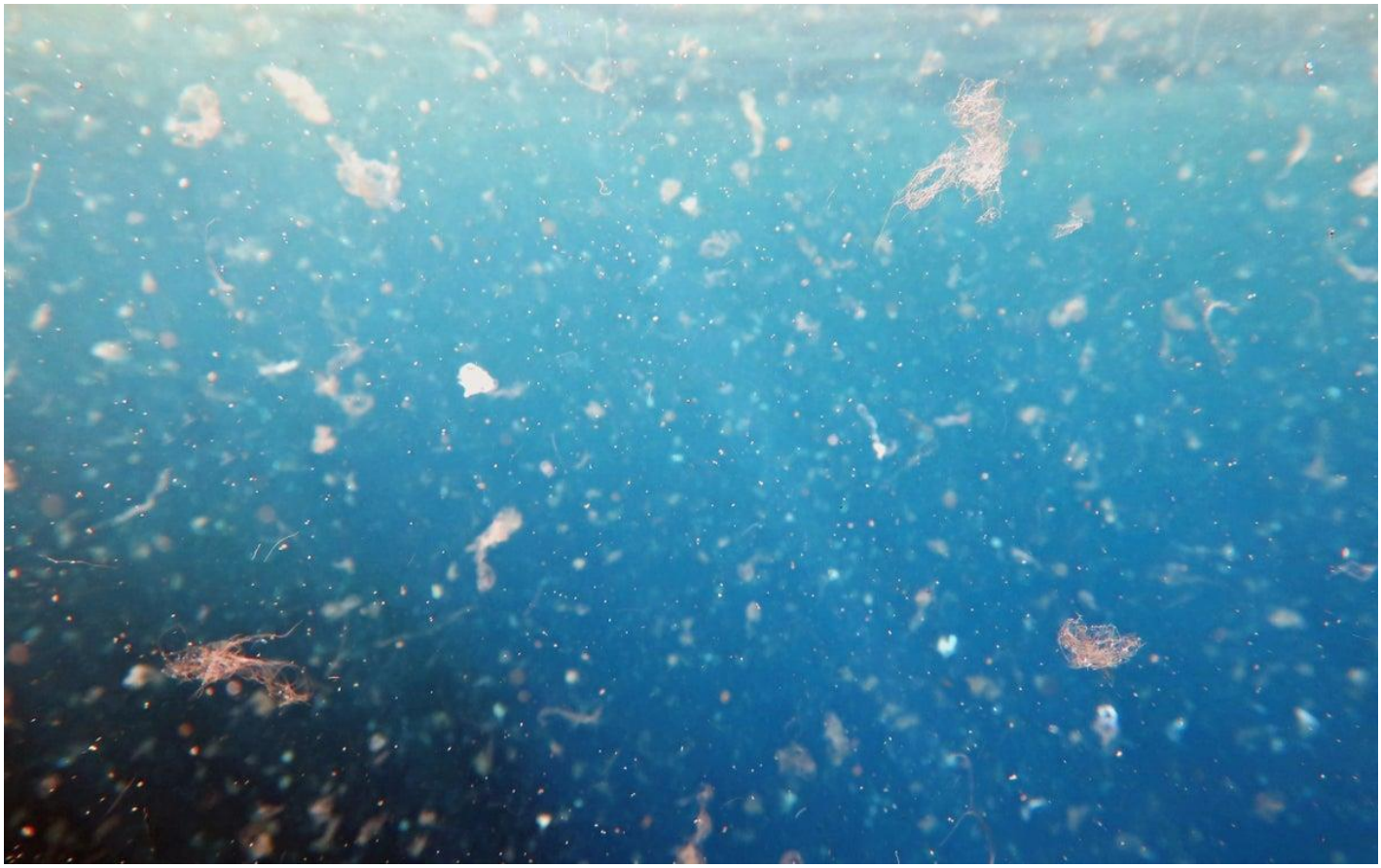
Microplastics in the canal ‘de Vaart’



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HELEN PARKHURST
Daltonschool mavo havo vwo

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Abstract

Concise

Microplastics are a new threat that people have been taking easily. It's something not everybody knows about. Microplastics are residue of plastic, textile, tires and cosmetics smaller than 0,5 mm. Studies have shown that in a few years our bodies won't be able to handle the plastics because that 0,5 mm could turn into something huge in our organs after a long period.
We, students from Helen Parkhurst have been doing research for the Deakin university in Australia in this international project (they gave us this task). Before starting our microplastic count we did a ton of research online using rubrics given from our teacher. All the sources used in our research will come up after reading on how we conducted the sampling and count.

Context of research:

In this project, different students have collected water from different locations in the Netherlands. With specific data protocols we have filtered our retrieved water and filtered it. With precise techniques we were able to count the majority microplastics on the filters of 500 ml filtered water. We collected 2 samples following the protocols: 1 sample from the shallow end of the Vaart and one sample from the deep end. We were just interested to see the difference of amount, that's why we chose to do multiple filters.

