Blue: Finn; Red: Bjorn; Green: Fenna

Begin talk

Hello, we are Bjorn, Fenna and Finn and we have researched the impact of the Sluices Ajar Decree. But let's start by introducing ourselves.

Who are we?

We are three students from the Netherlands. Our school is called: 'the d'Oultremontcollege'. This is a high school in Drunen, which is located in the south of the Netherlands.

To show exactly where our school is located, we're going to show it on the map. So here is the world, and when we zoom in we see Europe. The Netherlands is located quite centrally in Europe, it is the brown country on the map. Here we see the Netherlands. The red dots are big cities, but one red dot is where our school is located. And that is this one, in a small town called Drunen. This is what our school looks like from the outside.

So, back to who we are.

Bjorn: I am Bjorn, I'm seventeen years old and …

Fenna: I am Fenna, I'm sixteen years old and my hobbies are drawing, baking and eating cakes. And as you can see on the picture I also play korfball.

Finn: I am Finn, I'm sixteen years old and I like sailing.

Preface

Back to our project.

So we have researched the impact of the opening of the Haringvliet sluices on the ecosystem behind it. We focused specifically on the flora and fauna in the estuary of the Haringvliet.

Orientation

We assume that the Haringvliet sluices don't mean much to you, so we are first going to explain what they are.

The Haringvliet is a large inlet in the North Sea. It is an important estuary of the Rhine-Meuse delta, which means that it's a place where rivers meet the sea. The weird thing is that the Haringvliet is not directly connected to the North Sea anymore, because a dam with sluices was built right between them. This is what the dam and the sluices look like.

The dam and sluices were built because a major flood in the south of the Netherlands killed about two thousand people in 1953.

Here's why: in the night of the 1st of February, a combination of a high spring tide and a severe windstorm over the North Sea caused a storm tide. And with the Netherlands having 20% of its

territory below sea level and 50% less then a meter above sea level, the country relies heavily on sea defences. That night those sea defences broke... causing a major flood.

So the government decided to build the Delta Works, which you can see on this map. Some of the Delta Works completely stop water from coming in, like the Haringvliet Sluices, and some are only shut when the situation is critical, like the Eastern Scheldt storm surge barrier. On this map number 6 represents the Haringvliet Sluices.

Now, there was a physical barrier between the North Sea and the Haringvliet. The original brackish environment with ebb and flow disappeared from the Haringvliet, along with the unique flora and fauna associated with it. Migratory fish also cannot complete their migration routes anymore.

In the beginning of 2019, after 30 years of consultation and research, the government decided to open the Haringvliet Sluices occasionally again. Primarily to encourage fish migration and to improve the biodiversity of the Haringvliet. We researched the impact of this opening of sluices on the flora and fauna in the Haringvliet.

Research

On the picture on the right you see a cross-section of the sluice. The Haringvliet dam has seventeen sluice gates, each about 58 meters wide. Each opening has a slider on the seaward side and one on the riverward side. The slider on the seaward side is used to control the waterflow, therefore the size of the opening of the sluices is measured at that side. In the so-called Sluices Ajar Decree, the decision to partly open the sluice gates, stipulates that the opening for admitting seawater can vary from 25 square metres, this happens when 1 slider is open 40 centimetres, to a maximum of 1,200 square metres, when several sliders are open 2.50 metres. Of course, in a storm, the normal closed position is resumed.

When a slider is open, fish and salt water come in. This means that the Haringvliet, which initially was a fresh water area, becomes a partly salt water area. This mixing of freshwater and saltwater causes a lot of changes in flora and fauna.

The Haringvliet is not only an area for fish and plants. The agricultural sector also uses water from the Haringvliet, as do drinking water companies. And there are more stakeholders. All these stakeholders have their own ideas about the opening of the sluices. This made it very difficult to find an agreement.

The most important stakeholder is the water company Evides. They used to take freshwater from the Haringvliet to turn it into drinking water. But after opening the sluices, there is no freshwater anymore. In order to keep using freshwater, Evides moved their intake points to the east of the imaginary Middelharnis-Spui line. Consequently, salt water can be introduced to the west of the line without compromising drinking water abstraction or agriculture being affected by salt water in the ditches. On the eastern part of the line, the water needs to remain freshwater. Therefore the opening of the sluices needs to happen gradually. Currently, the various opening sizes and their salt water impact are being tested, so that in the future a computer could open the sluices automatically.

Like Fenna just said, the Sluices Ajar Decree allowed for an interaction between saltwater and freshwater. Of course we know that saltwater is heavier than freshwater, therefore saltwater sinks to the bottom and the upper layers remain freshwater. We wanted to do some field research, so we went to the Haringvliet and take samples from the upper layer to doublecheck. We did this by collecting water samples from the water surface at 6 strategically located places. You can see these places here, numbered 1-6. We measured the salinity of the surface water at these locations by evaporation. Unfortunately our scale only had 2 decimals, which is why it says that some of our measurements contain 0 grams of salt. Most likely there is a tiny bit of salt that we couldn't measure because we evaporated only 100 ml of water. We did manage to prove the most important thing about this field research and that is that the salinity of deeper water is always higher than the salinity of surface water, which of course implicates that the salt sinks.

The data from the deeper located measurements are derived from the website of the official instance that manages the water in our country, called Rijkswaterstaat. These data prove that our theory is correct: the salt water sinks. This represents of the 2 most important variables that determine the salt water distribution in the Haringvliet.

