The Dender

MULTI LAYER SAFETY APPROACH IN BELGIUM

Figure 1 At the Dender Source: (johanbaldewijns, 2007)

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HZ UNIVERSITY OF APPLIED SCIENCES | DELTA ACADEMY | RESEARCH ASSIGNMENT |

Foreword

We are a group of second years Delta Management students at the HZ University of Applied Sciences. The report is for the course of Research Assignment. The reason for this report is to do a relevant research about multi layered safety in Belgium for the project FRAMES. The pilot area for the research is The Dender River, focused on the municipality of Denderleeuw. We want to thank our teacher Mr. Buijs for his lessons, information and feedback and Mr. Papenborg and Mr. Fundter for the guest lectures. Furthermore we would like to thank Hannelore Mees of the municipality of Oost-Vlaanderen and her contacts for their cooperation for the interviews and delivering useful information from documents.

Vlissingen, January 20th 2016

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Summary

The Dender river area pilot project case is one of the studies that has been assigned to the class. The river has a length of 65 kilometers and I located in one of the most densely populated municipalities in the country**.** The area near the river Dender is located in the Belgian province of Flanders
The area of the municipality of Denderleeuw is very sensitive to flooding's because of its low lying flood prone location. The focus of this proposal research is mainly focused on the area of the municipality.

In 2010 the city of Denderleeuw was flooded because of excessive rainfall. A peak discharge of 115-121 m^3/s caused the river to break its banks and flood the area. This event was very interesting to investigate and research for the assignment. Weak spots in the river dikes and inadequate response to the situation lead to a disaster for the municipality.

From the desk research that has been conducted by the research group we wanted to research what kind of improvements have been made since the disaster of 2010. In the research we took a look at what went wrong on the day of the disaster and days after and the Flemish Multi-Layer approach. From the information. We analyzed specific measures that were taken after the flooding and took a conclusion.
The overall strategy for this report was mainly focused on desk research, but we also contacted local officials and professors who gave us more specific information about the MLS approach and current situation in the municipality of Denderleeuw. A conceptual model and Arc GIS situation descriptions are presented in the research. The conceptual model describes the analysis of the problem, while the Arc GIS models present a clear overview of the location of the research.

The main problems that occurred during the events of 2010 was that the response of the evacuation was not executed well because of the slow reaction of the local officials Vulnerable spots in the municipality where identified as the train station, fuel station, and the police/fire stations. These structures were all essential in the evacuation of the inhabitants.

1. Introduction

The Dender River is a river located in Belgium, in the river basin of the Scheldt. The river flows through the provinces Henegouwen, Oost-Vlaanderen and Vlaams-Brabant, and has a length of 65 km. The beginning of the Dender is in the area of Aat. After the conflux of the Eastern-Dender and Western-Dender, the Dender River flows through a lock at the city Dendermonde into the Scheldt. Between Dendermonde and Aalst the Dender River is used as a way of transportation over the water. But most importantly, this river is mostly used for recreation.

Figure 2 Arise of the Dender River. Source: ***Invalid source specified.***

Denderleeuw is a small village and municipality in the province of Oost-Vlaanderen. The municipality accommodates 19.000 inhabitants, the Denderleeuw lays next to the Dender River and Dender area.

1.1 Problem Description

The area of the Dender river is very sensitive for floodings. The focus of this proposal is mainly on one municipality, the municipality of Denderleeuw. (Starflood, 2014). In 2010, this municipality was hit by an extreme weather event. The area has a questionable 2nd layer, sustainable spatial planning, and 3rd layer, Disaster management of the multi-layered safety approach (Starflood, 2014). This became clear during the flood of 2010.

This flood was a result of the following things. A peak discharge of 115-121m3/s. This was caused by the fact that the Dender is a precipitation river. Because of the climate change there is a bigger amount of rainfall. Moreover, the peak discharge was also caused by upstream high water levels and very high water discharges coming from the several smaller river branches. Normally the high water level would have been reduced in a few hours. However, this high water level was still noticeable 3 days later. The Dender River exceeded his banks, causing a total of at least 620 houses, farms, sheds and basements to be flooded (Intergraal waterbeleid, 2010).

The cities which bordered the Dender were near protected or prepared to deal with the flood. Firstly, the sustainable spatial planning was discussable, a lot of silt in the river that was not dredged and the sluices and weirs were are not optimally maintained through the years. Secondly, there were many weak spots in the dikes. Besides, the disaster management came up short. The response time that was needed for evacuation, was slow and inadequate, the exact amount of time that was needed was not finable in the used or other sources.. There was no emergency plan ready or a coordinating person of the governance in the emergency area. In addition, the communication, for example, towards the municipality and the inhabitants needs to be improved.

After 2010, specific infrastructural measures were taken, such as the dredging of the watercourses. Also studies were done to research dikes and infrastructure. In addition, there is a Specific Emergency and Intervention Plan for floods in progress. However, it is assumed that those measures are not enough to protect these areas from every flood in the future. (Starflood, 2014).

1.2 Research Questions

- Which lessons are learned about the multi-layer safety based on the case study of Denderleeuw?
  - What is Multi-layer safety?
  - What happened with the flood in Denderleeuw in 2010?
  - Which improvements have been made in the third layer since 2010?

1.3 Research Goal

Commissioned by the teacher of the Course Research Assignment for project FRAMES, a research assignment is prepared about the Dender River. We found out that the Denderleeuw area has challenges regarding water management and the multi layered safety. Caused by the flood sensitive area and mainly the undeveloped third layer. We would like to find the weak spots of the third layer of the multi-layer safety. So we can recommend improvements towards the multi layered safety on flood risk management by doing research. The best possible solutions must be devised in order to maximize benefits to stakeholders and make the project cost effective.