Research question:

Main research question: How many microplastics stream on the surface water of the Hoge Vaart?

Other research questions:
What do we already know about the amount of microplastics on the surface water in the Netherlands and Europe?

(Hypothesis):

We think that there will be a large amount of microplastics in the Hoge Vaart. We're not sure how many. That's because it's a very populated place so there will be lots of opportunities to get microplastics in to the Hoge Vaart. Its industrial too, so that could also be a huge opportunity of microplastics in the river.

Objectives set:

The objective was to research microplastics in the water. With the information we got from the research we would need to answer the Research question we came up with and the question we were given. So for us the objective is to research the water in the Hoge Vaart and the numbers of Microplastics in it.

Brief Methods description:

We've used the sampling method following the protocols from Deakin University.
Filtering method following the protocols from Deakin University.
Microplastics monitoring guide from Deakin University.
Maths for calculating the volume of the Hoge Vaart.

Results:

Our results are the roughly calculated amounts of Microplastics in the Hoge Vaart.

Conclusions:

We can conclude that there are a lot of microplastics in the Hoge Vaart.

Recommendations for a way forward:

Overall, this project went better than all the others. Everyone was excited for this project. There were some troubles with the collaborations and our advice is to avoid quarrels at any cost. It will only take your time away and not be useful at all. But ultimately everything worked out and were very proud of our work.

Key words that emphasize key ideas in the paper:

Microplastics, Pollution, Cellulose

Research Questions

Include why they are important and are of scientific interest

The problem with Microplastics is relatively new and knowledge about this is necessary, you can get the knowledge by answering the Research Questions

Concern some aspect of Earth's environment (local or global issue)

Microplastics can have devastating consequences for the abiotic factor.That's because when it ends up in service water it's very difficult to filter the microplastics out. If it's not taken care of, animals can eat the microplastics and end up on our plates or it could end up in drinking water or products that need water.

Most of the times when you're eating an animal it contains microplastics. If you happen to eat microplastics its likely to increase the potential for toxic effects. Microplastics can also pass through the intestinal wall, lungs placenta and even the blood brain barrier.

Provide significant insight into both the topic of investigation and the research process

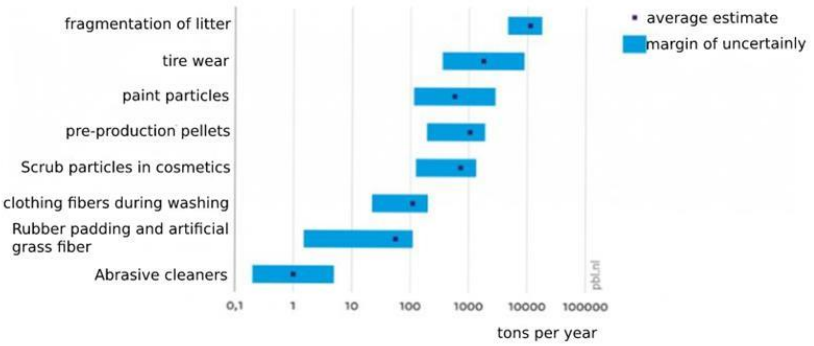
We could answer the research questions if we had enough information, which we most of the time found on the internet.

Here are the questions:

How many microplastics stream on the surface water of the Hoge Vaart?
There are around 9.99936e+11 Microplastics in the Hoge Vaart.

What do we already know about the amount of microplastics on the surface water in the Netherlands and Europe?

In the Netherlands, about 17,000 tons of microplastics are released yearly due to tire wear. Forty percent of this is not furtherly distributed in the environment. The remaining tire wear mainly ends up in the soil, and to a much lesser extent in air and surface water. On motorways and rural roads, rubber particles are emitted directly to the surface water, while in urban areas the rubber particles are transported with the sewage-to-sewage treatment plants (WWTPs).



The Purified water (which still contains 16% to 34% of tire wear) is discharged to surface waters such as streams, rivers, canals, estuaries and the sea. In contrast to the Netherlands, the rest of the EU still has a large part of sludge which is spread on land. That's how the 'captured' microplastics still end up at the bottom. This also applies to countries that are located by upstream of the Netherlands, such as Germany, France and Austria. A recent test calculation for the Seine River Basin has shown that transport of tyre wear in surface water is limited (relatively high specific gravity), with 18% of tyre wear remaining in the rivers and only 2% entering the estuaries. The route via the WWTP is not specific to tyre wear but applies to all microplastics that are discharged via the sewer, including microplastics from textiles, paint microplastics, scrub particles from cosmetics and abrasive cleaning agents. These particles do have a different shape and a lower specific gravity than tire wear and can therefore stay longer in the water column. Microplastics from PE, PP, SBR and EPS remain afloat, while microplastics from PS, PVC, Pur and PET, among others, are likely to end up in the sediment. In the Netherlands, most microplastic fibres enter WWTPs via the sewer where one part is removed. It is estimated that in the Netherlands alone, 110 tonnes of microplastic fibres are indirectly emitted to surface water each year from textiles.

