The effects of urbanization on the Pedosphere
Group 17

© ShutterStock

Foreword

Since our schools are involved in the very exciting Globe project we all got to participate in and learn from this experience. Even though we've had some issues with communication we can still proudly say we delivered and overcame those issues. For this we want to thank our teachers: Miss Blom, Miss Kedžo, Mr. Gotlibović and all other people involved. Special thanks to Mr. Vaas who helped the students operate the lab equipment and the use of Logger Pro.In this research project the relation between the state of the pedosphere and urbanization in Rotterdam, Buzet, and Nysa will be explored. The research question on differences between soil types in the three countries was chosen as fitting and a hypothesis and research plan were developed.

Table of Contents

Preface

More and more people are moving to the city and with this comes a great increase in production of greenhouse gas emissions and other pollutants in denser areas. When looking at the differences between Rotterdam, Buzet and Nysa we see that the degree of urbanization differs a lot with Rotterdam (620,000 inhabitants) being the largest city with a busy city center and an extraordinary big port, where Nysa (365,000 inhabitants) is less urbanized but has some forms of industrialization and finally Buzet (2,000 inhabitants) which has the least urbanization and infrastructure of the three. In this research project the relation between urbanization and ground pollution is explored by looking at pH levels at different locations and their location compared to a city or other inhabited area. It is expected that there is more ground acidification (thus a lower PH value) in areas with more urbanization compared to areas with less urbanization, thus further away from city center and more sparsely populated . To measure these differences, three different types of areas (two in Croatia) were investigated in the different countries: The Netherlands (Rotterdam), Croatia (Buzet) and Poland (Nysa). In all countries an area of industry was investigated to look at the effect of industry on pH in relation to urbanization as well as an area with a relatively dense population (urbanized) and one with a relatively sparse population (rural) to emphasise the differences between the different locations and countries. In Rotterdam and Buzet the researching students used an electronic pH meter connected to a laptop to get an accurate representation of pH levels in measured soil and in Nysa a pH liquid measuring test was used. The findings were put into graphs showcasing pH values in relation to: Distance from urbanized areas, Rainfall on measurement days, and specific temperatures on those dates.

Research question: “How do the soils of Nysa, Rotterdam and Buzet differ and why?”

Hypothesis: “It is expected that there is more ground pollution and higher ground acidification (thus a lower PH value) in more populated and urbanized areas (Rotterdam city center) compared to more rural and sparsely populated areas (village near Buzet) due to the increased levels of greenhouse emissions in cities/urbanized areas as a consequence of industry, higher population density and transportation.

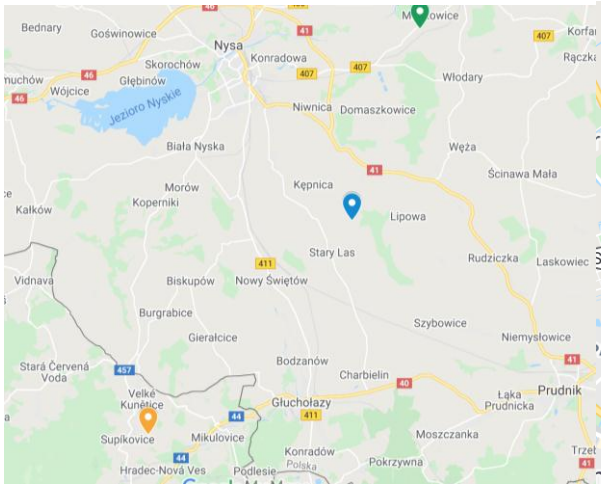
Summary

This report explores the effects of urbanization and industrialization on the ground pollution of the three different test-areas: Rotterdam (Netherlands), Buzet (Croatia) and Nysa (Poland). The Globe “pH protocol” was used to gather data and make the datasets. In each test-area, except for Buzet, three different types of soil were measured: In the most urbanized area, A rural area/suburb and near an industrial area. The goal of the project was to compare the three test-areas and find a correlation between the three different types of soil measured in each country. Despite the lack of data in Croatia and Poland an analysis could be done comparing the different pH levels and the level of urbanization. From these analyses, the overall conclusion is that urbanized areas have the lowest pH levels (thus the highest ground acidification). This shows that the hypothesis was partly correct, a clear correlation between industrial areas was not found however, this could also be because the data from Croatia is missing for this.