2. Theoretical Framework

2.1 Introduction

Flooding is one of the most harmful hazards in the region of Belgium and the whole of Europe (Maria Kaufman, 2015). While flooding is a common hazard in the region for a long time, these events cause more damage than they used to. The damage caused by flooding is relatable to socio-economic development in specific areas and because of the consequences of climate change. Recent floods are not directly caused by the consequences of climate change, but climate change could have an influence to certain events. (Maria Kaufman, 2015) Intense rain showers and sea level rise are not the only reasons for the incensement of flooding's, change in land use and population rise in specific areas. (Johan Brouwers, 2015)

While the report published by different sources worldwide give a clear message that the amount of flood disasters have increased since 1970, there is no clear connection to the influence of climate change. (Johan Brouwers, 2015) The Dender is a rain river and gets most of its water from rain. More frequent showers and intense showers could lead to more future flooding's.

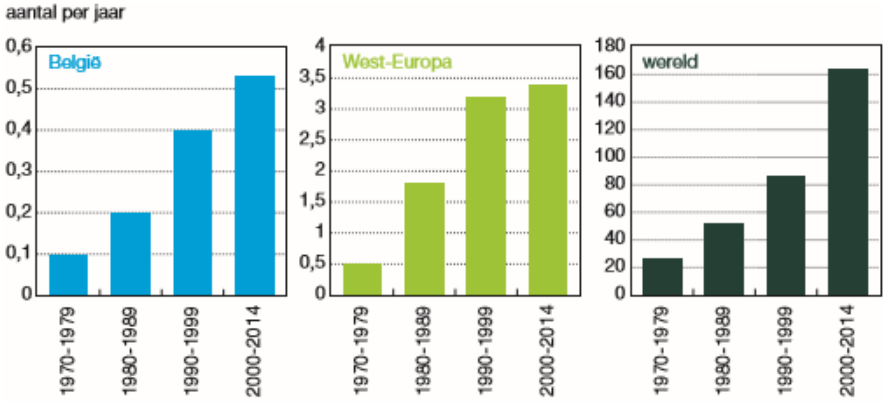

Figure 3 Evaluation of the amount of registered flooding's in Belgium, West-Europe and Worldwide. (Johan Brouwers, 2015)

2.2 What is Multi-Layer Safety?

The Belgian government has introduced a risk-based approach to flood risk management at the beginning of the 21st century. (Maria Kaufman, 2015). More adaptable approach has to be implied because of the challenges that we are facing. This approach has been labelled as the multi-layer (water) safety, taking care of different aspects when it comes to safety of the inhabitants. While the flood defence approach that used to be implied was mostly focused on hard protection from water, the risk-based approach focusses more on the management of the consequences and probability of a disaster. The Multi-layer Safety approach has also been implied into the Dutch water safety approach, but it does differ from the Belgian approach. The main difference in water management between the Netherlands and Belgium is the risk. In times of a flooding the Netherlands have to deal with a huge amount of damage as well as economic as dead people. This brings another strategy in the Multi-Layer Safety approach. While the Dutch approach is characterised as a more institutionalized system with a discourage of traditional flood defences, the Flanders has less of a discourage for traditional flood defences. While the Dutch government is more focused on probability management, Flanders gives more attention towards consequence management. (Maria Kaufman, 2015)

Flanders has a very fragmented actor structure, while the Dutch management is only in hands of a limited number of water managers. (Maria Kaufman, 2015) The Flemish land is divided over four categories of watercourses and four governmental levels. In contrast to the Netherlands, Flanders has no safety standards by law, neither is the state legally responsible for flood protection. Because of this standard it is up to the water managers involved to determine the most appropriate protection level. Each water manager enjoys more freedom in managing local water courses, but the development and structuration is executed on a regional level. The freedom given by the institutions results into a more creative protection with possibilities into developing new ideas and initiatives.

Multi-Layer Safety in the Flanders tries to increase the multi-level governance coordination of the water safety plan. The government is mainly busy with policymaking in terms of flood prevention and protection, while the concern about flood protection is arranged on a federal level. Recently further steps have been taken into strengthening the link between water and crisis management. One example of the improvements is an intergovernmental emergency exercise on flooding and a Flemish Crisis Centre.

Multi-Layer Safety terminology in Europa, Netherlands and Flanders		
Europa	**The Netherlands**	**Flanders**
1. Prevention Avoiding or adapting construction in flood-prone areas **2. Protection** reduce likelihood of floods through flood defence measures **3. Preparation**	**1. Prevention** Avoiding by reducing their likelihood through flood defence measures **2. Adaptive spatial planning** avoid or adapt construction **3. Risk management** evacuation	**1. Prevention** avoiding or adapting construction in flood-prone areas **2. Protection** reduce likelihood of floods through flood defence measures **3. Preparation** Emergency management

As shown in in the graph above it reveals the difference in the approach to the Multi-Layer Safety. The main difference between the Dutch and Flemish is that the first two layers of the approach are switched. The Flemish government enforces laws to prevent people from building in flood prone areas. While the Dutch government makes emergency plans, the Flemish government tries to plan ahead with preparation measures.