Which methods are being used to measure microplastics and nano plastics on big surfaces of water in the Netherlands and Europe?

There are some things that are almost always secrecy with measuring microplastic like: sampling, extraction, quantitation, and quality control. All those steps can require more methods.

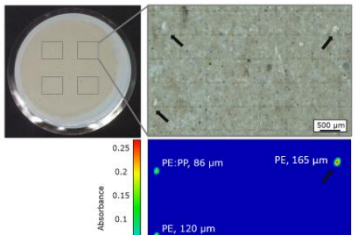
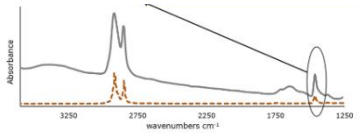


Figure 1 scanning microplastic

The most methods of measuring microplastic is used in the west of Europe and every country uses many different methods. most of these country's use the same methods.

One of the most frequently used methods is counting with a microscope. This technique is labour intensive and prone to human error.



KWR is in progress of making something that can measure the amount of micro and nano plastics in rivers. An example is the project TRAMP, that is focused on measuring and knowing what the side effects are, special for the Dutch service waters. Over the last few years TRAMP was busy with creating samples and measuring methods. In 2019 they tested their methods on many different rivers. With all this testing they can learn more on how microplastics work and on how to prevent it in the future.


Figure 2 home made filtering device

Infrared spectroscopy is a way to view the microplastics/nano plastics that are in the water. That's a step which is handy when it comes to extracting microplastics and measuring them.

You can also measure the microplastic yourself you just need to make a triangular shape with wood and some floaties and a net and a rope. Then you can just go to a river and try to get some samples. When you are done with taking some samples you can filter the plastic and see how much microplastic lays on the service of the water.

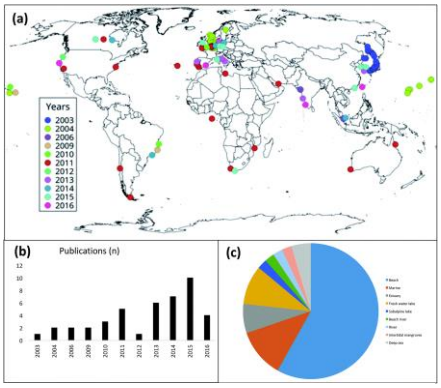


Figure 3 measuring places

Another way to measure microplastics is separation. There are many sorts of separation ways like:

Electrostatic behaviour

This method uses the electrostatic behaviours of plastic particles to facilitate their separation from sample matter, with 99% of the original sample mass removed. To determine the quality of this approach they tested it with other types of minerals like sand or other types of water with microplastic. This method has a recovery rate of around 100% for all the materials. This demonstrates how accurate this technique is.

Principle of density flotation

This method uses the density of the microplastics. This method is constantly extracting microplastic from sediments in a single step. This method has an efficiency of 95.8% (±SE 1.6%; min 70%, max 100%). With this method the fine sediment settles on the top of the water and the rougher sediments settle on the bottom.

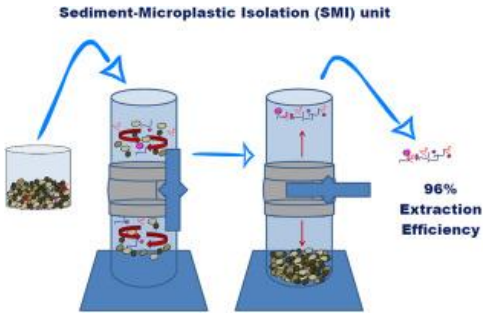


Figure 4 sediment measuring device

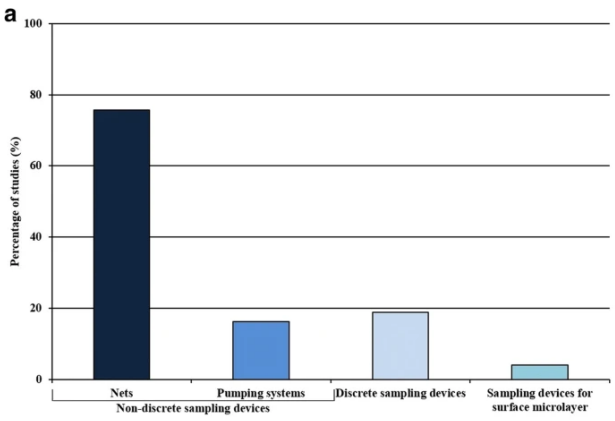
Which solutions have already been discovered to extract microplastics and nano plastics out of the surface of water in the Netherlands and Europe?

