designed in such a way that they improve the quality of the immediate surroundings. The Room for the River program will be completed by approximately 2016.

We will look into the direct environment of the school and investigate which measures can be taken to create more room for the river and what the effects would be. If measures already have been taken, we will explain why they were taken and which effects these measures have or have had.

Introduction:

In creating this project we have worked together with several parties. First of all and most importantly our teachers, Mr. Streefkerk and Mr. van de Greef, have supported our group throughout the project and have acted as a helpdesk for any questions to keep us on the right track. Another key part of our project was Mr. van de Greef's knowledge about the Dommel and its landscape. By carrying out fieldwork with him and Mr. Streefkerk, we acquired a lot of information about the Dommel and the Bossche Broek. For the gathering of more detailed information about the waters we have researched, we

had help from Mark van de Wouw of the Dutch Waterschap (Waterworks), who was also very helpful in assisting us with the putting our presentation together. We acquired the rest of our information from the library and the internet.

1. The Dommel

The Dommel is a 117km river which flows from Belgium to the Netherlands. It begins in Wauberg, Belgium, which is located 77 metres above sea level. It used to be a bog from which all kinds of small streams flowed. To compare it with a sponge, the bog is the sponge full of rain water and when it is eventually full, the water flows out again. It rises in north-eastern Belgium near Peer and flows into the southern part of the Netherlands. The mouth of the Dommel goes through a little river that we know as the Dieze. This spot is two metres above sea level. The decline of the Dommel is 75 metres. Due to the 75 metre-height difference over a distance of 117 km the water flows slowly. The Dommel, being a lowland stream, is another reason for its slow flow rate, resulting in the river meandering. (Meanders are curves in a river.)

The most original part and natural state of the Dommel can be found between Eindhoven and Boxtel. Here the Dommel still has its original winds and meanders and forms a cultural-historical and valuable landscape area called the Dommelbeemden.

2. The Bossche Broek

The Bossche Broek is a wetland in 's Hertogenbosch, situated right next to the river Dommel and just outside the centre of the city. Back in the Middle Ages, this wetland was a natural defense system. During heavy rainfall, the water in the wetlands would reach the centre of the city making it a difficult task for people from outside the city reach it. For this

reason, 's Hertogenbosch was nicknamed "the Swamp Dragon". To date, only the city walls separate Den Bosch with the extraordinary vegetation in the Bossche Broek. From the city centre you have a breathtaking view on this pristine expanse of grasslands and rivers. Today, the Bossche Broek functions as an emergency water storage area, as well as a place to relax, get some fresh air and explore nature. It is also a popular place for bird watchers because of the variety of species including the marsh harrier, bluethroat, reed warblers and bittern.

Keywords:

Biodiversity

Biodiversity is a contraction of biological diversity. It reflects the number, variety and variability of living organisms and how these change from one location to another and over time. Biodiversity includes diversity within species (genetic diversity), between species (species diversity), and between ecosystems (ecosystem diversity).

Canal

An artificial waterway.

Flood plain

A nearly flat plain along the course of a stream or river that is naturally subject to flooding.

Project:

1.1 Description of the Dommel's landscape

The Dommel is a renowned and much-loved landscape. You can wander endlessly through one of the most beautiful valleys in Northern Brabant in absolute silence with merely bird sounds. You can walk, ride your bike and even canoe from one village to another.

The Dommel is wide, straight and the banks are inclining. This is due to canalization in 1970-1971, when 80 meanders were cut off. At the moment, most cut-short meanders are free of special water plants and animals which is due to the still water. There's a big, modern dam in the Dommel with a big drop, namely 1.7 metres. Since a few years, fish have been passing the dam through a fishing stairs of nearly one kilometre. Due to this, fish can swim up the river again. This fish passage consists of fifteen natural stone thresholds, making it possible for fish to cover the 1.7 metres of difference in small steps.

If the flow rate through the winding river varies a lot, it is convenient for many animals and plants to live there. Today, most parts of the Dommel are canalized, making it ecologically less convenient. The question is, how can we improve the ecological value in this area and especially in the Dommel while increasing the spongy character? The valley of the Dommel should be wetter and undeveloped areas should allow for flooding.