Research plan:

In Rotterdam, Buzet and Nysa the students will take three soil samples on 3 different types of locations: One in the most urbanized area which will most likely be the city centers or close to them to see the effect urbanized places have on pH levels and ground pollution. Opposed to this the second location will be away from urbanized areas so in suburbs / nature to hopefully showcase a contrast between the measurements from urbanized areas to prove the hypothesis. Thirdly an area close to industry will be investigated to see if this has an effect on pH levels and to see if this is in big contrast to the other two measurements that have been done. For further comparison, urbanized places will have to be defined. This is done by population density and distance from city center. After the data has been recorded it will be analyzed and compared with the aim of answering the guiding question.

Different locations that are being sampled:



Sampled locations in Nysa

Sampled locations in Rotterdam

Sampled locations in Buzet

To record the samples, measuring equipment has to be sourced at the schools. This is in this case a pH meter of any kind to test soil sample. Protocols on how to operate different instruments can be found online or in a manual. Rain affects soil acidity levels severely and are not taken into account with our initial measurements .

Poland Measurements

Mańkowice, Poland

Researcher:	Klaudia Majchrzak
Place of research:	Mańkowice
Coordinates	50.49, 17.47
Altitude above sea level	192 m
Features in the North	there is a shop 50 meters away from the test object
Features in the South	there are buildings 70 meters away from the test object
Features in the West	there are buildings 120 meters away from the test object
Features in the East	there are buildings 120 meters away from the test object
Subsoil	Flora
Area	Semi-Urbanized
Degree of transformation of the environment:	Little
Distance from city centre:	916 m
Population density	50 pers. /km^2

Piątkowice, Poland

Researcher:	Sandra Adamczyk
Place of research:	Piątkowice
Coordinates	50.3, 17.27
Altitude above sea level	194 m
Features in the North	there is a field 100 meters away from the test object
Features in the South	there are buildings 50 meters away from the test object
Features in the West	there is a forest 5 meters away from the test object
Features in the East	there is a river 10 meters away from the test object
Subsoil	Flora
Surrounding area	Rural
Degree of transformation of the environment:	Little
Distance from city centre:	1080m

Nysa, Poland

Researcher:	Julia Stankiewicz
Place of research:	Nysa
Coordinates	50.40, 17.42
Altitude above sea level	195 m
Features in the North	there are buildings 30 meters away from the test object
Features in the South	there are buildings 60 meters away from the test object
Features in the West	there are buildings 15 meters away from the test object
Features in the East	there are buildings 2 meters away from the test object
Surrounding area	Semi-Urbanized
Degree of transformation of the environment:	Little
Distance from city centre:	~100 m
Population density	500 pers. /km²

Items used for research in Poland

1. Soil acid meter
2. Teaspoon
3. Scale indicator

Example of performing tests (2nd place 18.12.2019 16:04)

1. Put a little bit of soil into the holes and knead
2. Add solution
3. After 3 minutes, pour the liquid into the smaller cavity.
4. Compare the color of the liquid with the scale indicator

