Avans University of Applied Sciences

GEOGRAPHIC DATA ANALYSIS OF THE PEEL BOUNDARY FAULT ZONE IN NOORD-BRABANT

GIS REPORT

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Colophon

This report is a product of the (main) project; locating Peelboundary Fault Lines, which forms part of the minor Environmental Geography, given at the Avans University of Applied Science.

During the main project it was decided two split the group up in two, one group does the GIS report (Fernando Trouw and Wim Loonen) and one group would does the Lab Report (Linh Pham and Sophie Lurquin)

Wim Loonen	**Introduction, Methods (Fieldwork), Results (fieldwork), Conclusion**
Fernando Trouw	**Methods (Geo Information Analysis), Results (Geo Information Analysis), Discussion, Recommendation**

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Tutor: Marjon Verhoeven

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1 INTRODUCTION

1.1 BACKGROUND

The East of North Brabant is home to a fault zone (known as the Peelboundary fault zone) which houses a set of fault lines that bring with them a peculiar phenomenon. The fault zone near the village of Uden causes the differences in the topographical height, soil profiles and groundwater properties at two sides of the faults, one is called Peel Block (Horst) and the other is called Roer Valey Graben (Slenk). Grasslands (originally meant for pasture) on the horst side of the fault line find themselves transforming in wet forested area. This change in topography is largely attributed to the change in soil type, from dry and sandy to wet and peaty, due to seepage of groundwater onto the horst side of the fault line. Groundwater flowing from the horst side of the fault line to the slenk side is blocked and moved upwards as a result of an impermeable, iron rich embankment that generally occurs as a consequence of the fault being there. Seepage of groundwater as a result of the fault is given the Dutch term wijst.

Next, the wijst water is rich in metals (e.g. iron and nickel) and micronutrients (e.g. sulphur) which attract many (wild) plants and animals that are specific to wijst grounds. Next to having particular compositional characteristics, the area around the fault line brings with it certain features that are unique in terms of aesthetics. These features are visualized as a unique rust (red) colouring of surface waters near the fault or rainbow coloured reflections caused by oily (bacterial) layers that are visible on the surface waters around the fault line. Also, “fault line wijst” is a phenomenon that in general is rarely found across the globe. Therefore, the province of North-Brabant, together with the municipalities situated in the fault zone region want preserve these areas. By working together, they want to transform the areas where this phenomenon occurs into a geopark that has a protected UNESCO status (1–3).

Moreover, past investigations undergone by different scientists and the waterboard of the area revealed the approximate location of the fault lines (Figure 1) (1–3). However, the exact location of some fault lines still needs to be established. As a result of this, the province has requested students from the Avans university of applied sciences to determine what the location of the fault line is at three areas where the fault lines are yet to be located.

1.2 GOAL

The main goal of this part of the project is to present the located position of the fault lines and the ground water quality at those locations, in the form of maps created through geo information analysis in a timespan of around 2 weeks. Next to the main goal there are two (sub) goals that need to be achieved so that the main goal can be completed these include:

- Show what kind of data was collected and how the process was undergone
- Show what kind of geoinformation analysis techniques where used and how they were applied in terms of data processing and analysis.

1.3 READING GUIDE

Chapter two describes what kind of data was collected and how this process took place. Furthermore, it goes deep into the different forms of data that was collected during the field work mainly: photographic, GPS data, information on the water table and other information that was shared by residents living in and around the study area.

Chapter three goes into the processing and analysis of the data that was collected. Firstly, it describes the different methods that are used in terms of geo-information processing and analysis and lastly it presents the different products that stem out of the latter.

In chapter four the problems that have arisen in this process of data collection and analysis are discussed. Finally, Chapters five, six and seven present the concluding paragraphs with regard to the whole process from collecting data, to analysis and lastly to the created maps that stemmed out of this project.

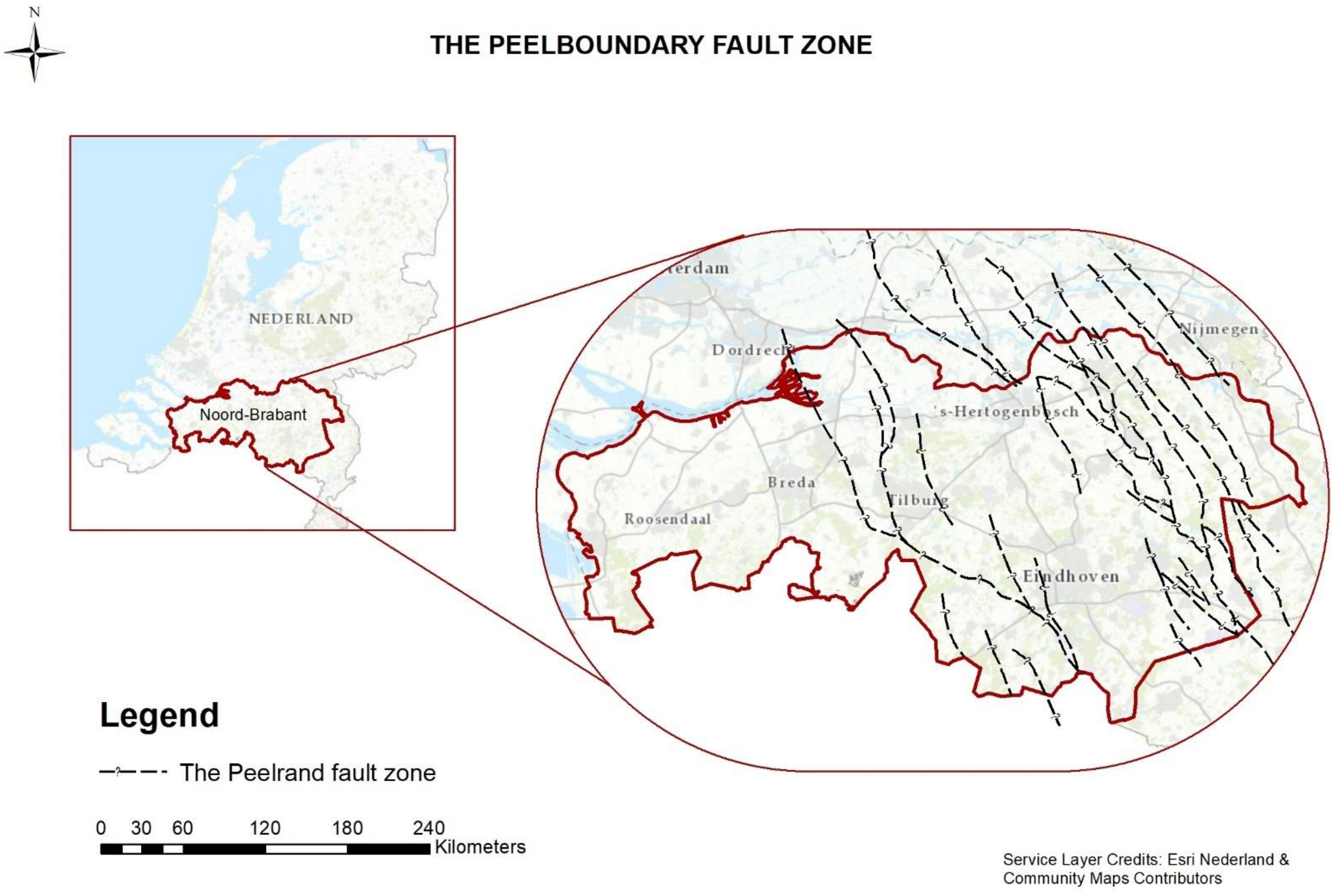


Figure 1 Map depicting the Peelboundary fault zone located in North-Brabant

2 METHODS

A total of three locations (areas of study) were chosen for the localization of the fault lines. One in Deurne (Breemortelweg) and two in Boekel (Arendstraat and Boekweit) (Figure 2)The collection of data was conducted by following a carefully constructed fieldwork plan, in order to make efficient use of scarce time and materials. The following paragraphs describe in detail what kind of data was collected and how the whole process was undergone.

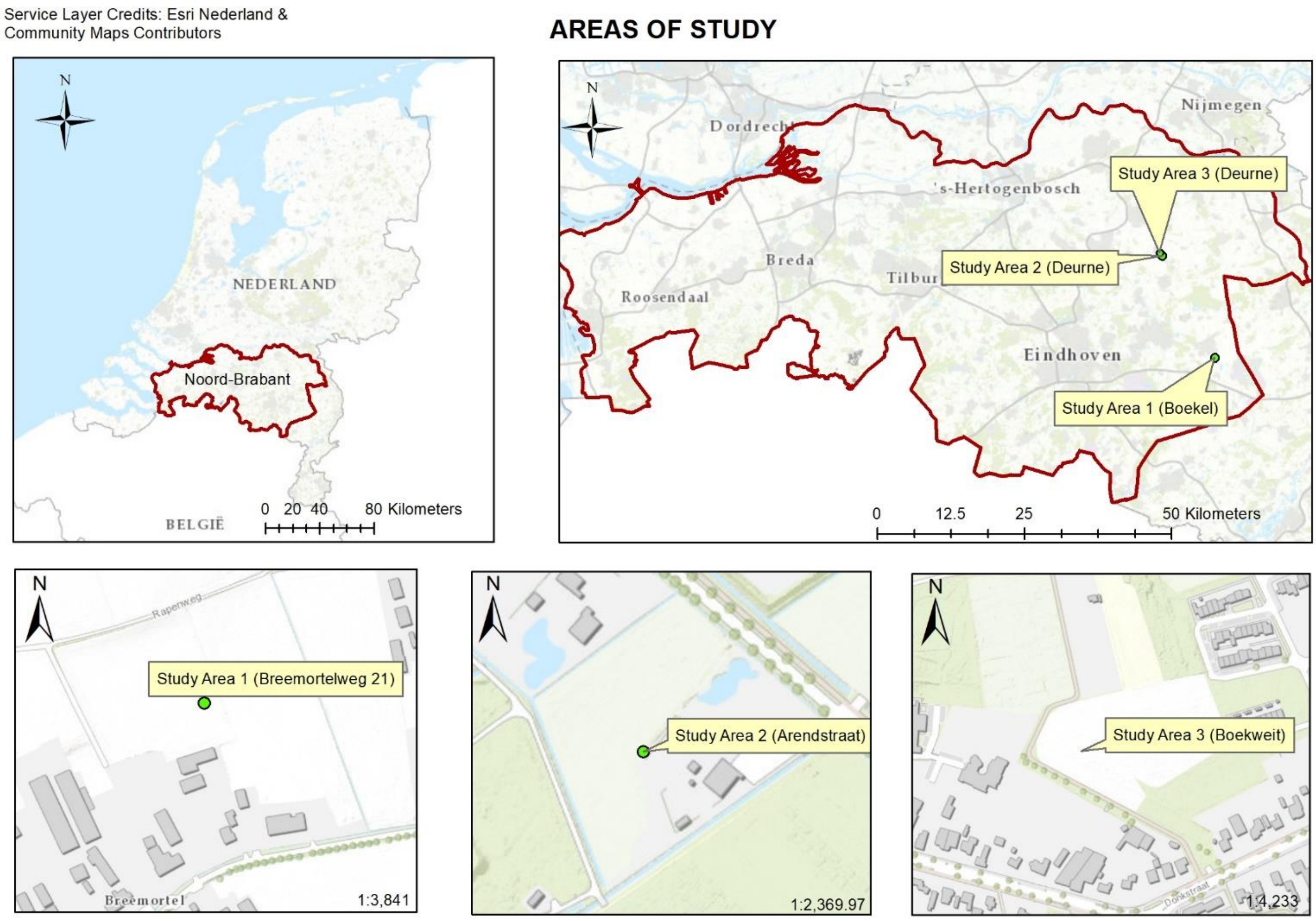


Figure 2 Depiction of the three areas of study

2.1 FIELDWORK

four parameters are taken into consideration in the field work namely:

- pictures of the different soil profiles that were dug up during the drilling of boreholes
- Pictures of the different types of "wijst specific" vegetation that were found in and around one of the study areas
- Drone photos (for further use in the process of geo information analysis)
- The collection of ground water monsters at each side of the fault line for laboratory analysis

2.1.1 Drilling boreholes and photo capturing soil profiles

Soil profiles are visualized by making borehole. The drilled soil is then laid down in chronological order from the top to the deepest point. While laying the profile, there were some trace elements of the previous drill due to sand that fell down in the hole might be in the drill. These trace elements are removed before the profile is laid down. This is done with a chisel or just with hands. Maximum depth of the drill hole is reached when water table is reached or until reaching a maximum depth of around 3-4 meters if needed. Figure 3-5 show how the drilling was done in each area of study. Each green line represents a so "called drill location or drill line", the numbers represents the number of holes that were dug (not necessarily in chronological order). Generally, the drill lines are located approximately 10-15 meters from each other, depending on the size of the study area.

Figure 3 Depiction of drilling process in the study area 1 (Arendstraat)

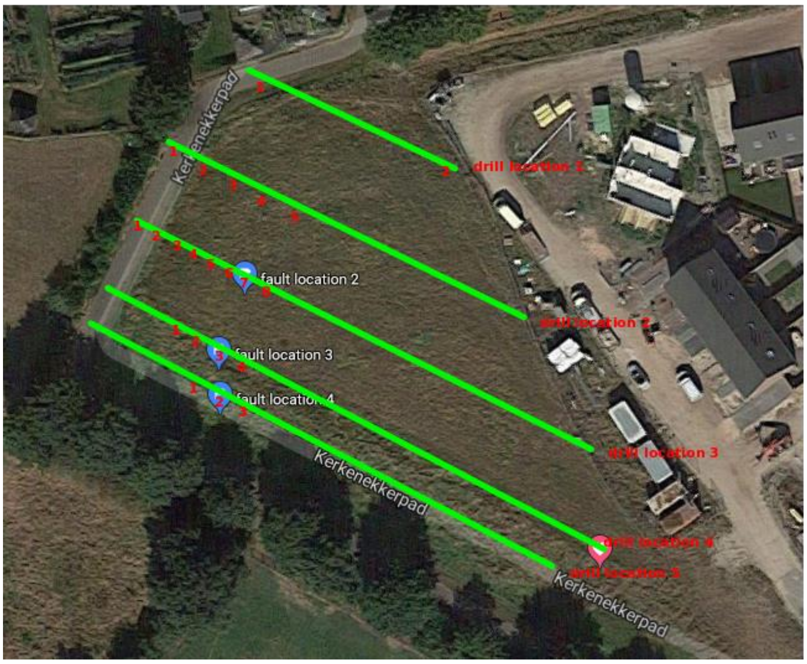


Figure 4 Depiction of drilling process in the study area 3 (Boekweit)

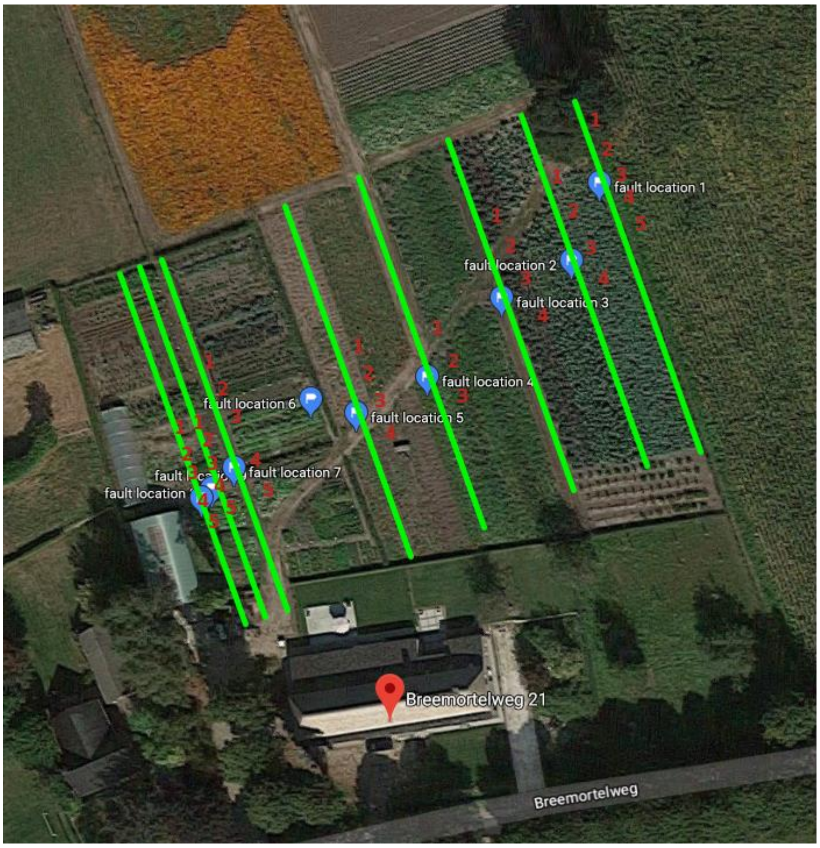


Figure 5 Depiction of the drilling process in study area 1 (Breemortelweg)

Soil profiles have been dug up for every drilling point in the three areas of study. In the name of efficiency and non-repetitiveness, not all soil profiles from all drill holes are photographed, because of the similarity between soil profiles in terms of soil composition. Therefore, at each drill line only one picture is taken for each side of the fault (Horst and Slenk/Graben) but not for all of the drill points. Hence, for each area of study, out of all of the profile photos, only one picture is chosen for each side of the fault (Horst and Slenk/Graben). Also, some pictures are shot of any (unexpected) peculiarities that are found in a soil profile. For example, the depiction of wet soil because of the "appearance" of a water table in actuality was none.

2.1.2 Wijst specific vegetation

According to the literature, because of the soil characteristics that are unique to fault induced seepage soils (wijst grounds), many specific species of plants and insects are drawn to the nutrient conditions that these wijst grounds provide. In this project as much data (mostly in photo form) is captured as possible if it is present at the area of study.

2.1.3 Aerial Photos

In order to give overview on the location and the current vegetation aerial pictures need to be taken. The photos are made during a drone flight with a camera attached to a Phantom 3 Drone. The drone is easy to use but needs some preparation: checking no fly zones and weather predictions, battery check, calibration etc. Picture taken from the drone usually come out as snapshots from individual aerial points in time and space (Figure 6).

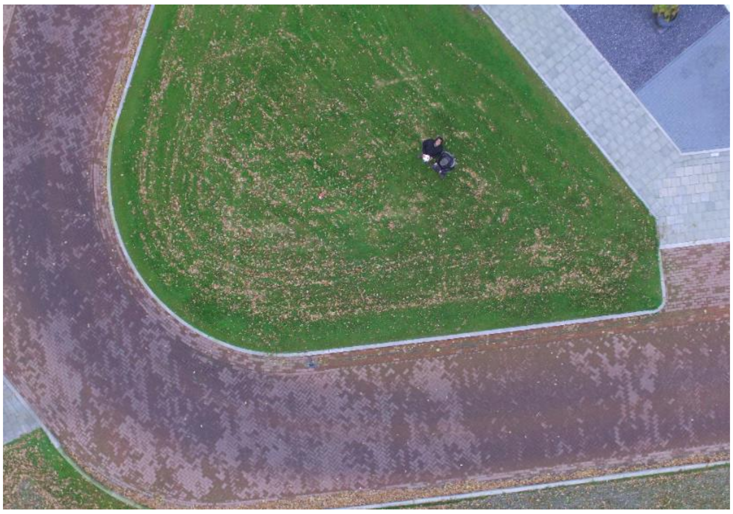


Figure 6 Snapshot taken from a camera mounted on a drone

Therefore, in order to get a complete picture of the study area, the partial photos captured by the drone are stitched into one picture. This stitching together of photos can be achieved with any photo editing software. The photos need to be oriented first in such a that it makes sense and then “stitched” together by moving one photo over the other.

The reason for choosing to create an aerial photo for all of the study areas is because it is assumed that aerial photos (like those captured with the help of a drone) contains a clear overview on the physical characteristics e.g. vegetation and geo physiological features of the area.

2.1.4 GPS data

In order to visualize the fault line and be able to communicate it through a map, the global positioning system is used (GPS). GPS is used worldwide and is relatively easy in use. The GPS locations are found by using a smartphone with an app as for instance Backcountry Navigator and HERE Wego. The data is used to refer to certain points on global scale to address the fault or specific landmarks. Furthermore, GPS data can also be used to geo tag pictures to points on a map, this is also one of the options that is looked into when thinking about collecting GPS data.

2.1.5 Water table data

The water table was also measured at each area of study and on each side of the fault line. Generally, the water table is measured relative to the soil surface. However, this method of measuring the water table a is prone to errors, because the height of the soil surface tends to differ. Therefore, a more accurate measurement method follows by measuring the water table relative to the Normaal Amsterdam's Peil (N.A.P). The N.A.P is a reference point for determining the height across the entirety of the Netherlands. Generally, the N.A.P is equated to the average height of the sea water in relation to the surface.

