Assessment of the number of homeless people and the value of damaged residential buildings effected by the firework disaster in Enschede, 2000

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Contents

1. Introduction

1.1. Title section

This is Body Text style. Use this for the body text!

Guidelines for the Introduction.

- *The introduction sets the context for the report and logically leads the reader from background and setting to the aim and the objectives.*
- *Simply 'copy paste' the introduction in the case study description that was provided to you is not sufficient. You need to elaborate and rephrase the information given to you and preferably find a few additional sources of information yourself.*
- *However, keep it simple and concise. Only present what is absolutely necessary for a reader to understand the '**WHY**' of this report.*

- *The Introduction should **minimally** contain a section on:*
  - *the background/setting,*
  - *the aim and objectives.*

A fireworks disaster occurred in Enschede on 13 May, 2000 ("Explosion of a fireworks warehouse Enschede The Netherlands THE FACILITIES INVOLVED," 2000). The fire started in a warehouse. The warehouse was located in the residential district of Roombeck. The warehouse was operated by a company for storing and repackaging the fireworks ("Enschede Fireworksdisater 13 mei 2000 - Visit Enschede," n.d.). On the day of accident, the blast broke out in the central warehouse. The warehouse stored approximately 900 kg of fireworks (ADPC, 2011). The blaze spread to two full fireworks containers. The two containers were placed illegally without any authorization. A chain reaction led to an explosion of nearly 180 tons of fireworks ("Enschede Fireworksdisater 13 mei 2000 - Visit Enschede," n.d.). The consequence was very severe. 23 people were killed. A total of 974 individuals were injured ("Explosion of a fireworks warehouse Enschede The Netherlands," 2000). 50 people among them were severely injured. Property damage was estimated at 500 million euros. Buildings in the accident zone were destroyed or damaged.

Current studies have analysed this accident from different angles. For example, what the reason was to cause the initial blast, how the accident happened, whether the rescue action was efficient or not, what the responsibilities that relevant departments should take, and how to prevent the similar disaster happening in the future ("Explosion of a fireworks warehouse Enschede The Netherlands," 2000).

However, the analysis on the effect of this accident is limited and incomplete. One of the missing part is the evaluation of how the firework disaster influenced the surviving residents and their living places.

It is necessary to analyse the residential building damage and to analyse the amount of people who suffered from this. Because, it illustrates how severe this accident was, economically and socially. The strategy for rebuilding the effected zone will be more efficient. Firstly, from an economic point of view, the government and companies can use it for rebuilding the houses, making a budget plan and distributing the allowance to the victims. Secondly, concerning the social impact, the homeless residents will feel sorrowful. The society should take special attention and care on them.

The purpose of this study is to analyse the residential building damage and the amount of people who suffered from this. This objective consists of two sub-objectives:

1) what is the value of residential buildings which were damaged?
2) how many people are temporarily or permanently homeless?
Spatial analysis and numerical analysis are both included in these two research questions

2. Method

2.1. Title section

This is Body Text style. Use this for the body text.

Guidelines for chapter 2.

- *In this chapter, you describe the method you used.*
- *Divide the chapter into numbered and headed (sub)sections, in a logical order (for instance **according to the sequence in your flowchart**), this will enhance the coherence of your report and allow the reader to readily follow the subsequent steps in your procedure.*
- *Once more, keep it simple and concise. Only present what is necessary for a reader to understand the '**HOW**' of this report.*

- *This chapter **has to contain a flowchart**. The setup of the flowchart should be:*
  - *systematic*
  - *logical*
  - *with correct use of symbols*
  - ***and lead to results which meet the objectives**.*

1) Assumption

The following assumptions are applied in this case study.

-Spatial Boundary: The effected residential buildings are all located in the study area.

-Temporal Boundary: Based on the available data, the two observation times are:

Observation before the firework disaster: March 30th, 1998

Observation after the firework disaster: May or after May, 2000.