A student from Ireland, North Europe, discovered a way to attract micro/nano plastics in the water by adding an eco-friendly magnetic powder which makes the plastics cling on to the surface of the water. Plastics are attracted to suspensions which makes it easier to separate the plastics from the water once retrieved. The suspension consists of oil, the ferro liquid, (which formed because of the powder) and water. In other words: The microplastics became attracted to the suspension like a magnet.

There are also projects right now, where scientists around Ireland have been designing water filter installations for big surfaces of water in Europe.

A partnered organisation in France and Italy have been studying microplastics since 2008. In their research they discovered that nets were an effective way to retrieve microplastics from big areas of sea water because there were no odd corners to fit in. In Rivers or small water areas, nets wouldn't be as effective. They found some other devices that were more effective for smaller areas of water, for example, special pumping systems that can clean each layer of the water surface, or sieve-rotating drum samplers.

In this organisation they tested different types of nets in west and south Europe. In their results, Manta nets were the most effective.



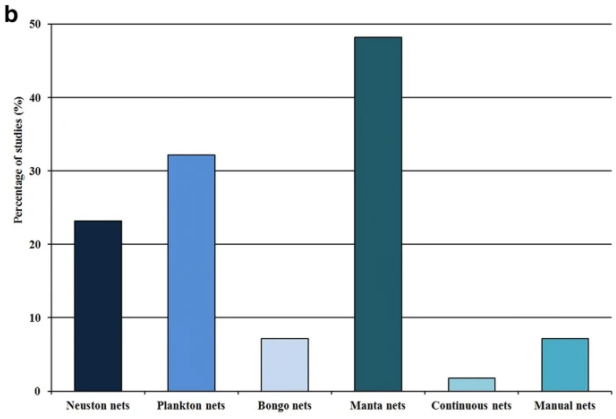


Table 1 results of nets effectiveness

These images show the results of research on which nets were more effective and which methods as well.

The province 'North-Holland' has already found a method to fix microplastics in their area and are planning to do this in the rest of the provinces of the Netherlands. In their research they found out that they could clean the sewer system and prevent it from giving 'microplastic' water out to the oceans, canals, and rivers. They achieved this with the "***great bubble barrier***". It's an invisible screen pane with a pipe that pumps air into the water which then forms air bubbles into the water. Right now, this pane can retrieve 1mm microplastics. They are still working on a pane that can retrieve 0,05-0,02mm microplastics in the sewage system. The flow of air causes all the rubbish and microplastics to float at the top of the surface of the water. All the rubbish

then floats off to the shore which is then sorted out. Marine animals won't be disturbed by this method if the pane is placed diagonally.

Me and my team have done a lot of research, but we were unable to find solutions in East-Europe. All we could find was the problem about microplastics and the hazards. Right now, the Eastern side of Europe is on the research stage.

In conclusion, 70% of Europe has found a way to extract micro/nano plastics with either devices or nets. The Netherlands have found an effective way to extract micro plastics, but it's still in testing and research on whether it's going to work in other areas of the country and Europe.

What is already being done to prevent new intake of microplastics into surface water in the Netherlands and Europe?

Sweden already has a ban on microplastics in cosmetics, especially in rinse-off products where plastic particles have been added for scrubbing. The UK has banned single-use plastic items (e.g. straws and coffee stirrers) that can later be broken down into microplastics. European law: The intentional addition of microplastics to products such as paint, cosmetics and abrasives is prohibited, also consumers are made more aware of changing their behaviour (Buying products containing harmful substances/microplastic) this can prevent 500,000 tons of microplastics from entering the natural habitat. An anti-plastic campaign in cosmetics called "Beat the Microbead" has been launched in 2012.

Answering them requires an advanced understanding of the subject matter

Answering the questions does indeed require advanced understand if the subject. You need to look up for information from various sources for the more complete image. When looking for information focused on the exact question you want to answer, you read a lot of other information which can help you answer other questions.

Require a thoughtful research plan.

When researching such a thing as microplastics you need to be prepared for what you're going to do. You need to have all the materials and you must make sure you don't forget any. Make a planning because there is a lot of things you got to do which all use a lot of materials. You still have to make the research right and follow all the protocols.

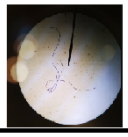
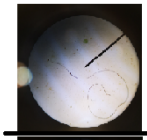
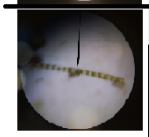
Are answerable through scientific research appropriate to the scope of the report

You can answer the questions if you do the right research. We were able to answer all questions, although there was not much information available about the subject.