2.3 What happened with the flood in Denderleeuw in 2010?

This flood was a result of the following things. A peak discharge of 115-121m3/s. This was caused by the fact that the Dender is a precipitation river. Because of the climate change there is a bigger amount of rainfall. Moreover, the peak discharge was also caused by upstream high water levels and very high water discharges coming from the several smaller river branches. Normally the high water level would have been reduced in a few hours. However, this high water level was still noticeable 3 days later. The Dender River exceeded his banks, causing a total of at least 620 houses, farms, sheds and basements to be flooded. And in the municipality of Denderleeuw the water flooded 51 buildings, basements and street level houses. (intergraal waterbeleid , 2010)

*Figure 4 Flooded backyard.**Invalid source specified.***

The cities which bordered the Dender were near protected or prepared to deal with the flood. Firstly, the sustainable spatial planning was discussable, a lot of silt in the river that was not dredged and the sluices and weirs were are not optimally maintained and outdated. Secondly, there were many weak spots in the dikes. Besides, the disaster management came up short. The response time that was needed for evacuation, was slow and inadequate. There was no emergency plan ready or a coordinating person of the governance in the emergency area. In addition, the communication about the problems and risk of flooding between the municipality and the inhabitants needs to be improved.

2.4 Which improvements have been made in the third layer since 2010?

The third layer of the Multi-Layer Safety approach is disaster management. In this layer the communication needs to be improved. This has to be done because when the flood of 2010 happened, nobody was informed, and nobody knew how to take action. The municipality of Denderleeuw was a political disaster and did not know how to react. There was already an Emergency planning official but he had other task than the crisis management in case of a flooding. (Intergraal waterbeleid, 2010) After 2010, there were specific infrastructural measures that were taken, such as the dredging of the watercourses. Also studies were done to research dikes and infrastructure. In addition, there is a Specific Emergency and Intervention Plan for floods in progress with an emergency planning official focussing on crisis management in flooding. The political balance in the municipality is found back. Inhabitants where prepared with shelf's to protect their buildings from flooding. (Mees, 2016)

2.5 Conceptual model

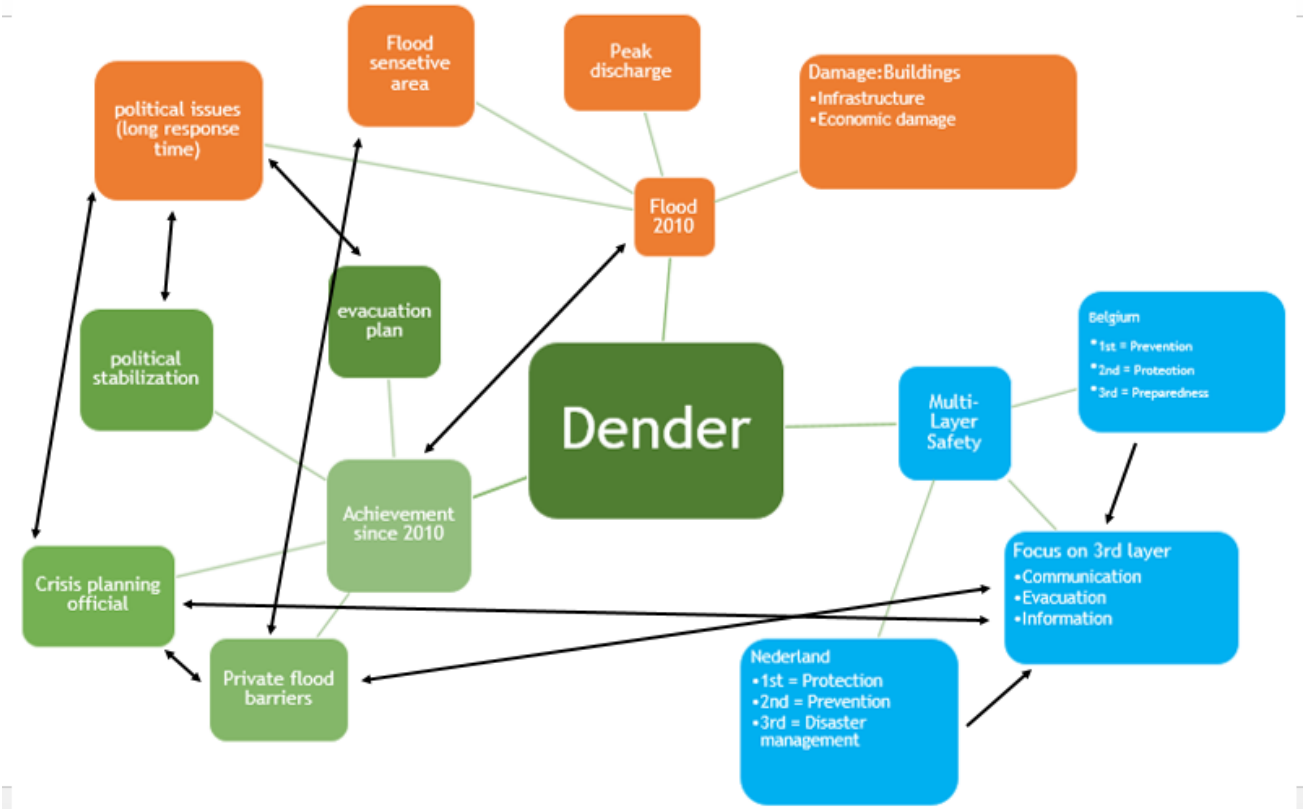

Figure 5: Conceptual Model

3. Methodology and operationalization

3.1 Research design

The overall strategy for this research was to integrate the desk research, the GIS map, and the advice from local officials to generate a report that advises what the best measures are regarding water safety according to the research questions. The collection of data was done according to the standards set by the assessment of research quality.

3.2 Explanation of methodology

Data was acquired by use of the search engines Sciencedirect and Google Scholar. Articles from scientific articles and journals from publishers such as Elsevier where examined. It was chosen to use desk research in combination with communication with local officials because of the geographic location of the project area, which did not permit (frequent) visitation for interviews. Communication would therefore be made primarily through online means.

Contact was made with a local official, who provided information regarding the previous flooding events, differences between Flemish and Dutch water management.