The period between these two observations is 2 years. It is assumed that, during these 2 years, the firework accident is the only event that influenced the properties and locations of the residential buildings. The buildings which existed in March 30th, 1998 remains unchanged until the day that the firework accident happened.

-the level of residential building damage is circularly distributed.

-the level of damage is estimated as the following way.

a. Within 200 meter from the blast: Total destruction of the living units

b. Between 200 - 250 meter: A damage of 50% of the value. The houses become uninhabitable for several months.

c. Between 250-300 meter: A damage of 20% of the value of the houses. The houses are still inhabitable

d. Beyond 300 meter: There is no damage at all.

- "permanently homeless people" means people who lived in the residential buildings with 100% damage.
- "temporally homeless people" means people who lived in the residential buildings with less than 100% damage.
- In one residential polygon, the value of all the living units are the same.
- In one residential polygon, the number of people in any living units are the same.
- The definition of living unit is based on the following principle: If the attribute table of "interpretation_landuse" provides the number of living units in a polygon, then this number is used for digitizing directly. (It is assumed that this number is reliable and correct.) Otherwise, the living unit is defined as:

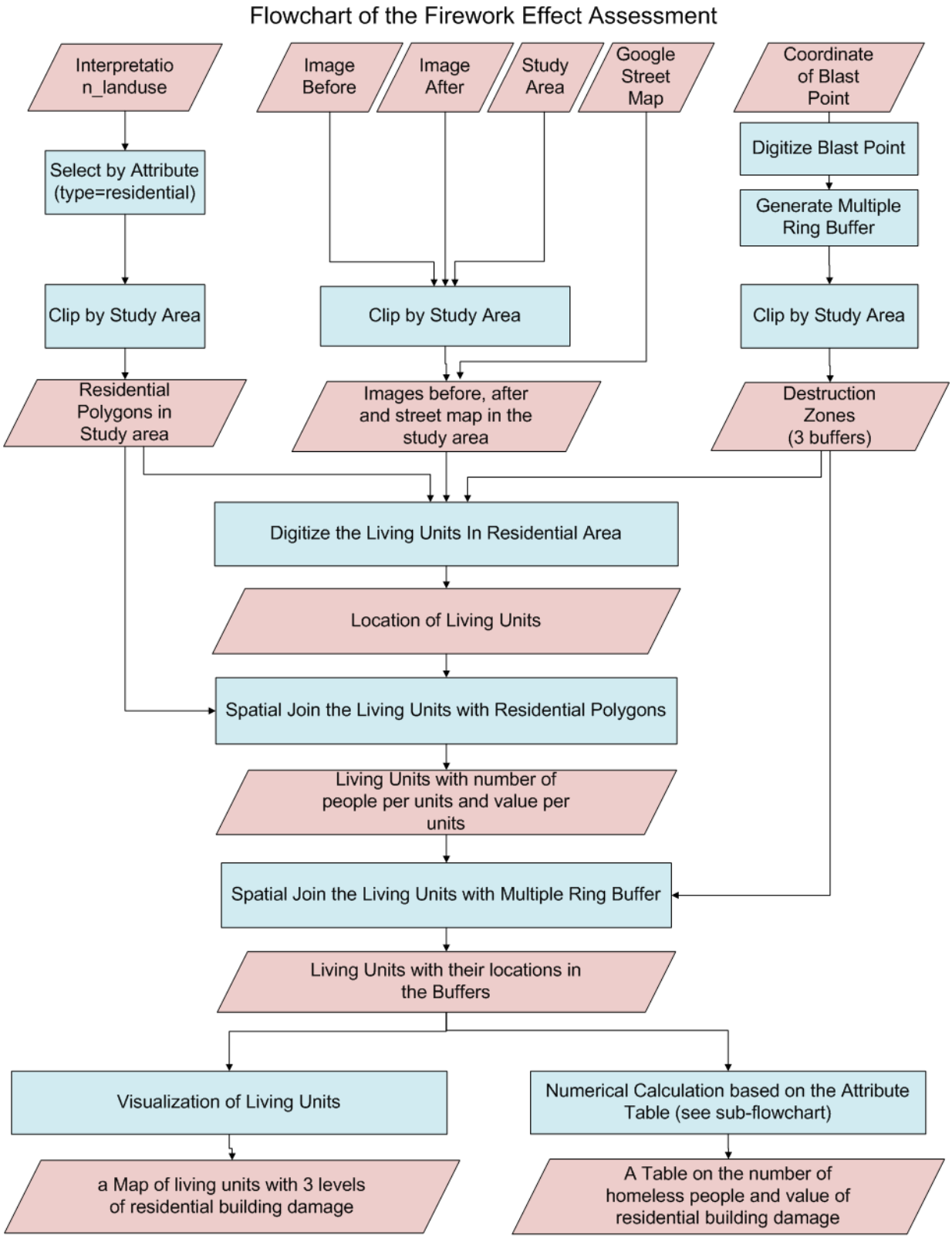
  -one chimney means one living unit

-one front door means one living unit
-one backyard means one living unit
-one kitchen block means two living unit

2) Hypothesis: If this assessment succeeds, then it will provide relatively accurate information on how many people are homeless and how much value was lost due to the residential building damage.

3) Data Description and Data Selection
The description of the data is shown in appendix1. Some data are collected but not used in this study. These data are mainly in the “Top10_34fn2.mdb”. Except for the feature class “buildings”, all the other data (such as water areas, roads, railways) in this mdb are irrelevant to this case. The feature class “buildings” is useful to some extent but limited.

Figure 1 flow chart the firework effect assessment



Note: The input and (intermediate) output data are symbolized by red parallelograms. The processes are symbolized by blue rectangles. The detailed calculation process can be seen in the sub-flowchart: "Process of Numerical Calculation" .