Results:

Tables and graphics applying statistical analysis of data to show mean, dispersion, or grouping data.

Datasheets from both samples

	Item #	Geometry - CHOOSE	Colour CHOOSE	Surface appearance CHOOSE	OPTIONAL Longest dimension (estimated) (µm)	OPTIONAL Shortest dimension (estimated) (µm)	Photo? CHOOSE Yes/No	Your assessment. CHOOSE from the drop-down menu	COORDINATES
Example	*01*	*Fibre/filament*	*Orange/Pink/Red*	*Rough or Porous*	*340*	*10*	*yes*	Cellulose Textile Fibre	N3E4
		fibre		porous	340 um	300	Y	celluose textile fibre	52°22'53.8"N 5°14'51.4"E
		fibre		porous	300	250	Y	celluose textile fibre	52°22'53.8"N 5°14'51.4"E
		filament		rough	200 um	150	Y	plastic piece	52°22'53.8"N 5°14'51.4"E

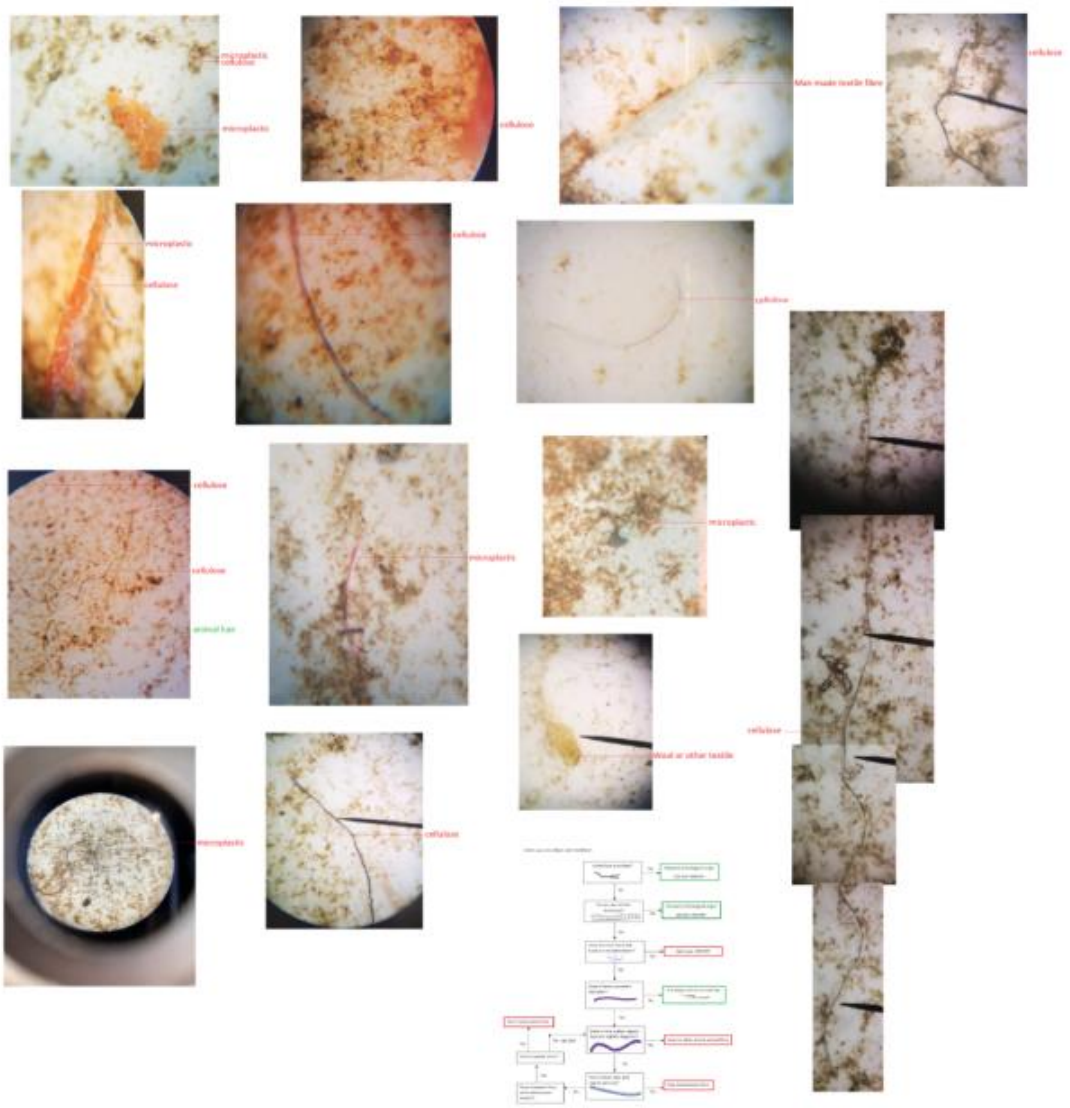
Data support the conclusions

TYPE OF OBJECT	COUNTER
Cellulose & Animal Textile Fibres	49
Man-made Fibres	1
Plastic Pieces	13
Unknowns	5

Sample 1

TYPE OF OBJECT	COUNTER
Cellulose & Animal Textile Fibres	57
Man-made Fibres	3
Plastic Pieces	3
Unknowns	2

Figure 5 Sample 2



Note: these are just a few of the microplastics we encountered. There are way more than just these few datasheets.