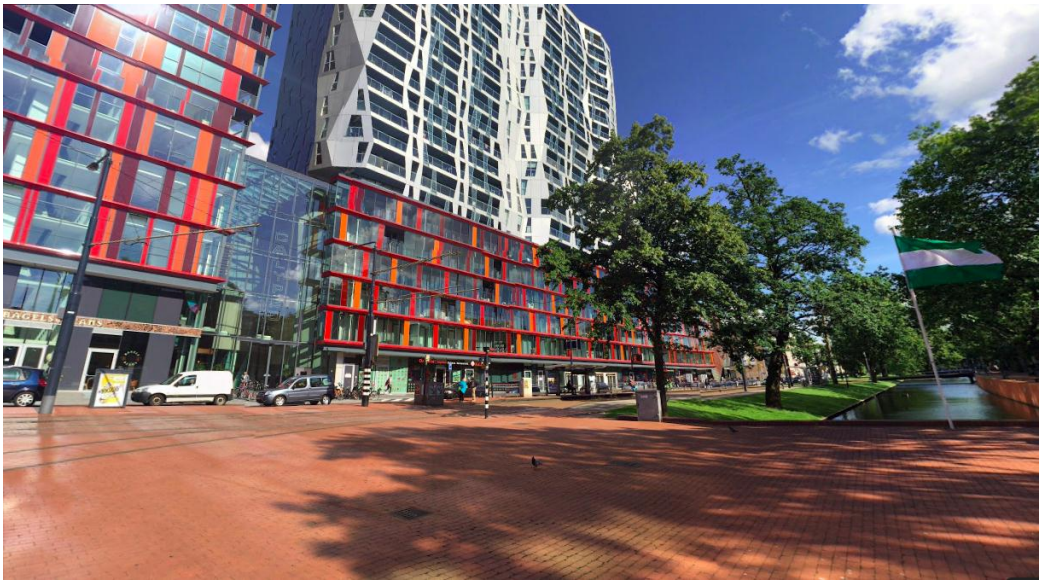
POLAND RESULTS

Place of research	Place 1			Place 2			Place 3		
Date and time of research	11.12.2019 16.00	12.12.2019 16.00	13.12.2019 16.00	15.12.2019 16.48	17.12.2019 15.37	18.12.2019 16.04	01.01.2020 16.46	02.01.2020 17.54	03.01.2020 15.19
	MEASUREMENTS								
TEMPERATURE	9°C	8°C	10°C	6°C	7°C	9°C	3°C	4°C	3°C
MOISTURE	54%	60%	62%	61%	65%	70%	76%	80%	79%
PH	6	7	6	6	7	6	8	7	7

Sandra Adamczyk, Julia Stankiewicz, Klaudia Majchrzak

Rotterdam measurements

City center, Rotterdam



Researcher:	Morris van der Zon
Place of research:	Rotterdam City Center
Coordinates	N 51.920813°, E 4.471812 °
Altitude above sea level	0 m
Features in the North	there is the train station 100 meters away from the test object
Features in the South	there is a canal/grass
Features in the West	are buildings 30 meters away from the test object
Features in the East	are flats 10 meters away from the test object
Surrounding area	Urbanized
Degree of transformation of the environment:	Servere
Distance from city centre:	~0m
Population density	7.948 pers. /km²

Recorded Data

Date	Temperature	pH

11 February 2020	7°C	6.95
12 February 2020	8°C	6.95
13 February 2020	9°C	6.31
Average	8°C	6.74

Near airport, Rotterdam

Researcher:	Quinn Zilvold
Place of research:	Near Rotterdam Airport
Coordinates	51.95778 N, 4.45386 E
Altitude above sea level	-10 m
Features in the North	there is the Rotterdam Airport.
Features in the South	there is road.
Features in the West	In the west there are industrial buildings.
Features in the East	there is a road.
Surrounding area	Small industrial area
Degree of transformation of the environment:	Moderate
Distance from city centre:	4100 m
Population density	1293 pers. /km²

Recorded Data

Date	Temperature	pH

13 February 2020	6.0°C	7.79
14 February 2020 (rainy day)	7.5°C	7.77
15 February 2020	10.3°C	7.83
Average	7.93°C	7.80

Suburban garden, Rotterdam

Researcher:	Quinn Zilvold
Place of research:	Suburban Garden
Coordinates	51.96353 N, 4.47042 E
Altitude above sea level	-7 m
Features in the North	there is a residential building.
Features in the South	there is hedge.
Features in the West	there are other residential buildings.
Features in the East	there are other residential buildings.
Surrounding area	Suburban
Degree of transformation of the environment:	Moderate
Distance from city centre:	4320
Population density	1829 pers. /km²

Recorded Data

Date	Temperature	pH
13 February 2020 (rainy day)	6.0°C	7.25
14 February 2020	7.5°C	6.58
15 February 2020	10.3°C	6.86
Average	7.93°C	6.90

Method used in Rotterdam

requirements: Dried sieved soil, pH Data Sheet, Distilled water, Pencil or pen, 100-mL graduated cylinder, Glass stirring rod or other stirring device, Four 100-mL containers, pH meter or pH paper, Balance (accurate to 0.1 g)

Steps
step 1: In a cup or beaker, mix 40 g of dried and sieved soil with 40 mL of distilled water (or other amount in a 1:1 soil to water ratio) using a spoon or other utensil to transfer the soil.

step 2. Stir the soil/water mixture with a spoon or other stirrer until it is thoroughly mixed. Stir the soil/water mixture for 30 seconds and then wait for three minutes for a total of five stirring/waiting cycles. Then, allow the mixture to settle until a supernatant (clearer liquid above the settled soil) forms (about 5 minutes). GLOBE® 2014 Soil pH Protocol - 5 Soil (Pedosphere)

step 3. Measure the pH of the supernatant using the pH paper or meter. Dip the pH calibrated pH meter in the supernatant. Record the pH value od the Soil using Logger Pro (Macintosh). If pH meter requires calibration, gloves should be worn.

step 4. Repeat steps 1-3 for two more samples from the same horizon.