4) Data Integration and Pre-Processing
The goal of this step is to make a subset of the information that I plan to use. Initially, it is necessary to convert the projections of all the raster and vector data into a common projection.

After that, the process is divided into three parts. They are all shown in figure1.
Process1) In the "Interpretation_landuse", select only the residential buildings. Then clip them by the study area. The result is a new feature class with residential polygons. The residential polygons provide both spatial and numerical information for further assessment. Each residential polygon has an attribute on the number of people in the living unit in this polygon and the value of the living unit in this polygon.

Process2) A group of images are integrated together. They serve for a common goal: visually detecting the living unit and visually assessing how severe the damage was. These images are: Imagery before, Imagery after, study area and google street map. In the Imagery after, all the digital aerial photographs are used. In the Imagery before, only two digital aerial photographs are useful. The image "po_7966res" is not useful. Because it is impossible to visually detect where a building is located or whether there is a living unit or not. Its resolution is 1 meter, which is very low. Since Imagery before and Imagery after have different spatial extent, it is necessary to clip them by the study area. Google street map cannot be clipped. But we can narrow down the view side by visually checking the study area.

Process3) This process is to generate a map of destruction. This process is suggested to be generated before digitizing (before the next step). Because the destruction buffer might improve the accuracy analysis during digitizing. Building the destruction map starts from digitizing the blast point by the given coordinates. After this, multiple ring buffers are made. The distances of buffers are set according to the damage estimation (see the assumption). Finally, clip the buffer by study area.

5) Digitizing the living unit
The goal is to find out where and how many living units existed before the firework disaster. When one living unit is detected, a point should be placed. Using a point is an effective and efficient way of digitizing. Because, firstly, a point gives a precise location. It is easy to relate its location with other spatial features such as buffers. Secondly, it is time-consuming to digitize a living unit by drawing a polygon.