Measuring the Vaart:

Length * width * depth = volume m³
62000 * 42 * 3 = 7812000 approximate volume of the Hoge Vaart M³
m³ to dm³ to l =
7812000 * 1000 = 7812000000 dm3 = 7812000000L
7812000000 * 1000 = 7812000000000 ml =7,812e+12ml

Rough calculations of the amount of microplastics in the vaart
7,812 x 10+12 : 500 = 15624000000
15624000000 * 68 = 1.062432000000 = 1.062432e+12 Microplastic in the Hoge Vaart.

If we take the results from 2 filters, which will make out answer more accurate we will get:
128 Reported objects in 1 litre water.
7812000000 Litres
7812000000 * 128 = 999936000000 = 9.99936e+11 Microplastics.
Note: these calculations are still too inaccurate to know the actual amount of microplastics in the Vaart.

Discussion:

Interpretation of results
The results are quite shocking. But the results can not be fully trusted because of temperature differences and the fact that the sampling bottle could already have contained microplastics. Wind can also carry microplastics which is also a reason our results cant be fully trusted.

Possible sources of error
Our answer to the research question could be wrong: it's an estimation because we didn't have the exact amount of microplastics. Checking the whole filter is difficult, so its possible we didn't check the whole thing. We made sure we brought the samples back in a glass jar, but the sampling rod was a plastic bottle, which could have given an additional amount of plastic.

Advice about the protocols:

Filter more water in one go instead of doing it in sections (500ml in one go instead of 100ml 5x

Our answer to the research question could be wrong: it's an estimation because we didn't have the exact amount of microplastics. Checking the whole filter is difficult, so it's possible we didn't check the whole thing. We made sure we brought the samples back in a glass jar, but the sampling rod was a plastic bottle, which could have given an additional amount of plastic.

Since we lost one sample of water , we had to go back and retrieve more. It was sampled at a different time, so maybe that could have interfered with our research.

Conclusion

How many microplastics are contained in one liter water of the hoge vaart?
There are a lot of microplastics in the vaart: roughly 999936000000 Microplastics.

Link Protocol files:

https://cloudstor.aarnet.edu.au/plus/s/FoUPa6PHtK0SOTD?path=%2FProtocol_files

Badge summary

After finding out what the answer was to our research question, we were shocked. The pre-research we did also informed us lot about daily products that contain microplastics. We can take action by avoiding products that contain these harmful chemicals, for example using toothpaste without a red tab on the top of the tube, or natural face washes without a beady scrub. Adding a filter on Drinkwater taps already cleanses a huge percentage of the microplastics and hormones contained in that water. You never know, our drink water could be the Vaart as source, so action must be taken. Our teacher Maaike sent us the PDF, giving a brief introduction on to microplastics and that's when we realised this isn't just any small local problem. Plastic is all over the world, thus making it a global problem. The Local amount was already huge, so the global amount is inconceivable.

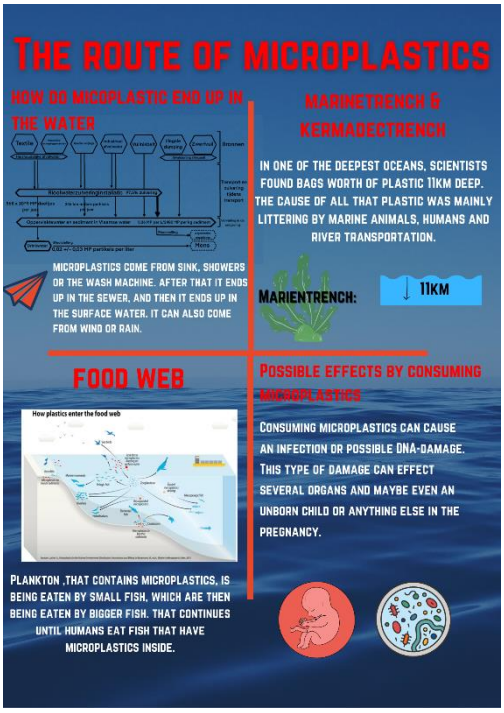


Figure 6infografic microplastics

We made this infographic to help us explain the small basics of microplastics in our school presentation.

We all had different roles in this project.