If this were the case, there would be a larger biodiversity, which is often regarded as desirable and is obtained by variations in the landscape.

There are still too many cornfields and grasslands for intensive agriculture. These should be removed to increase room for the river.

1.2 Room for the river and ecological value

Making room for the river while increasing the ecological value by making areas wetter, isn't a guarantee to success. The flood plains will become rougher and will provide more resistance against the flow which will make the water level rise at a certain drain. For this reason, the

measures taken must compensate this effect. One possibility is to manage nature by regularly cutting down or mowing the grass or by the natural grazing by cows or horses.

The climate in the world is constantly changing. In result, the rivers in the Netherlands have increasingly larger amounts of water to transport. In order to prevent flooding in the near future, the Dutch government is changing the course of more than 30 rivers throughout the country.

How will we make room for the river? Every river is different and requires an individual solution in order to make room for the water. So what can we do to make room for the river Dommel?

1.2.1 Lowering the flood plain

Lowering sections of the flood plain gives the river more space during periods of high water. Over the past few centuries, the natural process of sedimentation has gradually raised the level of the flood plain. Excavating the top layers of the flood plains makes them lower, which in turn contributes to making room for the river.

1.2.2 Dike relocation

Relocating a dike land-inwards increases the width of the flood plains and provides more room for the river. This entails exposing land that had once been protected by the dike to high water in order to expand the river's winter bed.

1.2.3 Removing obstacles

Removing or modifying obstacles (trees) in the river wherever possible helps increase the flow rate for the the river water. Removing obstacles includes work such as lowering or eliminating ferry pier banks, widening bridge openings and removing or lowering quays and flood-free areas.

1.2.4 Restoring the river

Restoring the river in its original course can help to make room for the river. Because the meanders are cut off the water's flow is too fast. When restoring the river, we want to bring the meanders back.

1.3 Reconstruction of the Dommel

The part of the Dommel that we researched is 4,85km long and streams from Boxtel to St-Michielsgestel. Our goal was to reconstruct the Dommel to make more room for the river and prevent area's around 's Hertogenbosch from getting flooded while improving the ecological values.

1.3.1 Dike relocation

The first part of the Dommel we looked at was situated very close to a village called Sint Michielgestel. We looked specifically at the surroundings of Sint-Michielsgestel as in 1995 a water-disaster caused by a rapid rise of water in our rivers, including the Dommel, Sint-Michielsgestel damaged the surrounding areas heavily. For this part of the Dommel it is essential that it is well-managed as it flows from here to the countryside into a populous area. In the image the red line suggests the area where dike relocation should take place. Alongside the river the dikes would need to be built higher to prevent the water



from flooding out of its riverbed. As seen on the right hand side of the image, the

dikes must be located more land inwards so the river will be given more space when the water level starts to rise.

1.3.2 – Removing obstacles

The second part of the Dommel we laid our eyes on was just a couple of kilometres under Sint-Michielsgestel. Here we found several parts alongside the river, in the image indicated by the black stripes, where obstacles should be removed. Our goal is to remove the trees and lower the ground underneath. That way, these grounds will be on the same level as the river water is. The result of this will be that when the river water starts rising these areas will be flooded and the river has more space.



1.3.3 – Restore the river

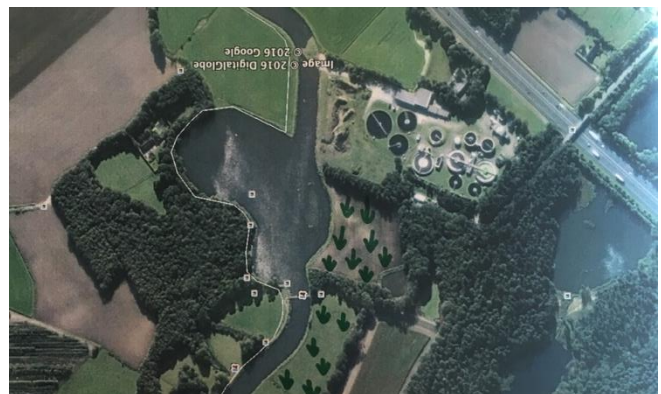
During our project we have learned that rivers can contain more water when they have the chance to flow where they want to. For example in a canal, a long part of a river that has artificially been 'pulled' straight, the water goes from point A to B very fast. Because of this a canal can't hold much water between A and B. A river that hasn't been pulled straight can take a much curvier road from A to B and so it can also hold more water between A to B. In this scenario we suggest to restore the old river flow. As seen on the image, the old river flow contains a lot of meanders and clearly doesn't go in a straight line. In this way the river takes more room for

itself, takes a longer route and can hold more water.