There are some rules of digitizing the living unit. a) The definition of a living unit has been described in the assumption. It solves the easiest problem in detecting a living unit. b) Digitizing process is at least based on the two before-photographs. The photographs were viewed by different sun angles. When a building is dark or in a shadow in one photograph, it is better to detect it in the other photograph. c) When a building looks blur in both of the before images, it is suggested to detect the living unit in the after images. Because the spatial resolution of after image (0.12 meter) is much higher than the before images (0.24 meter). d) Google street map is very helpful in detecting the living unit. Because the before images and after images are viewed from top of the building. Google Street map visualize the building from its side. The provided information is much more detailed. e) If a building is located on the boundary of a buffer ring (one part of the building is severely damaged and the other part is less severely damaged, according to the buffer), then the damage level of this building depends on: where is the most part (>50% volume) of the building locate. If most part of the building is located in the severer zone, then all its living units are counted as damaged in a severe degree. Otherwise, they are considered as in a less severe degree.

6) Spatial join the living units with residential polygons. The purpose is to join the two attribute tables. After processing, each of the digitized living unit will have two important attributes: the number of people who lived in this living unit and the value of this living unit.
7) Spatial join the living units with multiple ring buffer. The purpose is to join the two attribute tables. After processing, each of the digitized living unit will have two important attributes: the code of the buffer zone

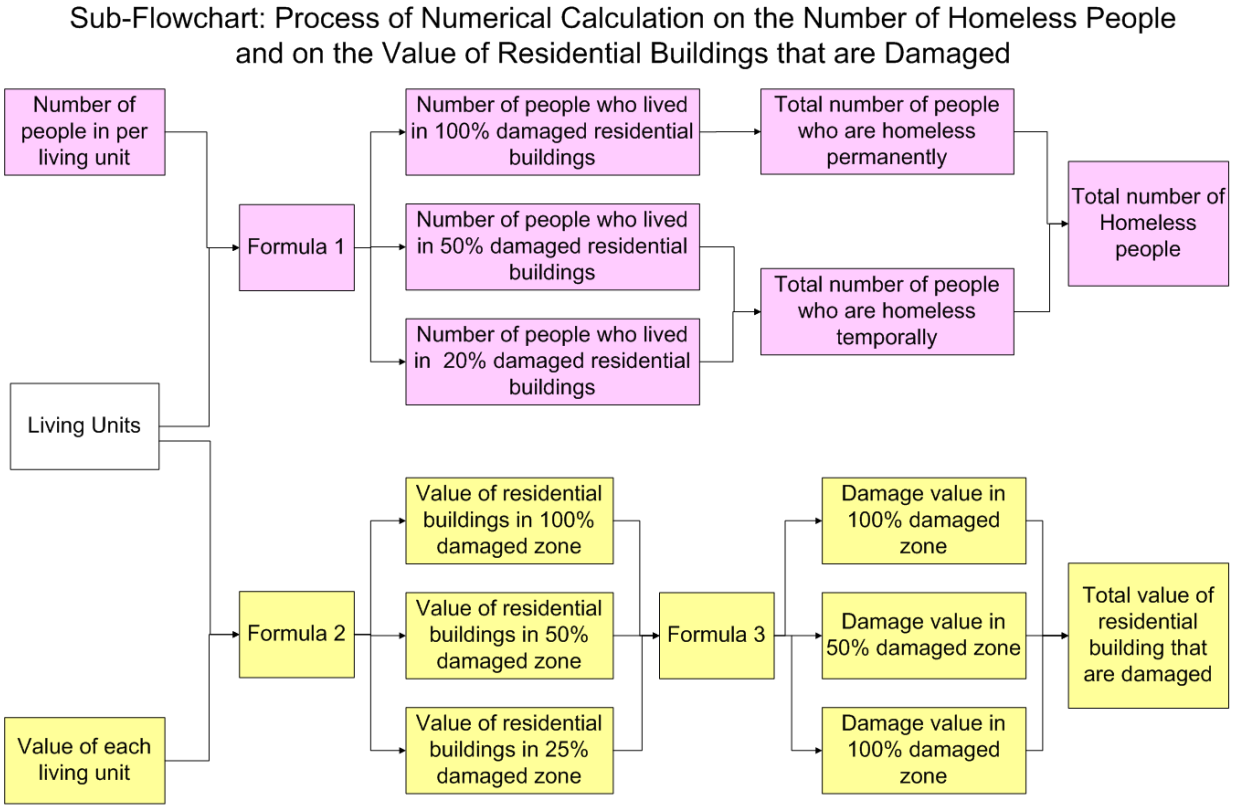
(damaged zone) that this living unit is located and the distance attribute of the buffer. It means that this living unit is suffered from the building damage by this proportion.