Qudsia was the Project companion; Planning everything, helping and taking the lead in this research.
Zakhar was the Quality checker. Before anything was conducted, he would make sure it was all in order.
Oscar was the designer. His role was to make all the documents neat, and his creative ideas helped us along the way (way of sampling for example).
Laryna was the Data analyst. Her job was to keep track of the coordinates we went to sample our water and she kept track of the data sheets. We all chose to take on these roles ourselves and this is how this whole project came together.
We have submitted the project complete thanks to our collaboration. Everyone was doing great with their role. Because of such roles it was easy enough to work knowing that your work could've been edited to complete the requirements by someone who is responsible for it, so you won't have to spend time on it. This is a very efficient way of working and we've all noticed that.

Additional Research

Microplastic in cosmetics

Cosmetic items such as makeup, shower gels, shampoo's etc.. contain the microplastics microbeads, glitter and PEGs.
PEGs consists of liquid polymer, which can then harden up to plastic.
Glitters contain colour pigments, aluminium and fine plastic bits which is also an endangerment to the environment. Microbeads contain synthetic polymers such as: polyethylene, polylactic acid, polypropylene, polystyrene, or polyethylene terephthalate. These are often found in toothpaste and facial washes. The goal of adding these microplastics in beauty products are to use them as bulking agents or abrasives. Companies add these plastics for a better finish and 'quality'.

Microplastics can be harmful to the human body. It can damage the cells and production. It can also cause immune and inflammatory reactions. Researchers have found plastic contamination in samples from the lungs, liver, spleen and kidneys. This disturbs the filtering of the organs in the human body.
You might have bought a toothpaste with flakes of mint, or a face wash with bits of "cleansing beads" that help your skin. These bits are made of microplastics and micro beads. That's something you can see with the naked eye. Glitters are also 90% made out of microplastics. The shine makes it more recognizable. An app has also been designed to recognize microplastics in the product you've bought. Microplastics are so small that you can even see them without a microscope, but on products such as toothpaste, have colour coded "tabs" on the top of the tube. This shows how harmful the chemicals can be in that specific substance. No matter how small the plastic, in cosmetics or not, microplastics can take at least 450-1000 years to fully decompose. Cosmetic microplastics can decay to about 0,1 mm or smaller. This is why it's such a threat.

Microplastic in clothing

Synthetic clothing usually consists of textiles such as polyester, nylon, polyamide or acrylic. The purpose of microplastic in this product is to make it cheaper. Microplastic fibres are created during the wearing of clothing. Clothes that are made largely of synthetic clothing and during washing will shed these microplastics as well. The sewage treatment plants remove 50 to 90 percent of these microplastic fibres. The rest is discharged into the surface water, where they can have harmful effects on the organisms present.

Regarding the effects on humans, it appears that microplastic particles and fibres smaller than 50 µm can enter the respiratory tract via the nose and mouth. Most of these particles would likely exit the lungs through the bronchial self-cleaning system. However, some may remain in the lungs and cause local effects, such as inflammation. Research among workers in the textile industry have shown a link between inhalation of microplastic fibres and increased respiratory irritation and allergic reactions.

Textile workers who have worked with polyester and nylon fibres have had complaints such as coughing, shortness of breath and reduced lung capacity. Clothing fibres such as nylon and polyester can hinder the recovery and development of our lungs.

Synthetic textiles are a source of microplastic fibres. During the production of clothing and during wearing (wear and tear), microplastic fibres are released into the air. However, this is a small

amount compared to the microplastic fibres that are released during washing. In the Netherlands, most microplastic fibres end up in sewage treatment plants via the sewer, where a part is discharged.

Microplastic in paint

There are different types of paint such as; spray paint, normal paint and water based paint. All paints generally have four main ingredients: binders, pigments, solvents (liquids) and additives. They use microplastics because they have polymers. These particles make paint layers that can cover and protect surfaces. But polymers can release when dried paint layers break down or get sanded. These types of leftovers are called 'secondary plastics'. There is also something called primary microplastics. That's when you add solid polymers.

Figure 7 paint microplastic

Many types of paint are mixes of different chemicals. Some of these chemicals are harmful to a human and give side-effects such as irritated skin and headaches. When your allergic it can lead to problems with more vital organs like the heart. If you're working with spray paint and inhale the toxins then there can be short-term side effects like eye, nose and throat irritation, headaches, loss of coordination, and nausea. There are also some long-term side-effects that can damage the liver, kidney and your nervous system. There also some people who can get cancer. Key symptoms are nausea, emesis, epistaxis, fatigue, dizziness.