Croatia measurements

Researcher:	Donat Prodan
Place of research:	Bank of river Mirna, near Buzet
Coordinates	45.402222 N, 13.964722 E
Altitude above sea level	Not specified
Features in the North	There is the Old Town of Buzet
Features in the South	there is CIMOS (car parts plant) plant and a car park
Features in the West	there are plains
Features in the East	there is a road
Surrounding area	Small industrial area
Degree of transformation of the environment:	Moderate
Distance from city centre:	987 m
Population density	Not specified

Researcher:	Ivan Črnac
Place of research:	Top of the hill near village Veli Mlun
Coordinates	45.396944 N, 13.925000 E
Altitude above sea level	Not specified
Features in the North	Mali mlun
Features in the South	Village Veli mlun
Features in the West	There is Pruhari
Features in the East	Plains
Surrounding area	Rural area in nature.
Degree of transformation of the environment:	Little
Distance from city centre:	5784 m
Population density	Not specified

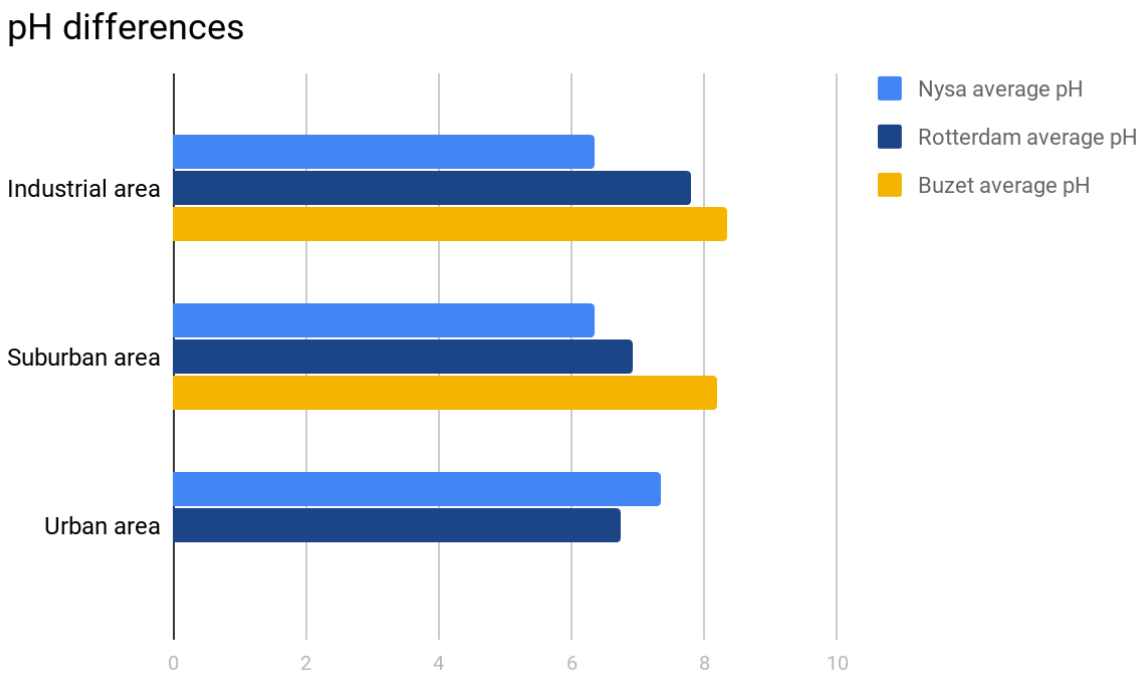
Croatia Results

place of research	top of the hill near village Veli Mlun			bank of river Mirna		
time of research	15:13	16:35	11:45	afternoon	afternoon	afternoon
date of research	20th of January	1st of February	10th of February	29th January	5th February	12th February
temperature	8°C	7°C	11°C	6°C	10°C	14°C
pH	8,3	8,1	8,3	8,3	8,3	8,4

Method used in Croatia:

1. picked a small shovel of soil
2. put it in a glass container and filled it with distilled water
3. left the soil in there for some time
4. measured the pH of the water as it should be very similar to the pH of the soil using a standard, usual electrode pH meter
5. repeated the previous steps to make sure we got the right results