After the water table is recorded, it can then be converted into a more accurate representation by subtracting the water table height from height of the soil surface relative to the N.A.P. at that specific study location. The average height of the soil surface relative to the N.A.P for a specific region can be calculated by looking at a map that depicts the height profile of a certain area (Figure 7). The three study areas fall into a region of which it's average soil surface height is around 27.5 meter above the N.A.P.

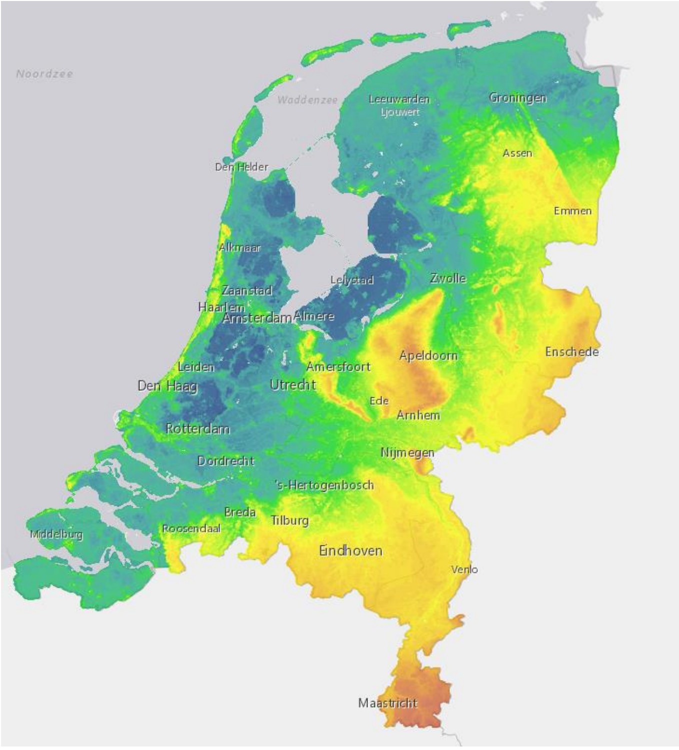


Figure 7 The Dutch height profile map (4)

2.1.6 Ground water samples

One of the main goals of the (main) project is to determine the quality of the ground water in the areas chosen for study. This is achieved through the usage of groundwater extraction tubes. A ground water sample is collected from each side of the fault line.

2.1.7 Other data

During meetings and site visits information has been given by the owners of the land:

- Information about the possible location of the different sides of the fault lines
- Landmarks with specific vegetation
- The assumed direction of the fault line
- And references to some online sources of geo-information

These data were very functional to determine the start points of the drilling activity and also for processing some of the data.

2.2 GEO INFORMATION ANALYSIS

After having collected all of the data pertaining to the fieldwork (e.g. photos, water table data, GPS data etc.) the phase of data analysis ensues. For this particular task, ArcGIS, a geo information software (tool) is utilized. This paragraph describes the different methods that are applied in this analysis stage of the project.

2.2.1 Geo-referencing

When one is georeferencing a map or an image (e.g. aerial photograph), essentially what is happening is that the internal coordinate system of that particular map or photo in question is related to a ground system of geographic coordinates. What this means is that the (geographic) features of a map or aerial photograph get positioned relative to the coordinates of the real (geographic) features pertaining to those of the map or aerial photograph. Essentially, what comes out is a map or aerial photograph of which its internal coordinates are positioned in exactly the same direction as the (real) coordinates of the ground system that pertains to the location of the map.

What followed is a sequence of actions that comprise the process of geo-referencing of say an aerial photograph (note: one of the stitched photos of the project was used to show how it is done).

1. Adding the picture to ArcGIS, first we click on add data, then connect to folder and search for the saved picture and click add. Now the picture is uploaded to ArcGIS and shows up on the screen (Figure 8).

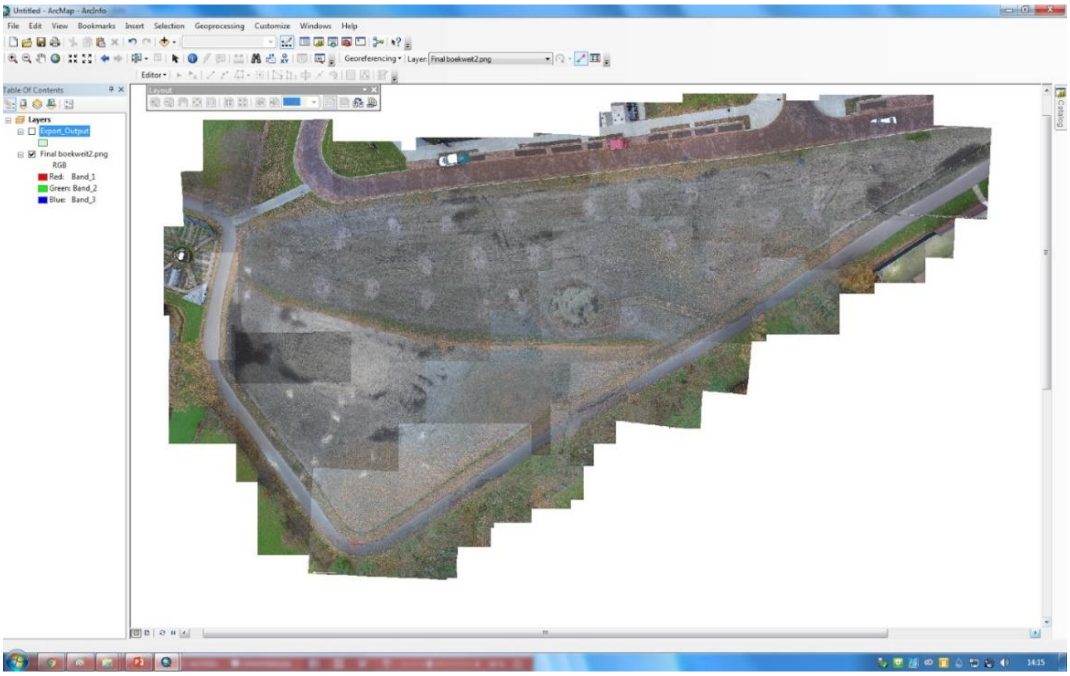


Figure 8 Adding the image to the image raster of ArcGIS

2. Finding the GPS data: Google maps is used for georeferencing, 3 points on every study area are chosen as reference point. The GPS coordinates from each point is added by clicking left and selecting more data. The X and Y values are then found and ready to be added to ArcGIS (Figure 9)

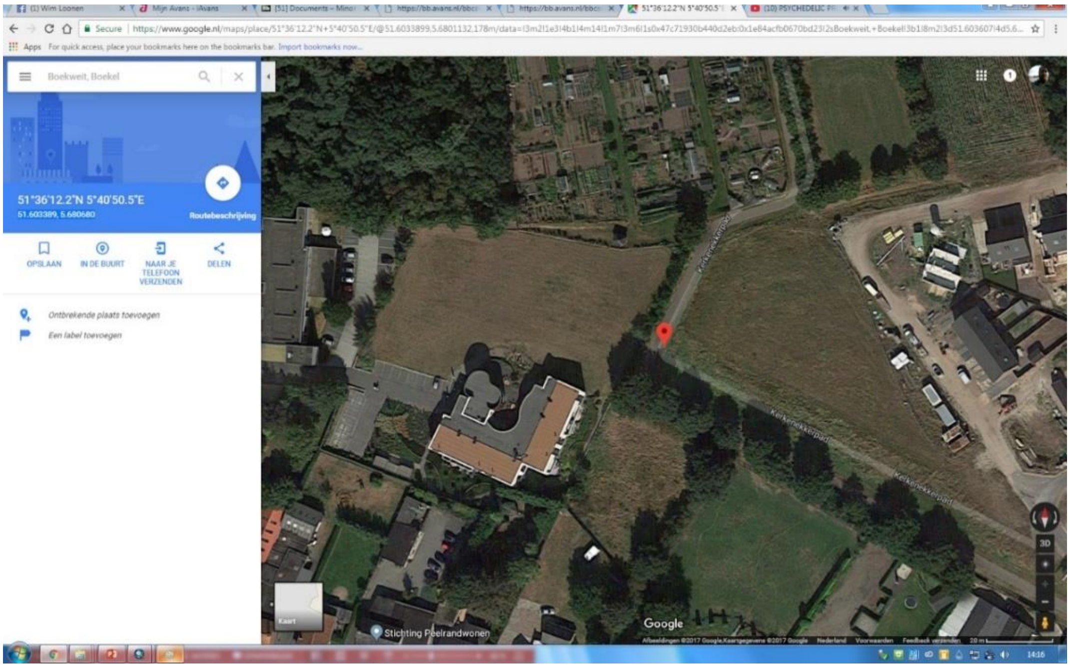


Figure 9 Gathering GPS coordinates from a chosen point on google maps

3. Adding of the GPS coordinates: The GPS data is inserted by using Geo-reference found under the tab Customize. A pictogram with the description “add control points” is used to add the reference points. The points are created by clicking left, after that right, then select ad X and Y values. Finally a screen pops up and the values can be added as shown in Figure 10.