8) Visualization the result. It is necessary to visualize the living unit and symbolize them according to the destruction map. Because visualization is an intuitive presentation. Readers would quickly understand where the severity level is high and where is low. The final output is a map.

9) Numerical calculation. The process is shown in the Figure 2, the sub-flowchart "Process of Numerical Calculation on the Number of Homeless People and on the Value of Residential Buildings that are Damaged". It is a mathematical model. The core functions in this model are the following 3 formulas. The final output of the calculation is a table.

Formula 1: Number of people who lived in each destruction zone = Σ the number of people in each living unit in this destruction zone
Formula 2: Value of residential buildings in each destruction zone= Σ the value of each living unit in this destruction zone
Formula 3: Damage Value of residential buildings in each destruction zone= Value of residential buildings in each destruction zone * the proportion of destruction

Figure 2



Note: The pink rectangles show the process of calculating the number of homeless people (temporally and permanently). The yellow rectangles show the process of calculating the value of residential buildings that are damaged.

3. Results

3.1. Title section

This is Body text style. Use this for the body text.

Guidelines for chapter 3.

- *In this chapter, you present your results.*
- *Divide the chapter into numbered and headed (sub)sections, in a logical order. You can use the same order as you used in the previous chapter, but this is of course nor necessary as long as you present the results in a coherent way.*
- *Make sure that maps, tables and graphs agree with the description of the results.*
- *Captions of tables and graphs should be **self-explanatory** and clearly describe the content of the table or graph.*
- *All maps have to comply with cartographic rules.*
- *Every map **has to have** a title, a map image, a legend, a scale indicator, a north arrow, information on the projection some bibliographic information and case of a polygon map, all units on the map need to have a code (see section 10.1.6 in the core book).*
- *If the deliverables do not explicitly mention some sort of validation or accuracy assessment, this chapter **has to contain** a (sub)section where you critically reflect on the validity of the results you obtained. You can for instance discuss some limitations of your work.*

Figure 3 shows the map. Figure 4 shows the table.

1) Reflection on the method

Two crucial intermediate steps are: digitizing the living units and digitizing the blast point.

The total number of digitized living unit is 341. This number is reasonable. Because it is close to the data provided by the external sources. “Almost 400 houses were reduced to their foundation. (ADPC, 2011) ”. “In all, 500 homes or businesses were destroyed or sustained considerable damage (Involved, 2009, p. 5) (“Enschede Fireworksdisaster 13 mei 2000 - Visit Enschede,” n.d.)”. But the external references are not fully comparable with the detection in this case, since their spatial extent might be different. Additionally, the assessment methods of external references are unknown.

The spatial distribution of the digitized living unit is questionable to some extent.

It is also important to make sure the blast point is digitized in the correct location. When digitizing it, I kept zooming in until the coordinate is exactly the same as the provided coordinate. After digitizing this point, I visually compared the blast point in the before imagery and after imagery. The blast point is indeed located on a place where all the buildings are destructed to ground. Finally, a professional study on the firework (Involved, 2009, p. 4) provides detailed location of the blast point. I used it for checking my digitizing as well.

2) Reflection on the calculation

The calculation fully follow the mathematical model described in the methodology.