Results and Analysis

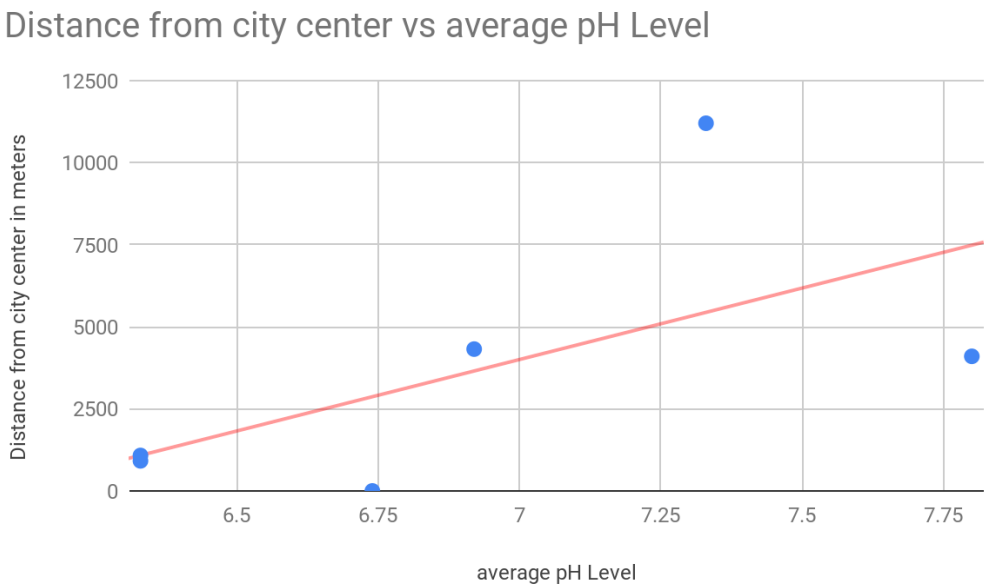


In this graph the average pH in every country in the three different types of areas is showcased. In the graph a clear relation between pH levels and the different countries is shown when it comes to industrial areas and suburban areas, with pH levels from low to high in this order: Nysa, Rotterdam, Buzet in both cases. We see an anomaly when it comes to the urban areas which lacks the data from Buzet but shows that Nysa's pH increases substantially opposing the hypothesis, where Rotterdam's pH is as low as expected.

An explanation for Rotterdam's low pH score in the Urban area compared to that off Nysa can be that on the 13th of February it was a very rainy day with 14.3mm precipitation[1] compared to 0.1mm on the other measurement days. This soil acidification is caused by acid rain, which is rain that has been acidified by pollutants in the air. These pollutants can be Sulfur Dioxide, Nitrogen and Ammonia. These are all emitted by either industry, construction work or farming. This ties back to the significance of urbanization and climate change.

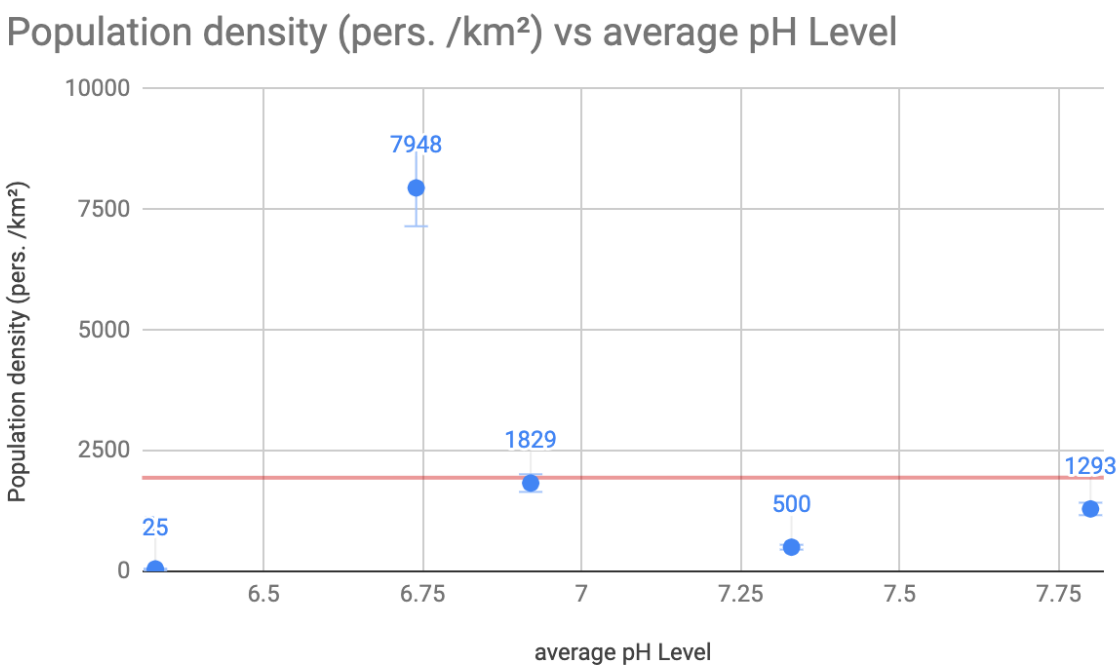
To test the hypothesis with the data that is collected, the average pH level of each place and the distance from the city center are plotted in a graph with the final goal in mind of discovering a correlation between soil acidity and urbanization.