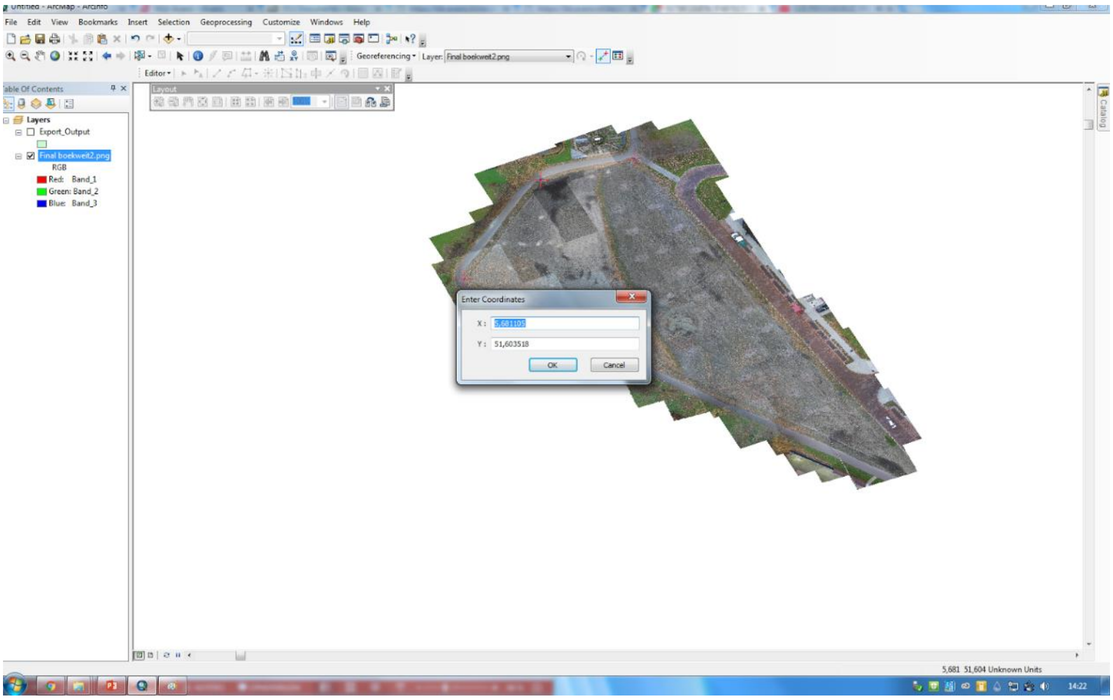
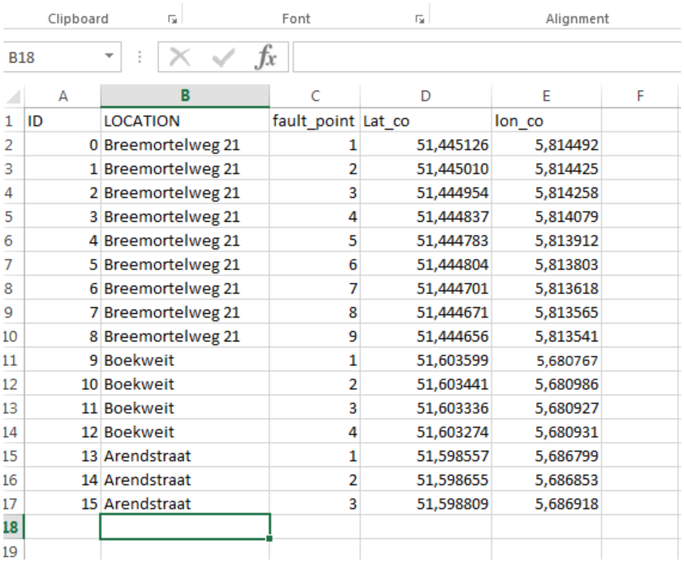


Figure 10 Adding the GPS coordinates, taken from google maps into ArcGIS

2.2.2 Importing GPS coordinates

In order to display the location of the fault on a map, the GPS coordinates of each GPS coordinate needs to be imported into the geo-information software. The following steps show how the GPS coordinates are imported using ArcGIS. First of all, all of the GPS data was stored in an excel workbook as shown in Figure 11.



ID	LOCATION	fault_point	Lat_co	lon_co
0	Breemortelweg 21	1	51,445126	5,814492
1	Breemortelweg 21	2	51,445010	5,814425
2	Breemortelweg 21	3	51,444954	5,814258
3	Breemortelweg 21	4	51,444837	5,814079
4	Breemortelweg 21	5	51,444783	5,813912
5	Breemortelweg 21	6	51,444804	5,813803
6	Breemortelweg 21	7	51,444701	5,813618
7	Breemortelweg 21	8	51,444671	5,813565
8	Breemortelweg 21	9	51,444656	5,813541
9	Boekweit	1	51,603599	5,680767
10	Boekweit	2	51,603441	5,680986
11	Boekweit	3	51,603336	5,680927
12	Boekweit	4	51,603274	5,680931
13	Arendstraat	1	51,598557	5,686799
14	Arendstraat	2	51,598655	5,686853
15	Arendstraat	3	51,598809	5,686918

Figure 11 Adding GPS coordinates to an excel sheet

After all of the GPS coordinates are inserted in the excel sheet, the sheet can then be imported into the ArcMap data frame through arc catalog, hence creating a new feature class (Figure 12).

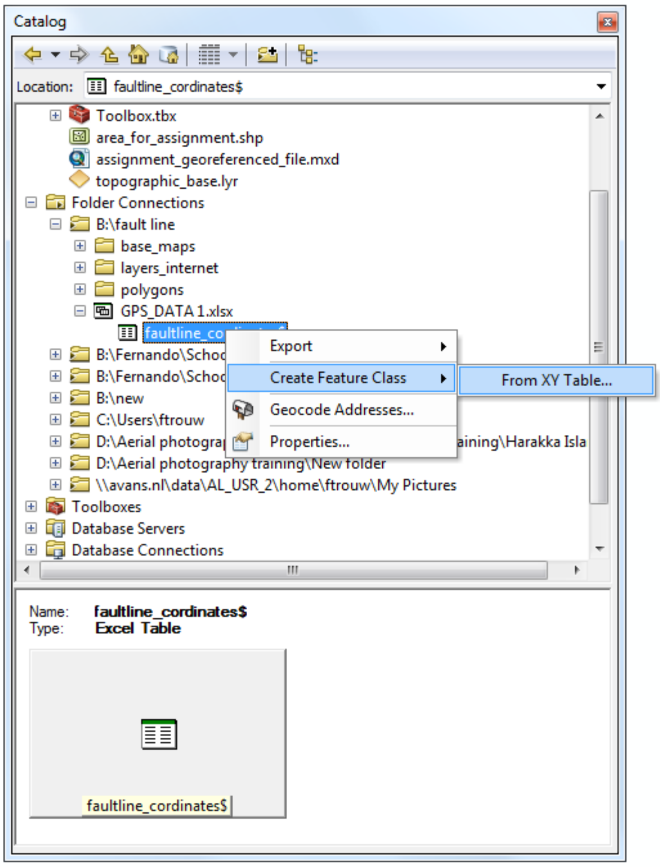


Figure 12 importing GPS coordinates into ArcGIS through ArcCatalog

2.2.3 Creating polygons

In general, on maps, additional elements (features) can be created for multiple purposes. In this case, no new points (resembling the GPS location of the fault) have to be created, since these are automatically created when all the coordinates are imported (previous paragraph). However, a fault line for example, is more accurately resembled by a line instead of a sequence of dots on a map. For creating these lines, the editor tool (Figure 13) in ArcGIS can be utilized.

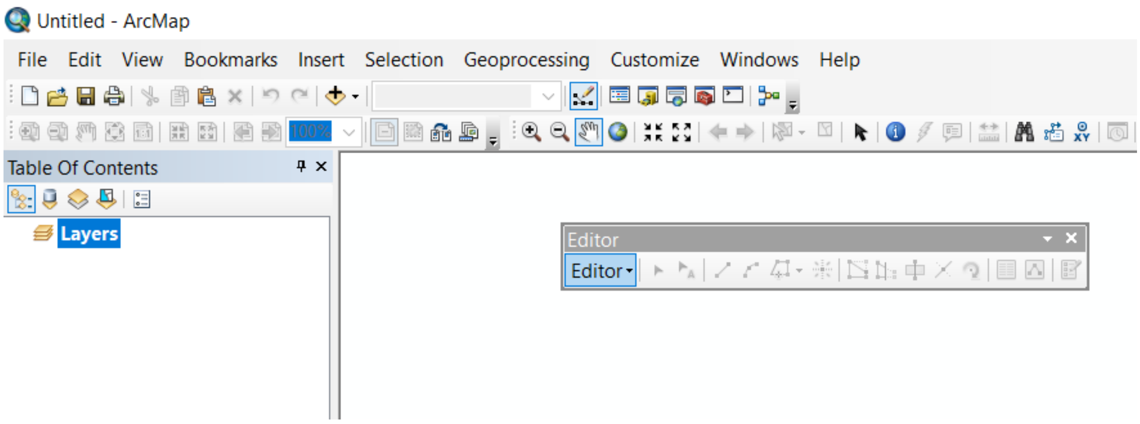


Figure 13 the Editor toolbar in ArcGIS

2.2.4 Geotagging

Geotagging refers to the attachment (tagging) of for example photographic data onto elements or features on a map by (geotagging) the photos with GPS coordinates. The geotagged data (photos) can then be dynamically displayed on the map by just hovering over the particular feature in question. In ArcGIS, the tool that makes this possible is called the “data management tool” (Figure 14).

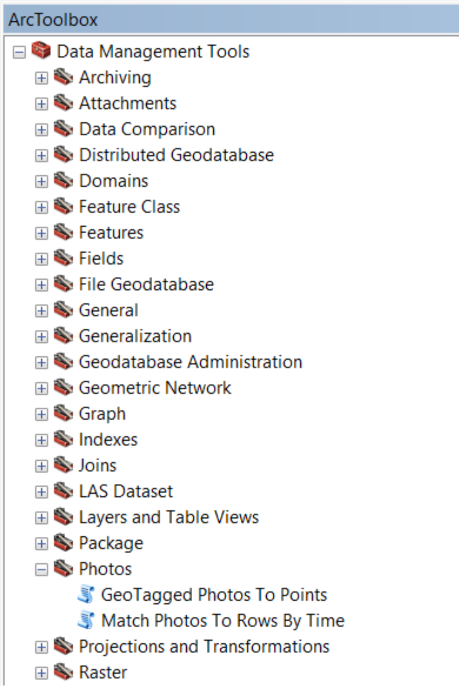


Figure 14. Depiction of the data management tool in ArcGIS

2.2.5 The creation of buffers

The buffer tool in ArcGIS is a geoprocessing tool that can be used to create buffer zones around features. In this particular case, the buffering tool is used to create a buffer zone of around 1-5 meters (depending on the location) around the located fault line. With this buffer zone, the approximate margin of error of the fault line is implied. Figure 15 shows how utilizing the buffering tool generally looks like in ArcGIS.