The other important variable is the river discharge, which has got a huge influence on the vertical distribution of saltwater and freshwater. Imagine that on one side there is an incoming flow of saltwater, the volume and strength depending on what degree the sluices have been opened. On the other side is the river discharge, which also varies in strength.

If these 2 currents interact with each other, a situation like the sketch below takes place. You can see that a horizontally layered estuary with a varying salt gradient starts to develop. This is also our conclusion about the salt part of our research, as you can see over here. (read conclusion)

We also have done some more research ourselves. We have planted three freshwater plants of the same species in water with different salt gradients. Each plant in its own vase. The salinity levels are: 0 grams per litre, 5 grams per litre and 10 grams per litre. We have kept track the growth process of all three plants. Here you can see this process. You can see that the plant that grew in water with a salinity of 10 grams salt per litre turned brown rapidly and died after 64 days. The plant that lived in water with a salinity of 5 grams per litre died after 71 days and the plant which lived in freshwater, is still alive. However, after 33 days the leaves also turned brown, but they changed back to green again and even new leaves started to grow.

As a conclusion, we can say that a fresh water plant can't survive if the salinity of the water is higher than 5 grams per litre. This means that if there are other fresh water plants in the Haringvliet, they won't survive, because the salinity of the water is often higher than 5 grams per litre.

Conclusion

All our predictions are based on the available information that we obtained from professionals. Other conditions may apply, but we didn't take them into account, such as species of fish disappearing or arriving to the Haringvliet and affecting the flora. We only focussed on the transition from freshwater to salt of brackish water. Because of the lack of information, our research results are a prediction.

Fish in the Haringvliet can be divided in 5 categories: … For each of these categories we took a picture of an exemplary fish and outlined it with a colour, depending on how the Sluices Ajar Decree will most likely affect this fish species. Green means that the fish probably will stay after the Sluices Ajar Decree. An orange border indicates that the fish may stay under certain conditions, or move to a different area of the Haringvliet.

As an example of the anadromous fish species we took the Atlantic salmon. This fish will benefit a lot from the opening of the sluices. It can now swim to its spawning areas, upstream in the Rhine. On their way to their spawning areas or back to the open sea, they can gradually get used to saltwater or freshwater in the estuary.

Catadromous fish species like the European Ale will also benefit from the opening of the sluices. Like the Atlantic Salmon it can now easily reach its spawning areas again. Ales from ages 2-17 years can also grow up in the Haringvliet now because of its varying salt gradient.

Estuarine fish species, such as the flounder, will benefit as well. They can now live in the Haringvliet, breed and multiply. It is very likely that their population will increase.

The Atlantic Herring, a marine juvenile, will benefit from the opening of the sluices like the last 3 fish species. These marine juveniles can now grow up once again in the Haringvliet. A small side note to be made is that they favour the saltier parts of the estuary and most likely will be found towards the sluice sides.

At last there are the freshwater species. These will not benefit from the Sluices Ajar Decree. Their habitat will only get smaller, because of the new influx of saltwater. This probably won't be a problem however, because their population isn't that big that this reduction of habitat would pose a problem.

Altogether, thanks to the Sluices Ajar Decree, the original estuary nature will be restored.

A lot of different types of plants grow in the Haringvliet. These plants were examined in 2013 by a team of the Dutch government. This happened before the opening of the sluices, when de Haringvliet contained freshwater. This information formed our base for our research. The plants that grow in the Haringvliet are fennel, small and curled pondweed, zannichellia Eurasian watermilfoil and western waterweed. Besides these plants, there are some others, but we consider them as weeds. The weeds will survive under many circumstances, so if the water may become salty, they will still survive. Therefore we mention them here, but have not included them in our research.

Like we did for the fish, we gave the plants a coloured border too. A green border means that the plant will probably stay. An orange border indicates that plants may stay under certain conditions, or move to a different area of the Haringvliet. A red border means that the plant will disappear after the opening of the sluices and the arrival of salt water.

First of all, the fennel pondweed. This plant reproduces itself by seeds and roots. The biggest enemy of this plant will be the increasing salinity. If the salt sinks, and it does, the growth of these plants might be restricted.

The small pondweed won't be much affected by the opening of the sluices. They are able to grow in a salter area and they will have enough nutrition to stay alive. This means that the small pondweed will continue to grow in the Haringvliet.

Curled pondweed mainly lives in freshwater, like the Haringvliet used to be. Now the salinity has increased and has reached a level that is fatal to curled pondweed. This means this specie will disappear.

The Zannichellia reacts the same way as the fennel pondweed. This means that they will have the same difficulties in staying alive and continuing their growth. The growth of this species will probably be restricted too.

The same applies to the Eurasian watermilfoil. The increasing salinity is a difficulty.

However, the Western waterweed can survive under almost any circumstances. For them it is no problem to keep growing. They can reproduce at a rapid pace, because other species are disappearing.

In conclusion, only the small pondweed and the western water weed will definitely survive in the Haringvliet after the arrival of salt water. Probably the other species will disappear or move.

Whether or not new plant sorts will start growing in the Haringvliet cannot be concluded from our data. We do expect, however, that new fish will start appearing and living in the Haringvliet, but this will not result in drastic changes of the existing ecosystem of the Haringvliet.