[1] https://projects.knmi.nl/klimatologie/daggegevens/index.cgi



Here it is seen that the outcome of the measurements have a positive correlation of 0.6103691315 which means that the datasets have significant relation to each other. The outcome of this correlation graph is as expected, the samples that have been taken further away from the city center are more alkaline, which in terms means that it is more fertile. Whereas the samples that have been taken closer to the city center are more acidic, which can be explained by the huge amounts of traffic and industry closer to the city center.

To test the hypothesis with the second data set which population density, to test the correlation between soil acidity and urbanization. This is very important in having accurate evidence for answering the guiding question:



In this instance there is a flat line and there is taken into account margin of error. This means that with the data that has been recorded there is no significant correlation found. This can be due to human error or a genuine non-correlation between the datasets, this seems very unlikely as population density is a good indicator for urbanization, thus very plausible.

There is still the fact that cities use fertilizers to make the soils more fertile and the same is true for residential gardens. This could influence the outcomes of the measurements and left room for error.

Conclusion

The analysis suggest that there are many aspects that influence pH levels on soil which include climate change, that either changes precipitation pattern or overall temperatures. Soil fertility is heavily affected by acid rain that comes from industry and transport. Many cities use fertilizers to improve soil conditions that make up for soil acidity, these are nitrates and carbonates which could cause anomalies in measurements. Generally the trend that is being perceived is the closer soil is to city center, the more acid it is. To answer the guiding question: “How do the soils of Nysa, Rotterdam and Buzet differ and why?”, there needs to be a comparison between the countries and it is seen that the Netherlands has statistically the lowest pH levels, followed up by Poland, and the most alkaline soils are in Buzet Croatia. After doing extensive analyses to compare and to find a correlation between pH levels and urbanization the given hypothesis is confirmed. There is more ground pollution and higher ground acidification (thus a lower PH value) in more populated and urbanized areas compared to more rural and sparsely populated areas due to the increased levels of greenhouse emissions in cities/urbanized areas as a consequence of industry, higher population density and transportation.

Evaluation and Reflection

For the Globe research project three groups from three different countries had to cooperate to collect and analyse data. As a means of communication whatsapp was chosen over Email at the beginning of the project for it's convenience and because the Polish and Dutch students used it on a daily basis. the Croatian students were added as well but didn't add to the conversation and rarely read any messages. Due to the lack of communication and a different understanding of what the project entailed the groups in the different countries started working on their own, the Polish were the first to produce a set of data but did so without telling the other groups that they were going to start measurements beforehand. This resulted in a forced change of research question and hypothesis since there were no Polish measurements of industrial areas which was initially the plan that was tied in with the Hypothesis set up by the Dutch students. When the Dutch students then checked the projects progress they encountered all the Polish data was already put in and hurried to get their measurements done too but were obstructed by their test week. Meanwhile the Croatian students gave no sign of life, the Polish people then went on vacation and thus couldn't work on the project and the Croatian students uploaded their data at last but only had two measurements instead of three. Despite these obstacles, all countries produced data that was successfully compared, contrasted, reflected upon and finally put into this research project (mainly by the Dutch students). The students off all countries now know to establish a common communication platform beforehand to avoid miscommunication and a complete lack of communication, make a better planning to foresee problems like holidays and test weeks in the different countries and to not leave a big project like this up to the last minute for future projects like these.

Sources used

https://www.advancedconverter.com/map-tools/find-altitude-by-coordinates
https://allecijfers.nl/gemeente/rotterdam/