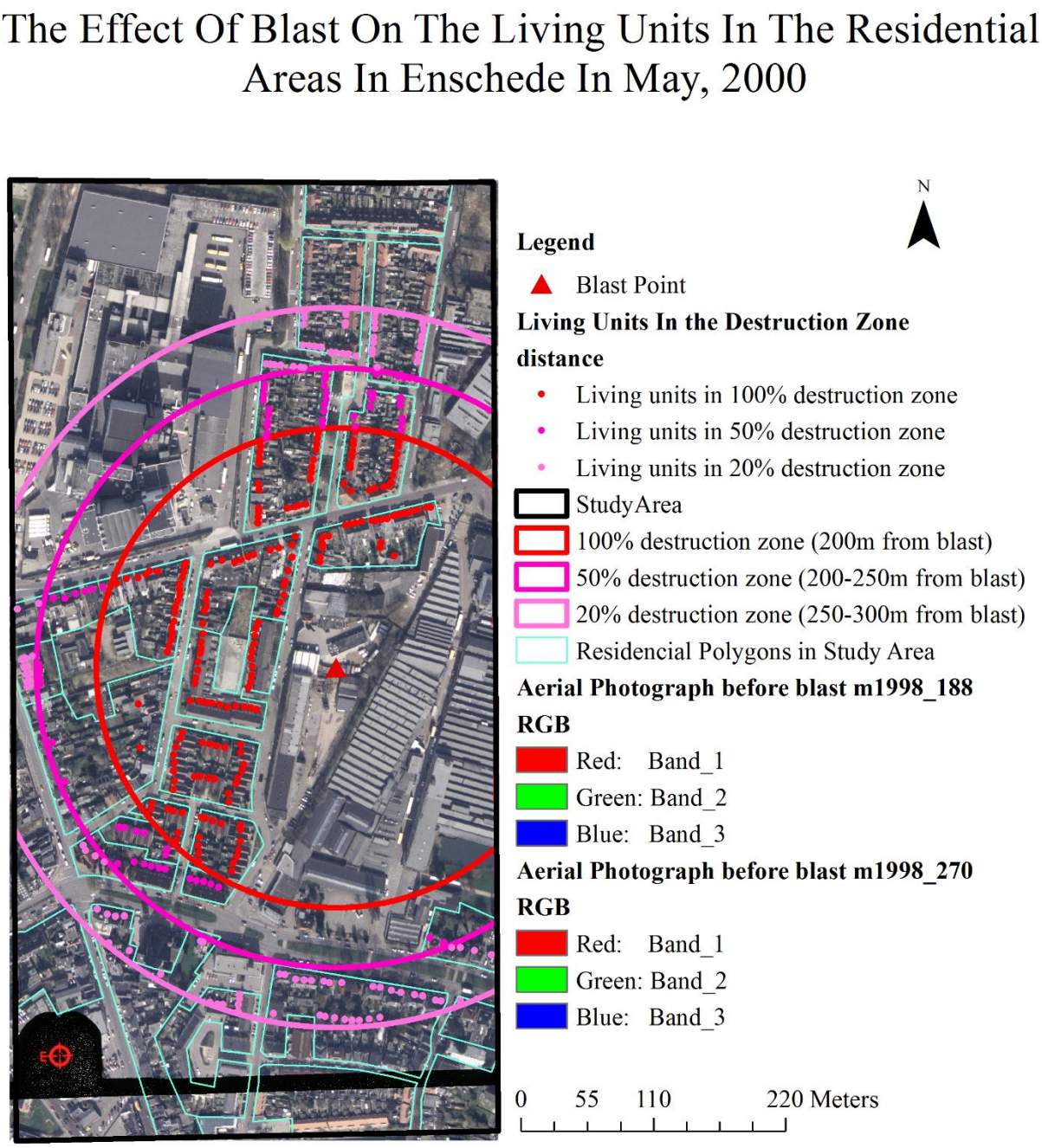
The table shows that 661.5 people are suffered form 100% destroyed residential buildings. The number of homeless people in 50% and 20% destroyed residential buildings are 233.9 and 344, respectively. Based on the assumption, 661.5 people is interpreted as the number of permanently homeless people. 577.9, the sum of people in 50% and 20% is interpreted as temporarily homeless people. After the calculation, all of these numbers are rounded up. Because, in the real word, the number of people should be an integer. In total, 1240 people are homeless permanently or temporarily. This number is also reasonable. According to ("Enschede Fireworksdisater 13 mei 2000 - Visit Enschede," n.d.), 1250 people are homeless. However, the reliability of the external references need to be assessed.