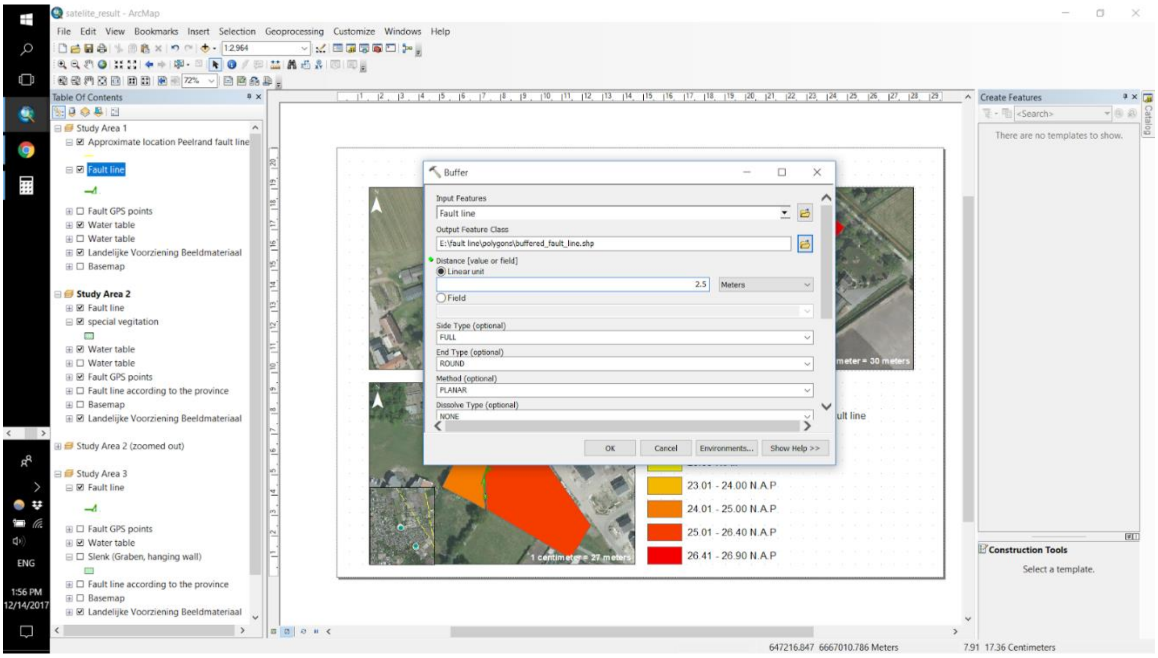


Figure 15. Creating buffers in ArcGIS

2.2.6 Gathering geoformation data through WMS servers

Next to the above-mentioned data analysis and processing methods, there are some other activities which include the actual gathering of geo-data. The types of data include layer files (e.x. Topographic maps, satellite maps, base maps, specific data etc.). Typically, these data can be downloaded through ArcGIS online, but there are other methods which downloading data from publicly (institutionally) managed databases that are stored in so called warehouse management systems (wms) that can be accessed remotely, through the internet, by using for example ARCGIS wms. Essentially the requester of information inputs a link that connects the client (ARCMAP) to a wms server.

3 RESULTS

The following paragraphs below describe the results from the field world activities and the GIS analysis.

3.1 FIELDWORK

3.1.1 Soil profile

First of all, with regard to the fieldwork that was done in Study Area 1(Breemortelweg 21, Deurne) the following pictures where taken (Figure 16 and 17). From the soil profiles that was collected at the site, one can make a clear distinction between the composition of the soil at the horst side and that of the slenk. The composition of the soil at the horst side compared to that of the slenk side of the fault was comprised of an upper layer that was much more peaty. Also, one can see the marked differences in terms of saturation of the lower layers of the soil. Profiles from the Horst side of the fault line appeared be much more saturated in the lowest layers compared to the lower layers of the soil profiles from the slenk side of the fault. These findings provided for a good indication that one was indeed standing on the right side of the fault.

Figure 16 Soil profile at the horst side of the fault

Figure 17 Soil profile at the slenk side of the fault

Also, some peculiarities where stumbled upon while looking for the water table at the slenk side. It seemed as the water table was found. However, when the soil at that specific depth was examined in terms of saturation (Figure 18) it showed that it was only the "appearance" of a water table. In actuality the water table was deeper in the ground. It was concluded that the reason for this phenomenon was possibly due to a loamy impermeable layer that was present at the slenk.

Figure 18 Appearance of water table as a result of a loam layer

Finally, at study area 2 and 3, Arendstraat and Boekweit respectively, the composition of the soil profile corresponds with that of study area 1 (Figure 19 -22). However, the water table on both sides of the fault at study area 3, was found to be much deeper into the ground compared to the other two locations.

Figure 19 Soil profile of the horst side of the fault at study area 2 (Arendstraat)

Figure 20 Soil profile of the slenk side of the fault at study area 2 (Arendstraat)

Figure 21 Soil profile of the horst side of the fault at study area 3 (Boekweit)

Figure 22 soil profile of the slenk side of the fault at study area 3 (Boekweit)

3.1.2 Wijst specific vegetation

The types of special vegetation were only encountered in study area 2, on the horst side of the fault (Figure 23 and 24). The reasoning for no appearance of special vegetation on neither the study area 2 or 3 was that these areas where either cultivated or developed to such an extent that the special types of vegetation that are characteristic to fault grounds were not present.

Figure 23 Straw (wijst specific vegetation) growing on the horst side of the fault

Figure 24 A row of different kinds of wijst specific vegetation (e.g. birch, black alder, dove tail and els). growing on the horst (right side from the pole) side of the fault

3.1.3 GPS and water table data

With regard to GPS coordinates (see ANNEX A) for each located fault point right in between the Horst and the slenk side of the fault line was collected by using an application called "GPS Data". At this location, the water table undergoes an abrupt change, as one moves across the fault line.

With regard to the water table data, Breemortelweg (study area 1) has 5 drilling locations with an average of 5 drilling points per location. Also, the water table at the horst is approximately 1.5 m. At the horst no soil water table had been found even though drilling reached a depth of 4 meters. Next, Boekweit has 5 drilling locations with an average of 4 drilling points per location.The water table at the horst is at 1,7 meters depth and the soil water table at the slenk has a depth of approximately 2,75m. Arendstraat contains 6 drilling locations with an average of 5 drilling points per location. Most of the locations had a water table of approximately 0.6 m at the horst a 1.2 at the slenk. (see ANNEX A).

3.1.4 Drone photos

Drone photos were taken at each area of study (Figure 25 – 27). However, the quality of the photos has turned out to be not so great after being stitched together and georeferenced. Furthermore, when the images where georeferenced they turned out to be deformed. However, in comparison, satellite images are showed to be much more useful because they were not deformed. Therefore, satellite images downloaded through wms servers where used instead.

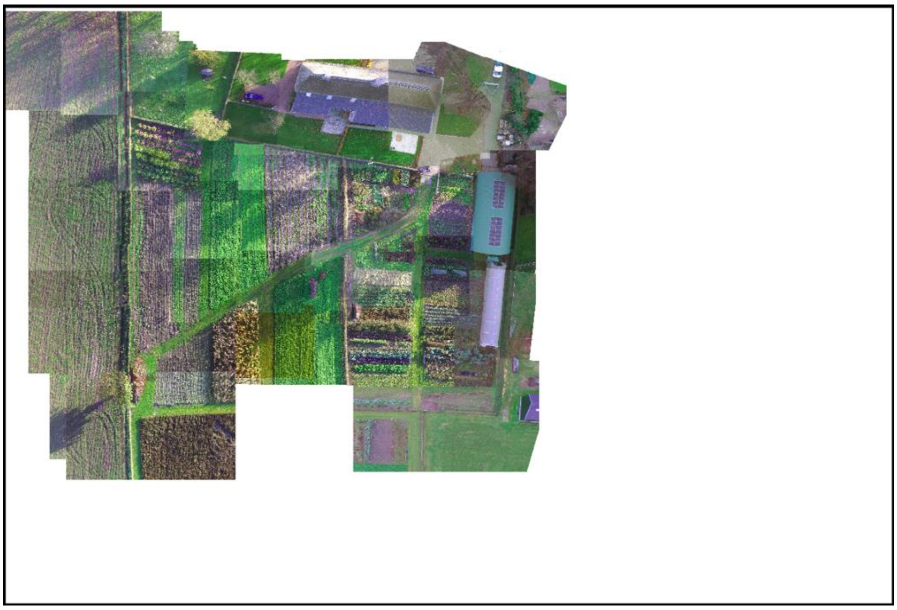


Figure 25 Aerial photo (stitched, not processed through ARCGIS) of study area 1

Figure 26 Aerial photo (stitched, not processed through ARCGIS) of study area 2

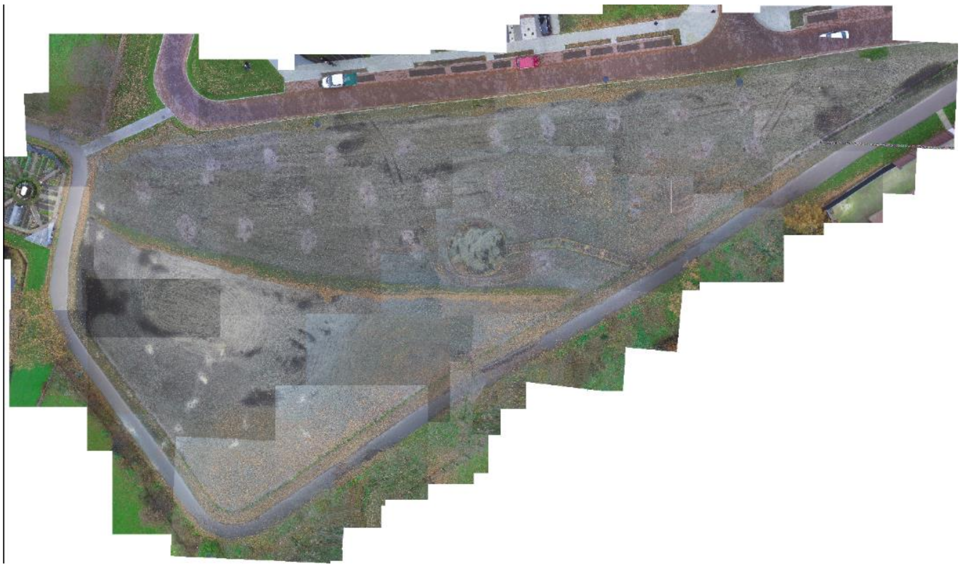


Figure 27 Aerial photo (stitched, not processed through ARCGIS) of study area 3

3.2 GEO INFORMATION ANALYSIS

The following maps are the products of the geoinformation analysis of the data that was collected in the field work and afterwards processed using the methods that are described in chapter two. In total around 6 different maps where created.

Firstly a map (Figure 28) was create that shows the difference of the water table height between both sides of the fault line. A buffer element was added to represent the margin of error with regard to the location fault line. In study area 1 this margin of error was 1 meter and in study area 2 and 3 it was around 2,5 meters. Also, in study area the location of the wijst specific vegetation was also presented by an element. Any change in the water table height is visible by the change in the colour. From the map it can be concluded that the water table is higher at the horst side of the fault line compared to that of the slenk side. This could be explained the blockage of water flowing from the horst to slenk as result of the impermeable (iron-rich) embankment that is located at the fault line.