1.3.4 Lowering the flood plain

Our last part is situated very close to an important water-filtering center. In times of high water, these are the kinds of places that should be well protected against the river. Due to years of sedimentation, the riversides have become higher and higher. Therefore, in this scenario we want to lower the river banks as indicated by the green arrows. That way these parts of the river bank can serve as flood plains. Ideal and vital for this plan is that there is already a natural partition between the future flood plain and the water-filtering center.



2.1 Overview of the Dutch rivers

The Netherlands is situated relatively low, because of that many rivers come together in the Netherlands to flow into the North Sea. That's why the Netherlands is called the drain of Europe. The main rivers in this country are the:

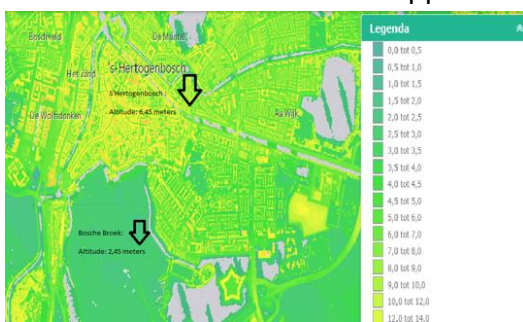
IJssel, Maas, Rijn and the Waal, which is an tributary of the Rijn. Because our country is situated so low, we are forced to take measurements to assure that there is enough room for the river. Otherwise there would be the huge risk of the disaster in 1953 repeating itself. The 1953 North Sea flood was a major flood caused by a heavy storm that occurred on the night of Saturday, 31 January and the morning of Sunday, 1 February 1953. The floods struck the Netherlands, Belgium, England and Scotland. The Netherlands, being a country with 20% of its territory below mean sea level and 50% less than one metre above sea level, was affected the most, recording 1,836 deaths and widespread property damage.

2.2 Local river research: 's Hertogenbosch

Our local example is 's Hertogenbosch. If you look at this province, you see that this city is situated a bit lower than the rest of the provinces. Because of the relatively low altitude of this city, there are many rivers in the drainage basin of the Maas that flow to 's Hertogenbosch. The main rivers are: the Maas, the Dieze, the Dommel and the Aa. There are also a few canals in 's Hertogenbosch which allows us to manage the amount of water which flows through 's Hertogenbosch. In the case of emergency, there is an overflow area which the city can fall back on. This area basically consists of two marshes. Because these marshes are lower than the city, they can store surplus water for a specific time.

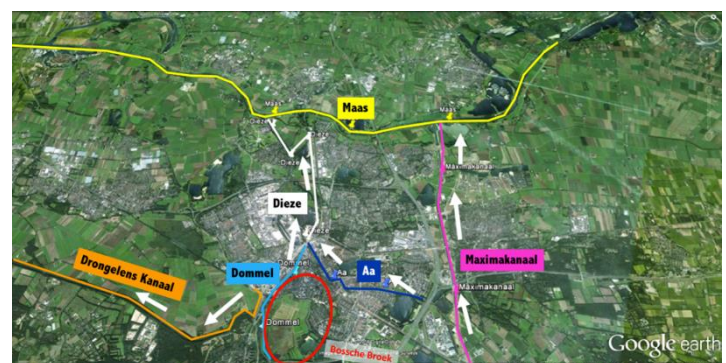
2.3 Function Bossche Broek

The Bossche Broek functions as emergency storage area for water. It is used when the water of the Dommel rises above 4.90 metres. This can happen with