Desk research- information on flooding events in the Dender was collected. Various ways of analysis where done including comparing the Dender flood protections norms against the Dutch water management norms. Key stakeholders and points were analysed to find weak links in the water safety and vulnerability

3.3 Assessment of research quality

In order to maintain transparency, sources will be listed at the end of the report. Before using a document, a quick check was done to see if the source would be considered accurate. Keywords for searching included (but not limited to):

- Dender flood protection
- Waterveiligheid Dender Belgie
- Wateroverlast Dender
- Dijken in Dender Belgie
- Flooding Belgium
- Derde laag Belgie waterveiligheid
- Vlaanderedn water management
- Etc.

In regards to transparency, someone can redo the research by looking at the sources which are stated at the end of the report.

3.4 Operationalization

Operationalization is the process of strictly defining variables into measurable factors. The process defines fuzzy concepts and allows them to be measured, empirically and quantitatively.

In the case of this research this means making clear what exactly is meant with improving the 2nd and 3rd layer of the Multi-Layer Safety approach in the area of Denderleeuw.

In order to make the most out of the interview with Hannelore Mees we had planned, to gather as much information as possible during the interview, and to make/ask our questions as clear as possible, we roughly prepared the interview and the questions we

wanted to ask, 2 days before. Half an hour before the actual interview, we reviewed these questions, and decided that it was better that not all group members started asking questions, so we appointed Nikki to be the main speaker. Because of this, the interview happened very fluently, and we learned a lot of it.

4. Results

This chapter consist of results of the area analysis and the main answers to the research question and sub questions. This chapter gives a better view of the crucial moments where people can prepare for possible flooding's in the future. All the maps that are made in this chapter are from the programme QGIS created by the members of the team.

4.1 Pilot description

The municipality of Denderleeuw consist of the one most populated municipalities in Belgium with more than 19.000 inhabitants. The surface area of the municipality consist of 13.77km^2. 56% of the area is undeveloped or agriculture, 23% is developed living area. The population density of the area is 1402 inhabitants/km^2. The village Denderleeuw lays next to the Dender River and located in the so called "Denderstreek". The municipality has problems with the political control of the area. (Gemeente Denderleeuw). In 2010 the high water level raised due to heavy rainfall. The village Denderleeuw was flooded for two days with 51 buildings: 18 storey and 33 basements (intergraal waterbeleid , 2010) a possible cause could be the old weirs and sluices in the Dender River. Another possible cause could be the cropped embankment with less protection. The high water level of the Dender River is almost the same as the street level. Together with the cropped embankment makes this a tall order to prevent. So to get a hand in it we will focus on the first and third layer of the Multi-Layer safety approach in how this could be improved. The agencies that could help prevent flooding's and or damage are shown in the stakeholder analysis.

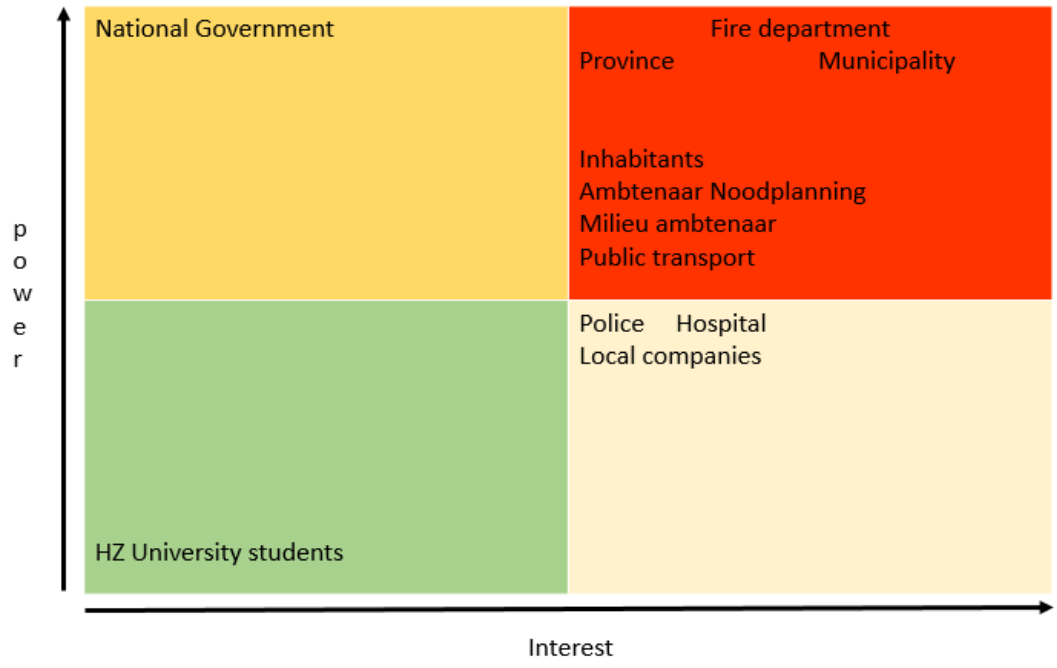

Figure 6 stakeholder analysis

4.2 Relevant data to answer sub question and GIS maps

The following maps give an overview of the main functions of the village Denderleeuw including housing, industry, agriculture and infrastructure. And about the problem by the protection against high water levels. By the Multi-Layer Safety approach this is the second layer the protection. Due to the cropped embankment the protection against the water is hard in high water levels. It is hard to prevent this so we focused on the first and third layer.