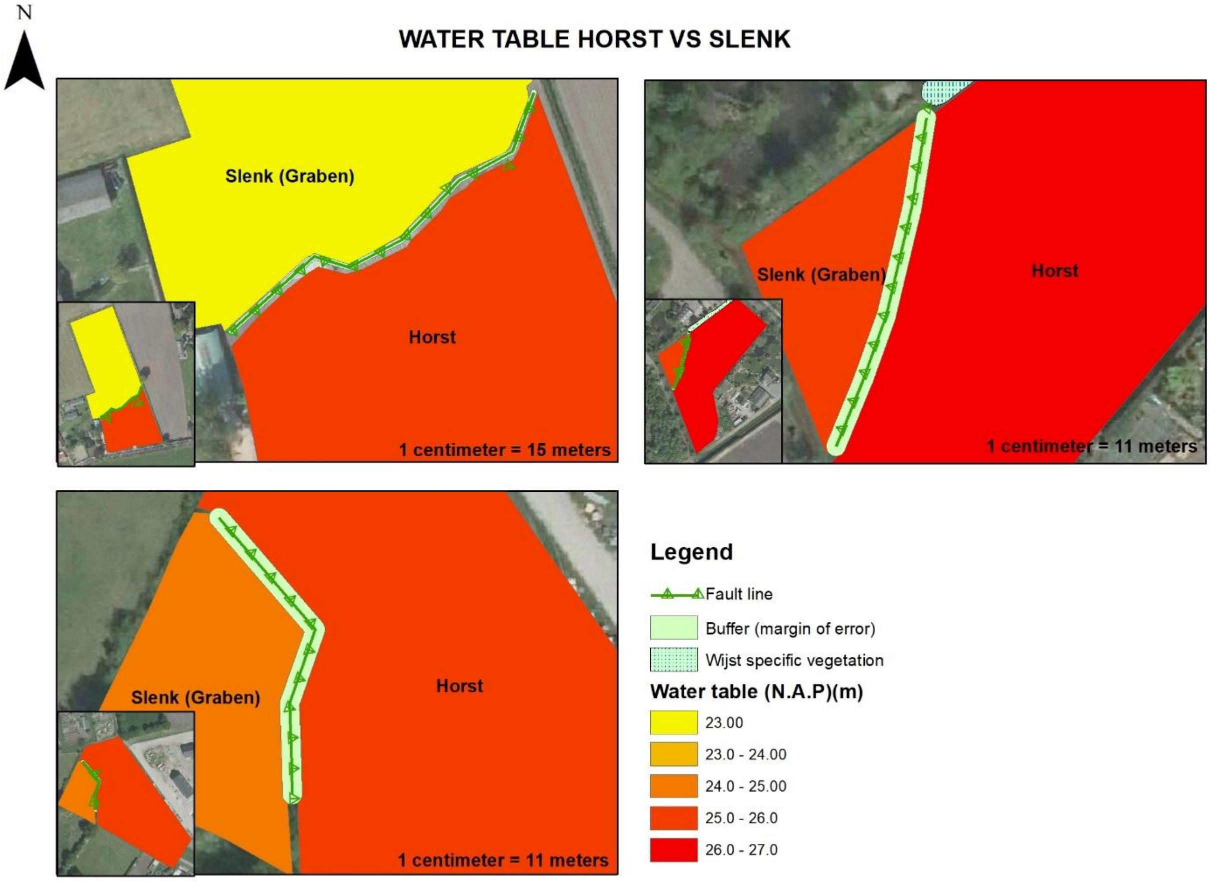


Figure 28 Map depicting how the water table differs from the horst and the slenk and also indicated the location of the wijst specific vegetation

Secondly, a map was created that presents the concentration of calcium in the groundwater between both sides of the fault lines. From the map in Figure 29 it can be concluded that the concentration of calcium in the ground water appears to be lower on the slenk side of the fault line compared to the calcium concentration on the horst side of the fault line.

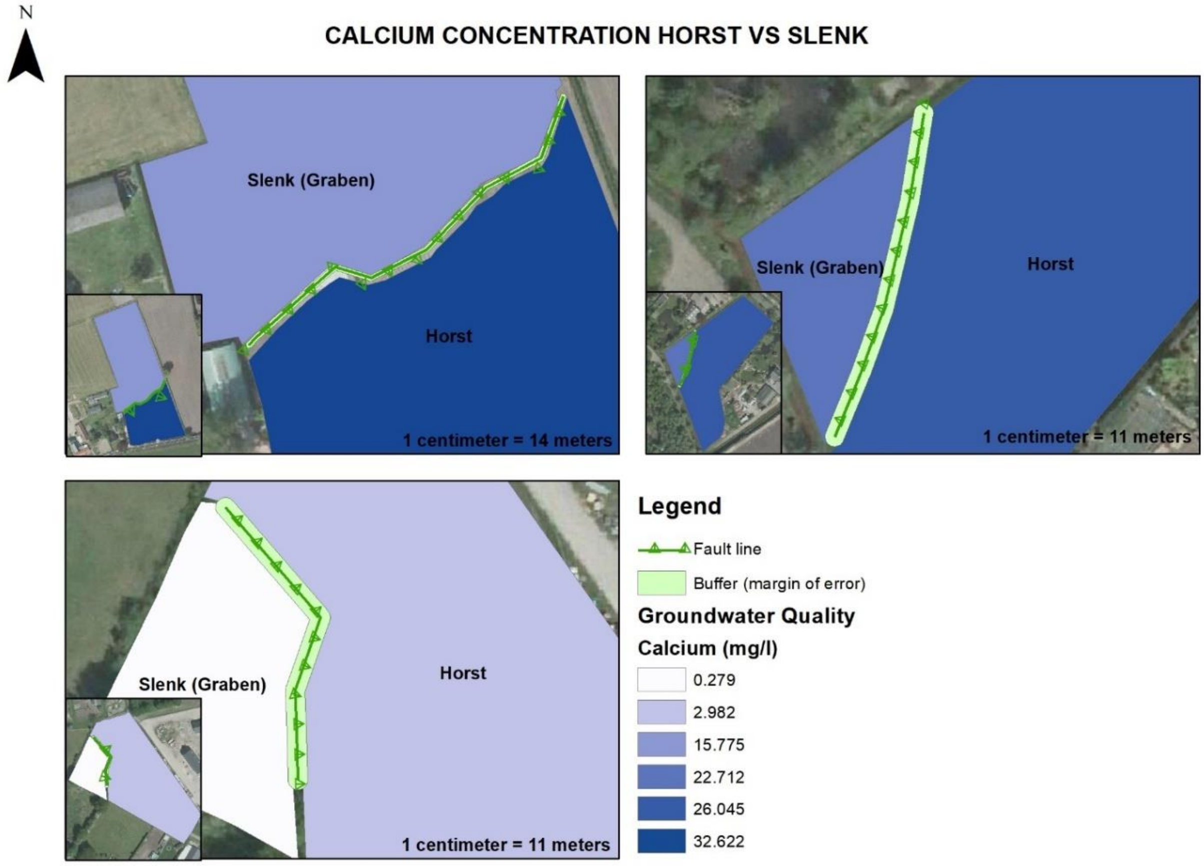


Figure 29 Map depicting the groundwater quality in terms of calcium concertation between both sides of the fault line

Thirdly, a map was created that presents the concentration of iron in the groundwater between both sides of the fault lines. From the map in Figure 30 it can be concluded that the concentration of iron in the ground water appears to be higher on the slenk side of the fault line compared to the iron concentration on the horst side of the fault line.

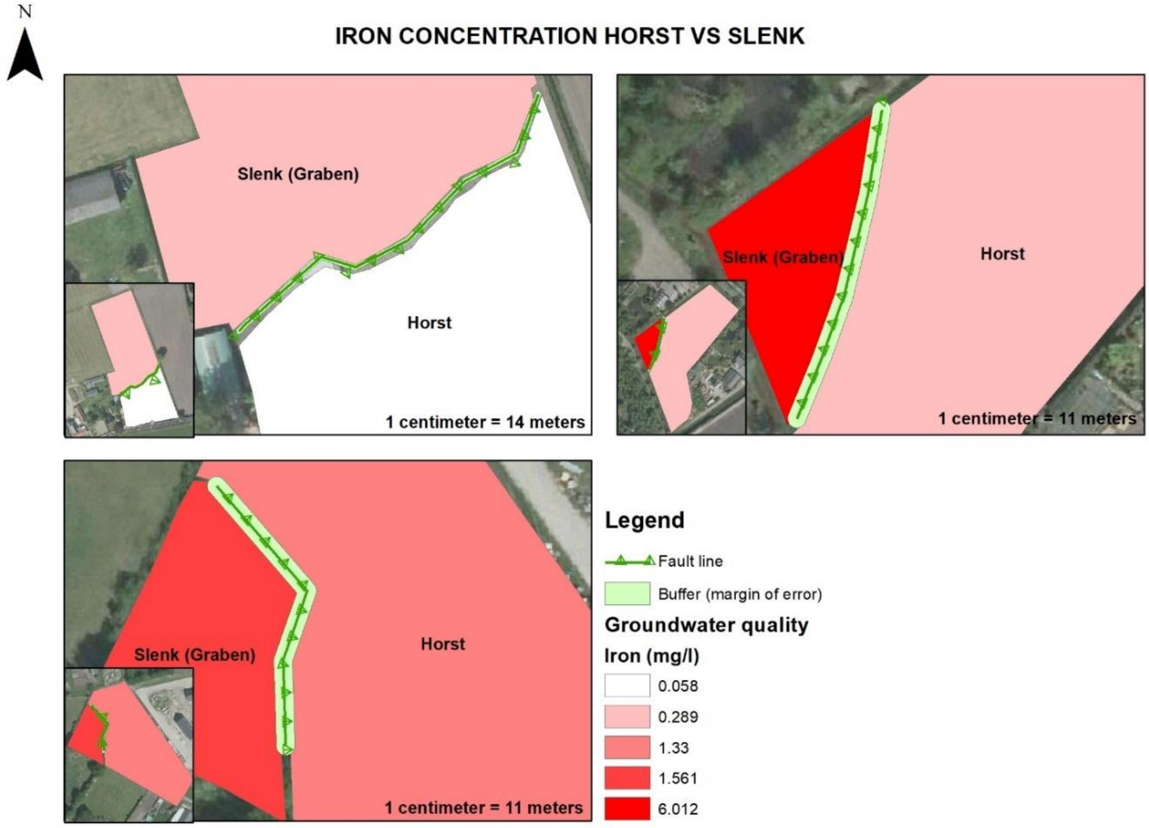


Figure 30 Map depicting the groundwater quality in terms of Iron concertation between both sides of the fault line

Next, a map was created that presents the concentration of nitrate in the groundwater between both sides of the fault lines. From the map in Figure 31 it can be concluded that the concentration of nitrate in the ground water appears to be higher on the slenk side of the fault line compared to the nitrate concentration on the horst side of the fault line.