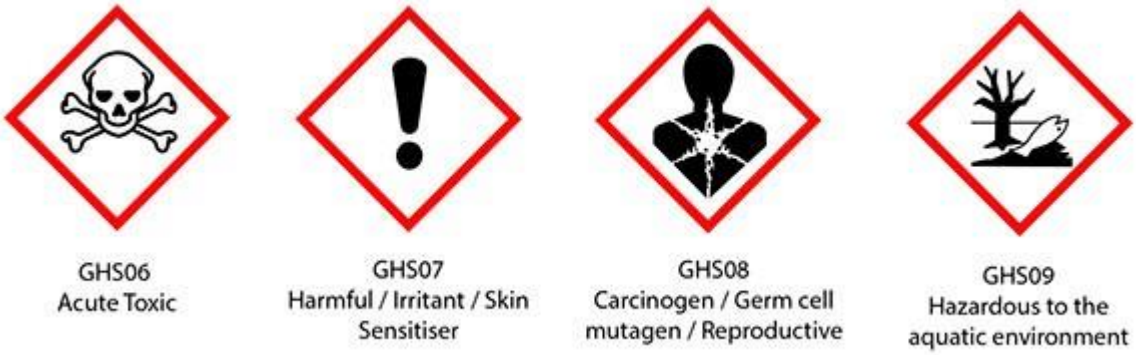


Figure 8 dangers of paint microplastics

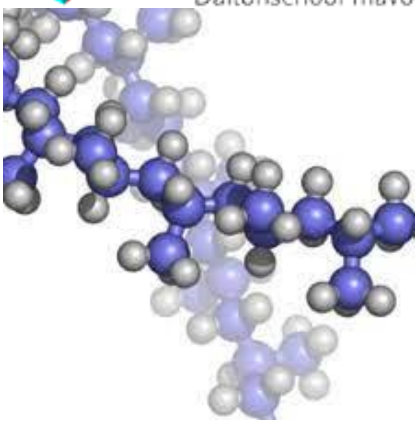
You can recognise microplastics when paint starts to dry. If you look at the image you can see dried paint stating to decay. When this happens the protective layers with polymers starts to go off the paint and become microplastics.

A lot of microplastics end up in the sea. That occurs when people clean paint off a boat with high pressure. They don't clean up a lot of microplastics which are not collected and end up in the sea.

Figure 9 decaying paint

Secondary microplastics

These microplastics are also called “Nano plastics. They are smaller than 5mm (size can descend from 5mm to 0,05mm). Nano plastics consist of polymer. It’s still unclear if nano plastics give the same side effects on mental health than microplastics.



The routes of microplastics

Microplastics are the bits of plastic that decay and end up as a small bit of plastic that is approximately 0,5mm or less. These small bits of plastic are light, which means the wind can easily blow these bits away and they can end up in the ocean. (Causes of wind: Big storms or just a bad weather) Littering, of any type (cosmetic, textile or packaging littering) in an area near water; or even far away can, one way or another, end up in rivers which then stream the plastic away and can decay in the ocean or whatever type of water source. Marine animals from an area can also consume and then spit out the swallowed microplastics in another area of water.

Living organisms can accidently or purposely consume microplastics. This can cause the feeling of toxicity in your organs. Sometimes you cant even feel it. That’s another reason why microplastics are dangerous. The side effects of this toxicity is metabolic disturbances, brain-toxicity and in some circumstances; cancer.

Mariana trench is one of the world’s deepest oceans…about 11 km! In scientific research it was shown that shopping bags worth of plastic was found deep underwater. Scientists found out that the cause was littering, and that plastics in the Mariana trench ended up because of river transportation of plastic.

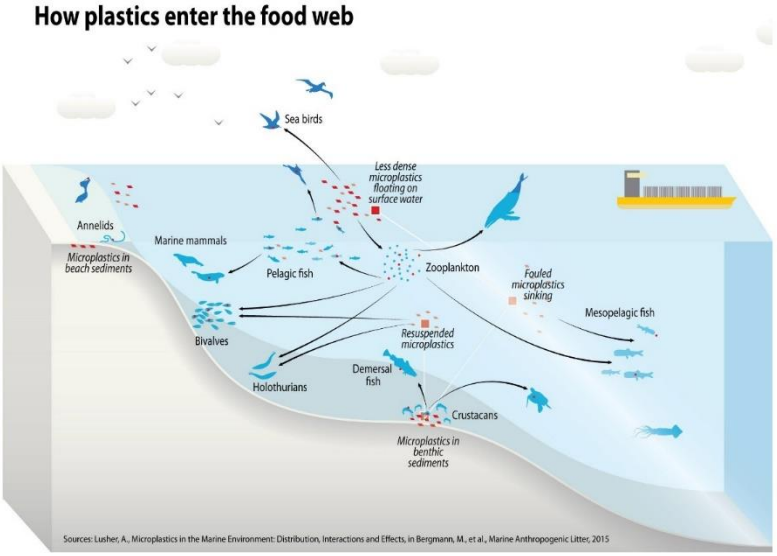


Figure 10 food web

Sources of our pre-research

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