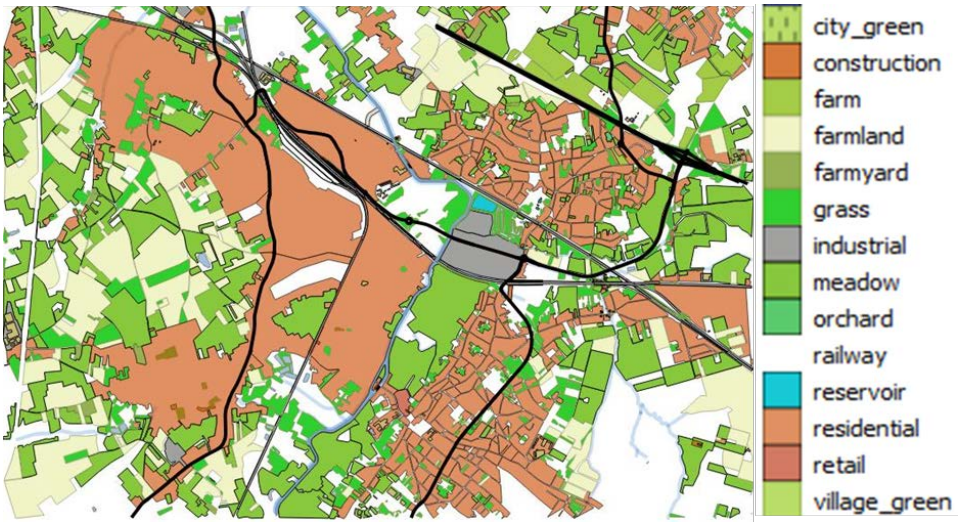

Figure 7 map with the functions of land in the Denderleeuw. (Oorschot, 2017)

Figure 8 urban area around the Dender River. (Oorschot, 2017)

*Figure 9 the embankment of the Dender River.**Invalid source specified.***

If the Dender River overflows, there are a couple vulnerable spots nearby, for example the railway/train station, fire department, police and a fuel station. These spots are crucial for the city so these have to be relocated with some better spatial planning or the buildings have to be adapted against flooding's.

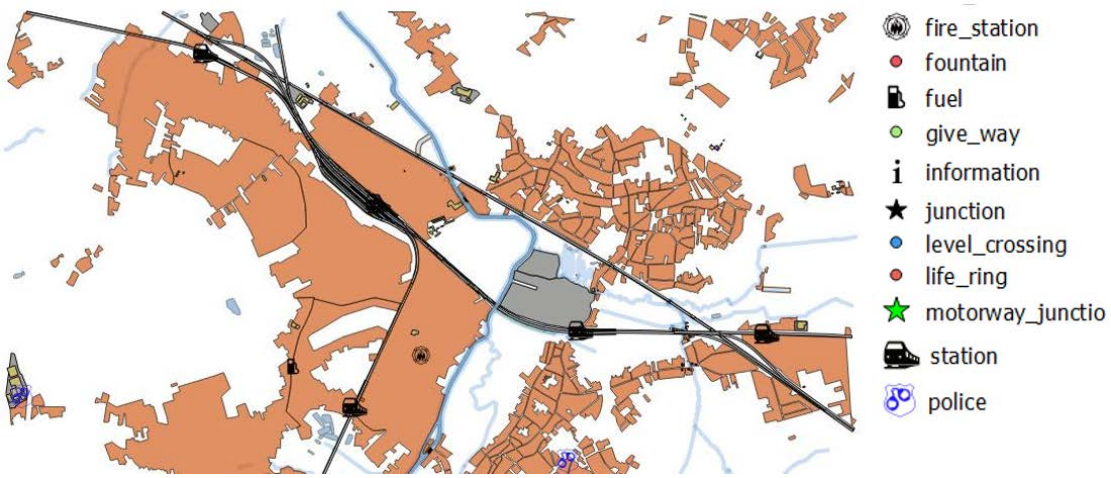

Figure 10 vulnerable spots in and around Denderleeuw. (Oorschot, 2017)

This map shows the third layer of multi-layer safety of the municipality Denderleeuw, the main roads are included for fast evacuation, but also the railroad. There are also spots as a fuel station and a link to the highway. This might be necessary when there is in need of emergency. The roads that make evacuation possible could be improved and people need to know about the risks to reach a better prepared Denderleeuw.

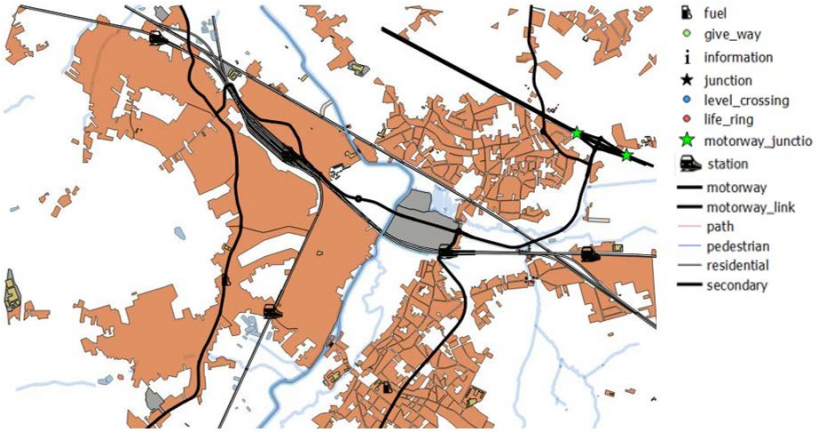

Figure 11: third layer the evacuation routes and possibilities. (Oorschot, 2017)

5. Discussion

5.1 Discussion of results

In the previous chapter, Results, we used the program QGIS to make a number of GIS maps. These maps show the area of the municipality of Denderleeuw, as well as the surrounding area. In these maps, it is clearly shown what the area consists of, but also these maps show the current possible evacuation routes in case the river Dender will flood again. On these maps it can be seen that there are no major evacuation ways from and to the hospital and police station, this makes the response time significantly higher. Looking at these maps, it can also be concluded that most, if not all available space around the Dender river, is occupied with mainly urban land uses. It is also clear to see that the hospital and police station are located relatively far away from the actual city of Denderleeuw, as just stated, this can cause some problems, however, these critical services are located on higher ground than the city of Denderleeuw, which makes it a more safe spot in the same time.