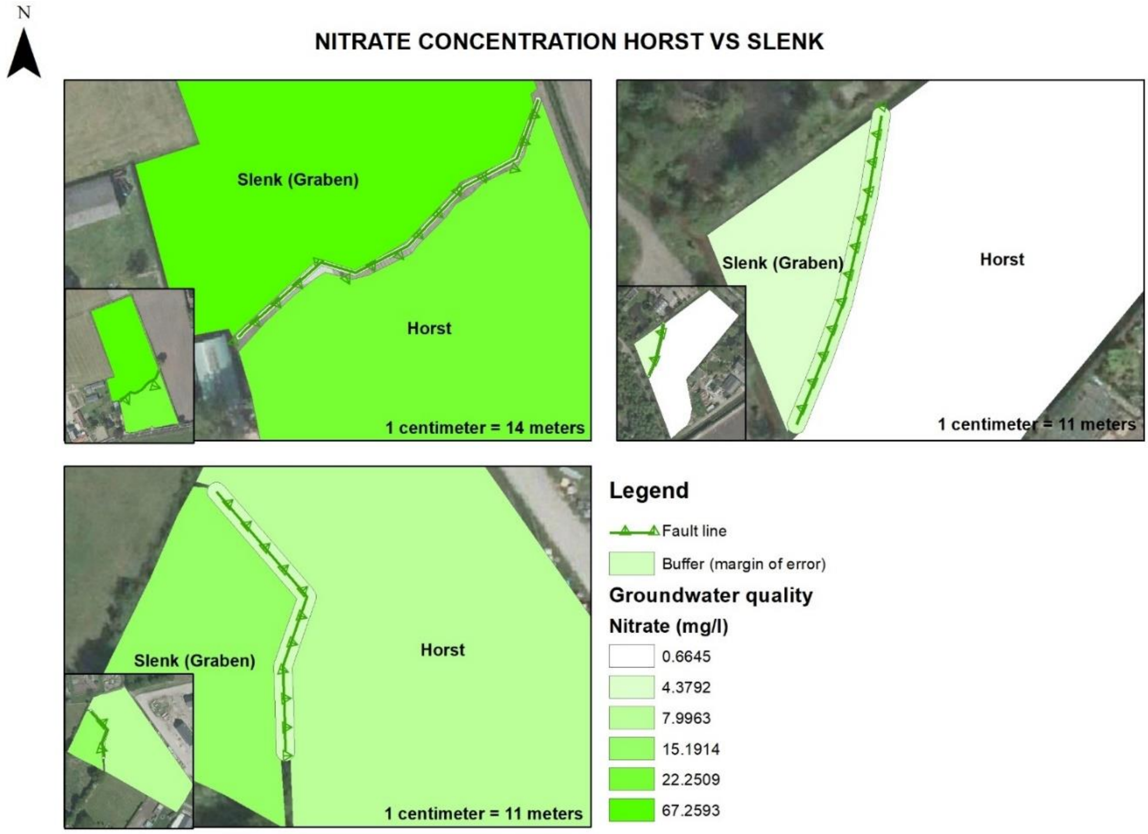


Figure 31 Map depicting the groundwater quality in terms of nitrate concertation between both sides of the fault line

Also, a map was created that presents the concentration of sulphate in the groundwater between both sides of the fault lines. From the map in

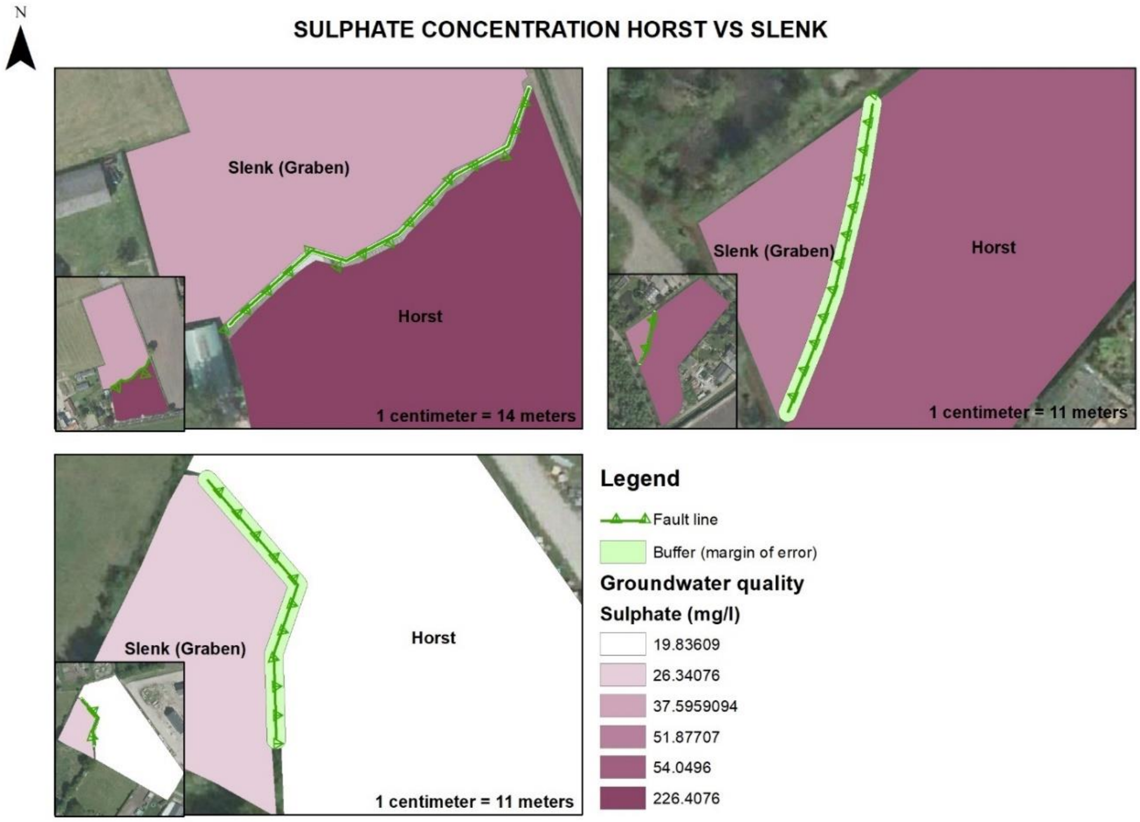


Figure 32 it can be concluded that the concentration sulphate in the ground water appears to be higher on the horst side of the fault line compared to the sulphate concentration on the slenk side of the fault line. However this seems to only be true for study areas 1 and 2. At study area 3, the groundwater sulphate concentration appears to be lower at the horst side of the fault line.

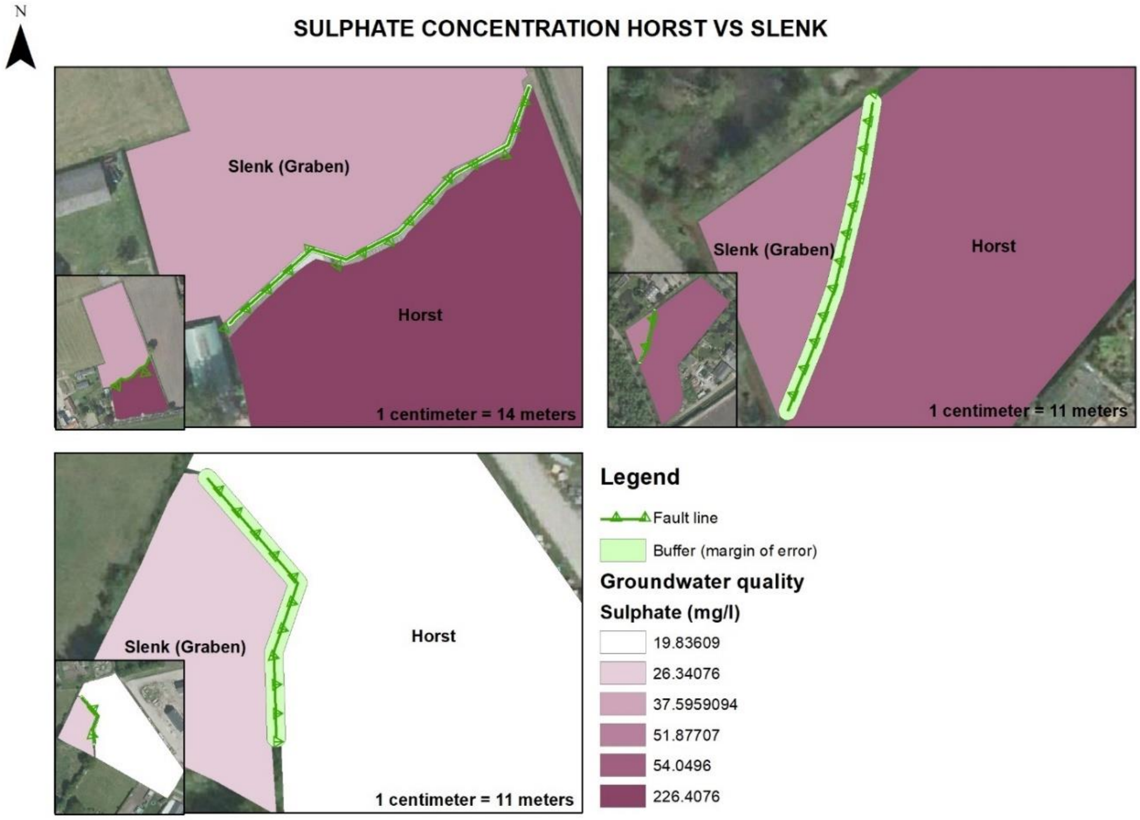


Figure 32 Map depicting the groundwater quality in terms of sulphate concertation between both sides of the fault line

Finally a satellite map was created that shows the location of the fault lines at all of the three areas of study (Figure 33).