extremely heavy rainfall, but also when there is a flood wave on the river the Maas. To explain this, you must know the following facts. The drain of the Dommel and the Aa is a maximum of about 260m³/s and the Drongelens Canal can dissipate up to 100m³/s to the Maas. The remaining flow of water coming from the Dommel and the Aa can be further dissipated by the Dieze. If there is no flooding on the river the Maas, this drainage can be done smoothly. However, when a flood wave hits the Maas, the discharge of the Dieze becomes obstructed. At that time, only the Drongelens Canal is available to transport water from the Dommel and the Aa to the Maas. When the drain of the Dommel and the Aa is larger than 100m³/s, a problem arises for 's Hertogenbosch as the water of the Dommel will rise above 4.90 metres. This could cause a situation as the one in 1995 when the water entered the city. To prevent this from happening again, two inlets have been placed in the dikes of the Bossche Broek.

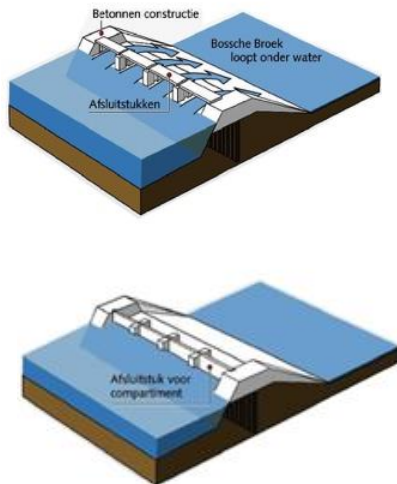
River	Maximum drainage available in m ³ /s
Dommel + Aa	260m ³ /s
Drongelens Canal	100m ³ /s
Dieze	+/- 160m ³ /s



2.3.1 Working inlets

When the Dommel rises above 4.9 metres, the dikes containing the two concrete

'Gemaal Bossche Broek'. Segersgemaal works like a waterscrew. The spinning effect pumps the water upwards back into the Dommel until the water level of the Dommel is around the 4.90 metres again.



constructions are dug out with a digging machine, making it possible for the water to flow into the Bossche Broek. The north part of the Bossche Broek has a water storage capacity of 5,6 million m³ and the south part has a water storage capacity of 3 million m³. This is a total of 8,6 million m³ which is you can compare with 3440 olympic swimming pools. Once the water has flowed into the Bossche Broek, a closure part is placed on the concrete inlet. This way, the water level of the Dommel can be managed around the 4.90 metres. If the water level is higher or lower, the drainage to the river the Maas can not be proceeded smoothly.

2.3.2 Working outlets

Once the water of the Dommel has descended, the water from the Bossche broek can be pumped up back into the Dommel. To do this, pumping system 'Segersgemaal' was installed in 2006. This pumping system completely took over the function of the old and traditional pumping system founded in 1936:

Conclusions

1. Dommel:

We have made a new plan for a part of the river the Dommel. We think that with this plan we can create more room for the river, and that way minimizing the risk that the Dommel flows out of its shores. With our new design we have also enlarged the biodiversity in this area which gives the possibility for new organisms to establish themselves. With this plan we have also given the authenticity of the Dommel back wherefore the river gets a more natural look which is also interesting for hikers. To create more room for the river, there are different approaches such as dike relocation or lowering the flood plains. We have discovered that we cannot use all approaches on one area as this is unnecessary.

2. Bossche broek:

We have investigated the Bossche broek and have seen the capacity of this area. We now know a lot more of the Bossche broek and we also understand how the area is used as emergency water storage area. The north part of the Bossche Broek has a water storage capacity of 5,6 million m³ and the south part has a water storage capacity of 3 million m³. This is a total of 8,6 million m³. 's Hertogenbosch is a point where many rivers come together, making it a dangerous place for floods. Luckily, because of all the precautions, this isn't the case anymore. We now know how important the existence of these areas are, and how important it is to keep

improving these kind of emergency solutions with an eye on the climate change.

Bibliography

<https://www.ruimtevoorderivier.nl/english/>

<http://www.dommel.nl/algemeen/recreatie/wandelen.html>

<http://www.greenfacts.org/en/global-biodiversity-outlook/index.htm>

<http://www.denbosch-cultuurstad.com/bossche-broek.html>

<http://static.waterschapshuis.hosting.onehippo.com/mer-hoogwateraanpak-s-hertogenbosch.pdf>

<http://ahn.nl/>