Of course the results could be much broader, however some restrictions that occurred during the project made it hard or impossible to further research certain aspects. The first restriction was the lack of time to get in contact with some other important people or institutions. For example, we also wanted to interview the head of the fire department of Denderleeuw, the environmental official, and the emergency planning official. Then there was another restriction in the interviewing process that we as a group could do nothing about, this was the fact that another very important person for our research, Barbara Tempels, was very busy finishing her report for her PHD at the time of our research. Because of this, Barbara Tempels didn't have time to get in contact with us until the 21st of December. Finally, this however is not a real restriction, we were also advised by Hannelore Mees to focus our research on the municipality of Ninove instead of on Denderleeuw. Hannelore suggested this because out of her own experience, she told us that Ninove was a more cooperative municipality towards water/flood related research. Furthermore, Ninove is a very similar municipality compared to Denderleeuw, and the flood of 2010 had been experienced in the same way and had a similar effect on the city compared to Denderleeuw. After some discussing and consideration between the group members, we decided not to change plans. The main reason for this was that we already had put a significant amount of time into the municipality of Denderleeuw.

The results of our research could have also be compared in a more broad way to the MLS in the Netherlands, however this has not been done because of a lack of time, and because we think for this report the current comparison is sufficient. The case study of Denderleeuw can also be compared to every other EU city in similar situation as Denderleeuw (located to a river, risk of flooding, possibilities to improve the MLS), this has not been done simply because it would've taken a huge amount of time, and wasn't part of the assignment.

6. Conclusions and recommendations

6.1 Conclusions

The information in the theoretical framework gave some clear answers to the main problems that occurred during and days after the flood of 2010. Weak spots in the dikes, no clearance about the evacuation plan and poor coordination's were the biggest issues for the municipality of Denderleeuw. The emergency official was not focused on disaster management and was not able to coordinate the evacuation. Also due to the cropped embankments protection from the river resulted in a disaster for the city and its surroundings.
After the flooding of 2010 specific measures were taken to prevent future disasters. Measures like dreading which could prevent such big disasters, making more way for water in the river, should prevent the high-water level which occurred during the flooding. Studies and research on weak links in the dike could improve the knowing of current situation of the river protection. The Specific Emergency and Intervention Plan which is assigned to the emergency planning official, this would result into an improvement of the crisis management for the river Dender.

6.2 Recommendations

Lessons should be learned from the disaster that occurred in 2010. The municipality needs to improve its view on the disaster management. A clean plan of approach toward hazardous situations that could occur needs to be present. Clear leadership and corporation towards the inhabitants are the key points that need to be improved.
Local governments should improve their communication with each other and with its inhabitants. The Flemish and Wallonian governments should improve their corporation, both regions are struggling with water issues. Learning from past mistakes and giving each other advise should improve knowledge about solutions.

The inhabitants of the municipality should be informed about forecasts of hazardous situations. If the inhabitants are informed well they could adapt themselves to the possible disaster. Raising awareness is important and should be continues. Sharing folders, information on the internet and meetings should improve the knowledge of the inhabitants. Early warning texts can give a clear picture to the people about the situation that could occur in the next few days.

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7. Appendices

7.1 Interview Hannelore Mees

Akkoord met gesprek opnemen

N is Nikki Leyte, H is Hannelore Mees

N: opdracht uitleggen MLS België, wat we al gedaan hebben (bronnen opzoeken etc.)

H: waarom we Dender hebben gekozen? Waarom op paraatheid laag 3?

N: veel te verbeteren en mogelijkheden.

H: evalueren wat is er sinds toen gebeurt en daarheen kijken? Wat voor soort onderzoek?

N: meeste deskresearch eventueel naar dender en het contact uit Nederland.

H: MLS is anders in België dan in Nederland wij hebben namelijk paraatheid, preventie en protectie.

H: vraagt zich af of we met deskresearch wel zover zullen komen in de gemeente Denderleeuw

N: welke contacten heeft u daar die wij kunnen aanspreken?

H: Jazeker zoals Brandweer etc. ze wil deze samen contacteren omdat ze via frames ermee gaan werken en het niet handig is om met die mensen meerdere keren via verschillende namen contact op te nemen. Ze maakt hier een lijstje van.

N: wij zijn eind januari klaar en jullie beginnen pas veel later.

H: geef aan dat jullie bij ons horen en dan komt dat goed.

N: waar focussen jullie op?

H: voor heel Vlaanderen worden overstromingsrisico plannen opgemaakt. Daar zijn ze mee bezig en de denderbekken dus onze locatie ook word als pilot project gebruikt samen met waterwegen en …… hun RWS. Samen met burgers om maatregelen te nemen omdat deze dat tot op heden nog nooit hebben gedaan. In Aalst Denderleeuw en Ninove samen met deze mensen actieplannen opmaken. Zoals schotten voor de deuren, afsluitklep in wc maar ook WhatsApp groepen via allermeren.

H: overheid doet alles in België wordt er gedacht en dit moet veranderen naar de burgers zelf. Ze aanpak moet gewijzigd worden. Omwille van klimaat verandering en slechte ruimtelijke ordening.

N: hier gaan ze nu al mee bezig of na jullie onderzoek?

H: frames loopt tot 2019 hoopt op laatste jaar een uitvoering van het programma.

H: meerdere mensen moeten nog aangenomen worden om aan het frames project te werken.

N: hoe nemen jullie contact op met burgers?