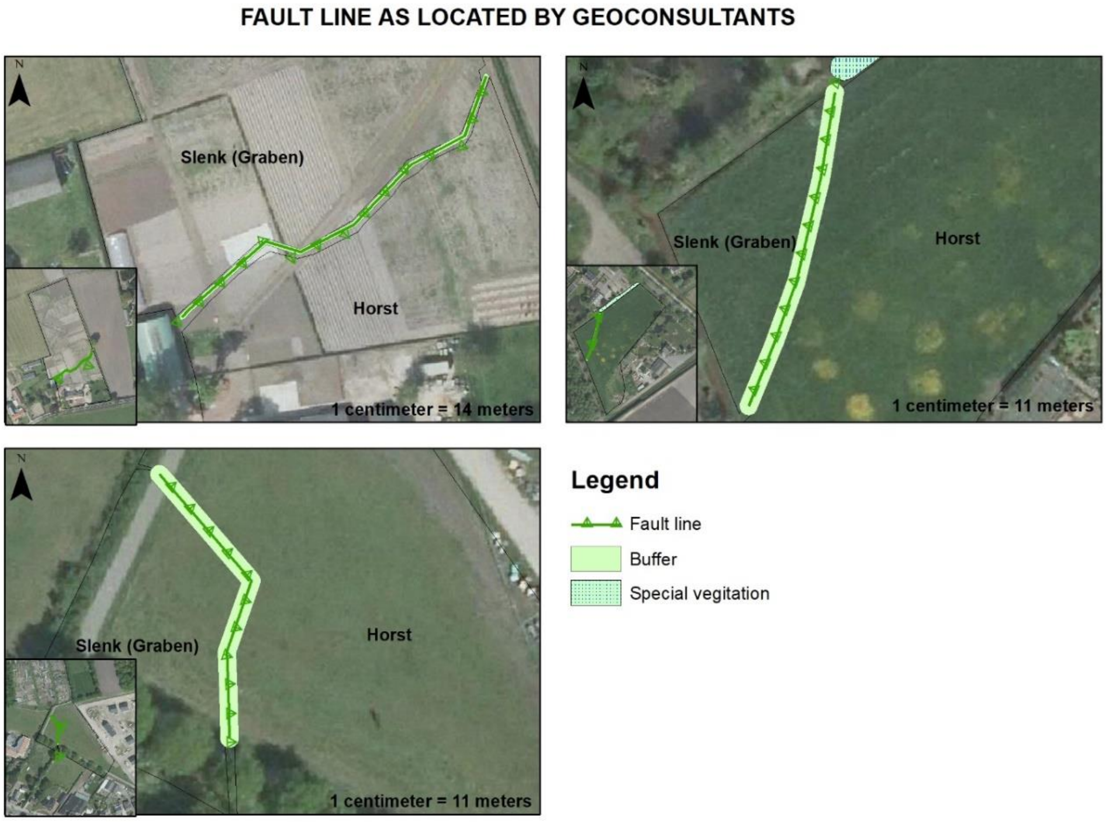


Figure 33 map depicting the fault location of the fault as located in the project

4 DISCUSSION

First of all, with regard to the field work, some peculiarities were discovered in terms of the soil profile at study area 1 (Breemortel). Because of the presence of an impermeable loam layer with the soil, the water table at the slenk side of the fault appeared to be much higher than then it actually is.

Next, even though drone pictures to some extend do show a higher resolution photo compared to satellite imagery, the stitching and georeferencing of the photos have proven to significantly reduce the quality of the picture because of deformation that occurs.

Also, in terms of geotagging photos onto the map via ArcGIS, no cameras where available that support tagging GPS coordinates directly onto the photos. Therefore, it was proven to be practically impossible to geotag the photographic data onto the maps. And when another method was endeavoured – a method in which the photos where not geotagged through GPS coordinates, but manually attached to features on the map via the attribute table- the software program kept giving an error and closing down.

5 CONCLUSION

Methods for collection, processing and analysis of geoinformation relating to the Peelboundary fault zone have been presented. Information was presented on the types of data (e.g. photos, GPS data, water table data, and groundwater samples) collected and also showed how that data can be processed and analysed by using geo-information software (particularly ArcGIS). Out of the analysis 6 maps have been created one of which depicts the localization of the Peelboundary fault line. Another one depicts the difference of the water table height between each side of the fault line. Furthermore, four other maps consecutively depict the concentration of calcium, iron, nitrate and sulphate in the groundwater between both sides of the fault line.

6 RECOMMENDATION

In future research projects, the appearance of the impermeable loam layer as found in the study area 1 needs to be investigated, in terms of why and how this layer occurs. Also, when looking drilling for the water table height, careful attention has to be put towards knowing whether that is the actual water table or not.

Next, if drone photos can be skipped all together for high resolution satellite images (updated yearly) it would cost less time and energy to located the fault.

Finally, the use of cameras which support geotagging will make it easier to tag the photographic data onto maps by using geo information software.

Reference

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Annexes

A (Drilling Data)

Study Area 1 (Breemortelweg 21)

Location 1:

Parameter/Holes	1	2	3	4	5
groundwater table (m)	The ground water was to deep, since no water was found after 2m depth	S	At this location, we suspect the fault to be and therefore mark it with the letter F	1.40 m	1.40 m
Groundwater (above NAP m)	-	S	F	26.1	26.1
GPS Fault location (Lat/Lon)	51.445126/ 5.814492				

Location 2:

Parameter/Holes	1	2	3	4
groundwater table (m)	The ground water was to deep, since no water was found after 2m depth	S	At this location, we suspect the fault to be and therefore mark it with the letter F	1.40
Groundwater (above NAP m)	-	S	F	26.1

GPS Fault location (Lat/Lon)	51.445010/ 5.814425

Location 3:

At location one around 4 holes where bored , see table below.

Parameter/Holes	1	2	3	4
groundwater table (m)	The ground water was to deep, since no water was found after 2m depth	S	F	1.4
Groundwater (above NAP m)	-	S	F	26.1
GPS Fault location (Lat/Lon)	51.444954/5.814258			

Location 4

Parameter/Holes	1	2	3
groundwater table(m)	4.35 no groundwater to deep	F	1.10
Groundwater (above NAP m)	N.A.	F	26.4
GPS Fault location (Lat/Lon)	51.444837/5.814079		

Location 5

Parameter/Holes	1	2	3	4

groundwater table(m)	no , to deep	Seepage	F	1.45
Groundwater (above NAP m)				26.05
GPS Fault location (Lat/Lon)	51.444783/5.813912			

Predetermined GPS location (fault location 6) (lat/lon): 51.444804/5.813803

Location 7

Parameter/Holes	1	2	3	4	5
groundwater table(m)	1.35	1.10	1.45, however at this location the loam layer was encountered	1.5 however at this location the loam layer was encountered	2.40 groundwater was to deep so we didn't find any
Groundwater (above NAP m)	26.15	26.4	26.05	26	25.1
GPS Fault location (Lat/Lon)	51.444701/5.813618				

Location 8

Parameter/Holes	1	2	3	4	5
groundwater table(m)	No, too deep	No, to deep	No, too deep	F	1.60

Groundwater (above NAP m)	N.A	N.A	N.A	F	25.9
GPS Fault location (Lat/Lon)	51.444671/5.813565				

Location 9 (second trip)

Parameter/Holes	1	2	3	4	5
groundwater table(m)	no, to deep	No, to deep	seepage	F	1.60
Groundwater (above NAP m)	N.A	N.A	N.A	F	25.9
GPS Fault location (Lat/Lon)	51.444656/5.813541				

Study area 2 (Arendstraat)

Location 1

Parameter/Holes	1	2	3	4	5
groundwater table (m)	0.60-0.75	0.60-0.75	F	1-1.20	1-1.20
Groundwater (above NAP m)	26.9-26.75	26.9-26.75		26.5-26.3	26.5-26.3

GPS Fault location (Lat/Lon)	51.598557/ 5.686799

Location 2

Parameter/Holes	1	2	3	4	5	6
groundwater table (m)	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75
Groundwater (above NAP m)	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75
GPS Fault location (Lat/Lon)	No fault found					

Location 3

Parameter/Holes	1	2	3	4
groundwater table (m)	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75
Groundwater (above NAP m)	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75
GPS Fault location (Lat/Lon)	No fault found			

Location 4

Parameter/Holes	1	2	3	4	5

groundwater table (m)	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75	0.60-0.75
Groundwater (above NAP m)	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75	26.9-26.75
GPS Fault location (Lat/Lon)	No fault found				

Location 5

Parameter/Holes	1	2	3	4	5
groundwater table (m)	0.60-0.75	0.60-0.75	F	1-1.20	1-1.20
Groundwater (above NAP m)	26.9-26.75	26.9-26.75	F	26.5-26.3	26.5-26.3
GPS Fault location (Lat/Lon)	51.598809/ 5.686918				

Location 6

Parameter/Holes	1	2	F	3	4
groundwater table (m)	0.60-0.75	0.60-0.75	F	1-1.20	1-1.20

Groundwater (above NAP m)	26.9-26.75	26.9-26.75	F	26.5-26.3	26.5-26.3
GPS Fault location (Lat/Lon)	51.598655 /5.686853				

Study area 3 (Boekweit)

Location 1

Parameter/Holes	1	2
groundwater table (m)	1.75	1.80
Groundwater (above NAP m)	25.75	25.70
GPS Fault location (Lat/Lon)	None - did not find the fault line	

Location 2

Parameter/Holes	1	2	3	4	5
groundwater table (m)	2.75	F	1.80	1.73	1.75
Groundwater (above NAP m)	22.75		25.70	25.77	25.75
GPS Fault location (Lat/Lon)	51.603599/ 5.680767				

Location 3

Parameter/Holes	1	2	3	4	5	6	7	8
groundwater table (m)	2.70	2.70	2.60	2.60	2.55	2.55	F	1.90
Groundwater (above NAP m)	24.8	24.8	24.9	24.9	24.95	24.95	F	25.6
GPS Fault location (Lat/Lon)	51.6034409311149/ 5.68098591641121							

Location 4

Parameter/Holes	1	2	3	4
groundwater table (m)	2.60	2.60	F	1.80
Groundwater (above NAP m)	24,9	24,9	F	25.7
GPS Fault location (Lat/Lon)	51.6033355286825 / 5.68092698871772			

Location 5

Parameter/Holes	1	2	3

groundwater table (m)	2.60	F	1.90
Groundwater (above NAP m)	24.9	F	25.6
GPS Fault location (Lat/Lon)	51.6032738378752 / 5.68093143404059		