H: Burgers bij elkaar zitten en die gaan bedenken wat de grootste problemen zijn in hun buurten/wijken en hierop worden passende oplossingen gezocht.

Voor jullie kan het interessant zijn om een eerste evaluatie te maken over hoe het ervoor staat.

N: Hopen dat de man van Nederlandse meerlaagsveiligheid goede info kan geven.

H: Overstromingsrisico in NL en BE zijn verschillende aard, BE overstroomd heel vaak, met kleine schades en heel zelden een dode. Schatting is 50 miljoen euro schade per jaar in Vlaanderen door overstroming.

N: Daar moet een hoop op bespaard kunnen worden dan.

N: Is er een groot verschil tussen Vlaanderen en Wallonië?

H: De communicatie tussen burgers en overheden is anders in Wallonië. In de Denderbekken is er een hele slechte communicatie en bewoners voelen zich in de steek gelaten. In Wallonië verloopt de communicatie beter. Of het beter beschermt is dan Vlaanderen is niet zeker.

H: Het is de bedoeling dat elke gemeente een noodplan heeft op het moment dat er een overstroming plaatsvind. Noodplanning die is federaal geregeld, niet beter in Wallonië dan in Vlaanderen. Er is gewoon een groot gebrek aan middelen (materiaal en manschappen).

N: Hebben veel waar we mee aan de slag kunnen bedankt voor het gesprek.

H: Ik ga documenten doorsturen en een lijstje opzetten en doorsturen naar jullie.

7.2 Research Proposal

research proposal Belgium (1).docx

7.3 Individual logs

7.3.1 Log Nikki Leyte

Personal Research Log of Nikki Leyte				
When?	*What?*	*How?*	*Additional space*	*Time*
5-9 tm 11-9	First lecture with egg experiment		No induvidual or group homerwork	
12-9 tm 19-9	Second lecture, groups are divided		Group Belgium	
19-9 tm 25-9	3th lecture, find a relevant articale	1. Problem: 2. Deskresearch 3. Google scholar 4. Read the whole artical 5. Summerized the artical 6. Made the rest of the questions for the assignment	Uploaded the artical on moodle and getterd the outcomes of the assignment in a group report	120 min
26-9 tm 2-10	4th lecture, reasearch proposal	Mostly groupwork. My induvidual preparation is search for background information and problem defention for in the proposal	3-10 groupmeeting, not present because of 'rijles'	100 min
3-10 tm 9-10	5th lecture, deadline draft research proposal & personal log	Worked on the theoretical framework mostly for the draft	Main sources: Starflood and Evaluatie inventarisatie overstromingen november 2010 Denderbekken	240 min
10-10 tm 16-10	6th lecture, feedback	improved feedback of the problem defenition	Made the problem defention more detailed and used information from the former theoretical framework	300 min
17-10 tm 23-10	7th lecture, guest lecture			100 min
24-10 tm 30-10	Autum break			
31-10 tm 6-11	8th lecture, group presentations research proposal			60 min
7-11 tm 13-11	Exam week			
14-11 tm 20-11	Excursion week			
21-11 tm 27-11	9th lecture, emailed the contact persons	Emailed our contact persons Hannelore		120 min

		Mees and Barbera Tempels		
28-11 tm 4-12	10th lecture, skype interview with Hannelore Mees	Prepared the skype conversation and realisted it.	After the skype interview had more mail contact	400 min
5-12 tm 11-12	11th lecture, GIS lecture	Working on the introduction and made the upset of the report	Mail contact with Hannelore Mees and other contacts	350 min
12-12 tm 18-12	12th lecture, GIS Lecture	Diveded the last work	Mail contact with Hannelore Mees and other contacts	300 min
19-12 tm 25-12	13th lecture,	Finished the last parts for the draft and put al the subjects togheter in the report	Deadline research draft	360 min
26-12 tm 1-1	Christmas break			
2-1 tm 8-1	Christmas break			
9-1 tm 15-1	14th lecture, Feedback on draft report	improved feedback on our own parts and re-diveded the theoretical framework	Re-diveded the theoretical framework because of struggels with a teammember	350 min
16-1 tm 22-1	15th lecture, Final presentation	Practiceted the presentation and made the conceptual model. Also the gettering of the report and the layout	Deadline final report	500 min

7.3.2 Log Strahinja Millenkovic

Strahinja Milenkovic – Personal research log				
Date	**Activity**	**Personal input**	**Difficulties**	**Time scheme**
Week 37	Introduction to the course			90 minutes
Week 38	Dividing groups via the learn.hz.nl site	Made power point and discussed about the topic with the group member	Finding viable sources	90 minutes
Week 38	Started gathering information for the research	Found a viable PDF script about the topic		180 minutes
Week 40	Working on the proposal and improving feedback	Gathering information about the research question and processing the information into the document		240 minutes
Week 41	Presentation about the proposal	Made an presentation with Jan and informed the class	Discussing what to present	130 minutes
Week 43	Discussing about further improvements on the project			120 minutes
Week 44-45	Connecting experts for information about the Dender river area.		Discussing a viable moment for the conversation	120 minutes
Week 47	Improving feedback, Skype call with expert with an expert and gaining more information about detailed information about the area	Recording the skype conversation and improving personal part of the report		180 minutes
Week 48-49	Lessons about GIS		Working with the program	240 minutes
Week 50	Working on report	Finishing the concept report		300 minutes
Week 1	Feedback on the report	Finishing the concept report		180 minutes
Week 1-2	Final presentation	Helping group members with the final presentation	Discussing the information that would be mentioned in class	300 minutes

7.3.3 Log Jan van Oorschot

Date	Activity	Summary of Activity	Knowledge gained	Time scheme
13 september 2016	Decide on project	We choose the project of the Dender River in Belgium.	Basic information gained about the Dender River and the Belgium system.	1,5 hours
19 September 2016	Research source	Find out more about the Dender area and the group work.	Understanding the problem of the Dender River.	2 hours
27 September 2016	I wasn't there this week.			
4 October 2016	Further research	Information about the Dender and improving the feedback		4 hours
11 October 2016	Improving feedback	Further improving the feedback		3 hours
18 October 2016	Presentation and lesson	Presentation of research proposal and lesson Fundter	Resilience	3 hours
1 November 2016	Lesson	Just a normal lesson		2 hours
21 November 2016	Lesson and report	Further with the report, contacting people		3 hours
28 November 2016	Feedback, contact and report work	Contacting people and feedback round. Further with end report	How to implement the results of contact and interview questions	2 hours
8 December 2016	Lesson GIS	Learning about GIS and working on concept report		4 hour
12 December	Lesson GIS	Learning about GIS and working on concept report		5 hour
19 December	Project work	Finishing the concept report		6 hours
10 January	Feedback lesson	Feedback about the concept report		2 hours
14 January	Project work	Improve of the project work		6 hours
16 January	Lesson and project work	Presentation and project work		5 hours
17 January	Project work	Improve of the project work		4 hours
18 January	Project work	Improve of the project work		4 hours

7.3.4 Log Wessel van Pul

Personal Research Log of Wessel van Pul			
When?	*What?*	*How?*	*Additional space*
5-9 until 11-9	1st lecture: Introduction to course, project and egg experiment		no further work to be done
12-9 until 19-9	2nd lecture: dividing of groups, introduction to each project area	Via online selection 'tool' groups are made	Group Belgium
19-9 until 25-9	3rd lecture: finding and uploading a relevant article about selected project area	looking for a relevant article on the internet, most preferrably via Google Scholar. Then read the article and upload it on the Moodle page	
26-9 until 2-10	4th lecture: start working on the reasearch proposal	dividing of the work to be done: I did the 'Problem Formulation' part	3-10 groupmeeting: working on the proposal together
3-10 until 9-10	5th lecture: deadline research proposal & personal log	working on the research proposal and the personal log	Main sources: Starflood and Evaluatie inventarisatie overstromingen november 2010 Denderbekken
10-10 until 16-10	6th lecture: feedback	improved feedback on the 'Theorethical Framework' about the Third Layer	followed the notes of Mr. Buijs to improve the text, and used some other resources
17-10 until 23-10	7th lecture: guest lecture from Mr. Fundter about Resilience and the 4+1 model		
24-10 until 30-10	Autum break		
31-10 until 6-11	8th lecture: group presentations research proposal	presented the (at that time) current developments about the research proposal and got some good feedback	
7-11 until 13-11	Exam week		
14-11 until 20-11	Excursion week		
21-11 until 27-11	9th lecture: emailed the contact persons	Emailed our contact persons: Hannelore Mees from the municipality of Denderleeuw and the University of Gent, and Barbera Tempels	

28-11 until 4-12	10th lecture: interview with Hannelore Mees	group meeting with Mr. Buijs about preparation for the skype meeting with Hannelore Mees, and eventually the final interview with Hannelore Mees	After the skype interview contact has been kept and Hannelore sent us 5 relevant articles we could use
5-12 until 11-12	11th lecture: reading the documents provided by Hannelore	each group member read one article provided by Hannelore, and used this to work on the final report, also the skype interview with Hannelore was typed out	
12-12 until 18-12	12th lecture: working on the final report	dividing of the work to be done for the final report, my part was the conceptual model and the operationalization	I fount the conceptual model very hard to make, I didn't understand how it should be set up and I couldn't find the information to fil it in
19-12 until 25-12	13th lecture: finalizing the final report	working together on the parts that were found to be difficult (like the conceptual model), adding everything together, and checking the grammar and spelling	
26-12 until 8-1	holiday	finalizing final report for final feedback round	
9-1 until 15-1	14th lecture: final feedback possibility	after feedback, feedback was improved and remaining chapters were devided	
16-1 until 22-1	final lesson: presentations	final presentations were given, and the report was finished	after some problems with strahinja, remaining tasks were devided again over the other groupmembers

7.3.5 Log Tom Siekman

Date	Activity	Details	Knowledge gained	Time
13 september 2016	Decide on project	Dender River in Belgium chosen.	Basic information gained about the Dender River and the Belgium system.	1,5 hours
19 September 2016	Research source	Find more info, and specifically the Denderleeuw area	Understanding the problem of the Dender River.	2 hours
27 September 2016	Lesson			
4 October 2016	Further research	Information about the Dender and improving the feedback		2 hours
11 October 2016	Improving feedback	Further improving the feedback		3 hours
18 October 2016	Presentation and lesson	Presentation of research proposal and lesson	Resilience	3 hours
1 November 2016	Lesson	Normal lesson		2 hours
21 November 2016	Lesson and report	Further with the report, contacting people		3 hours
28 November 2016	Feedback, contact and report work		How to implement the results of contact and interview questions	2 hours
8 December 2016	Lesson GIS	Learning about GIS and working on concept report		4 hours
10 December	Practice GIS	Watch youtube videos with instructions on making maps on GIS, and practice with the Dender area		2 hours
12 December	Lesson GIS	Learning about GIS and working on concept report		4 hours
19 December	Project work	Finishing section 3		5 hours
10 January 2017	Read comments from Mr. Jean Marie			.5 hour
11 January	Project work	Finish editing section 3, and personal log	Editing from feedback	2 hours
18 January	Meeting	Meet with Mr. Buis and discuss problems with the final product	last minute problem solving	1 hour
20 January	Project work	Finish final edits		2 hours