The total value of residential building damage is 31342500 euros. It is difficult to assess its accuracy. Because too little information is provided in this case.

3) Limitation

1. Some buildings are across the border of buffer. I still count the living unit inside the buffer
2. Totally damaged area are classified into 250 meters, according to the material. But this is not true. My calculation is based on material. So does not totally match the reality.
3. Residential area does not totally match the real buildings or houses
4. The amount of living units in the apartments is questionable. Because google street map shows very differently from the data provided by "interpretation_landuse".
5. The year of google street map (about 2010) is different from the year of aerial photographs (1998). So, when there are some buildings that I don't know living unit, I also can not find them in street map, I have to guess the amount of living unit. This causes inaccuracy.
6. Comparison: before and after, For some houses, the degree of damage is not the same as the destruction estimation map which is the buffers.
7. The low resolution of the input data, especially image before, has a negative impact on digitizing the location of the living units. Google street map does not give all the details of living units.
8. The acquisition date of imagery before is two years earlier than the time that firework happened. The acquisition date of google street map is 10 years after the time that firework happened. During these 12 years, it is possible that the residential buildings has some changes which are not due to the firework disaster.
9. The spatial extent is limited in the study area. It is unknown whether the residential buildings beyond the study area also got severely destroyed.
10. All the assumptions in the methodology is not totally the same as reality.

Figure 3 map of the effect of firework accident



Projected coordinate system: Amersfoort_ITC_Coordinate_Frame_Double_Stereographic
Geographic coordinate system: GCS_Amsfoort_ITC_Coordinate_Frame
Projection: Double_Stereographic

Figure 4 table

Table of numerical calculation on the number of homeless people and the value of residential buildings that are damaged

	Assessment of homeless people			Assessment of residential building value	
	Number of homeless people (Before rounding up)		Number of homeless people (After rounding up)	Value of residential buildings (euros)	Damaged value of residential buildings (euros)
In 100% destruction of residential building area	661.50		662	24065000.00	24065000.00
In 50% destruction of residential building area	233.90		234	8665000.00	4332500.00
In 20% destruction of residential building area	344.00		344	14725000.00	2945000.00
Subtotal	Permanently homeless people	661.50	662		
	Temporally homeless people	577.90	578		
Total	1239.40		1240	47455000.00	31342500.00

Note: In the table, the pink cells show the results of assessing the number of homeless people. The yellow cells show the results of assessing the value of residential buildings that are damaged. The numbers in the dark pink cell and in the dark yellow cell are the final results.

4. Conclusions

This is Body text style. Use this for the body text.

Guidelines for chapter 4.

- *In this chapter, you provide a concise and logical summing up of concluding statements.*
- *They give an overview of the **key findings** in your case study work and their **significance.***
- *The concluding statements show **whether or not the objectives were met**.*
- *In this chapter, you **have to confine** yourself to the work you have done and is described in this report.*
- ***Be specific and precise**. At all times avoid vague language or statements such as: "Remote sensing and GIS are a useful tool for …".Instead, be specific about what **you** conclude from the case study concerning the methods applied as in: "Since post classification change detection, based on supervised image classification captures changes from one discrete class in to another, …etc."*

This assessment reaches the purpose. This assessment has found the number of living units in each destruction zone, the number of permanently homeless people, the number of temporarily homeless people and the value of residential buildings that are damaged.

The accuracy of this assessment is not high. The assessment of the number of homeless people is relatively high, based on checking with external reference. However the value of the damaged residential buildings could probably have a low accuracy. Because the destruction zone is based on a model, instead of reality. Additionally, it is difficult to detect accurate living unit, due to the limited amount of input data and the low resolution of the images.

The result of this assessment could be very useful to various users. The government and companies can use it for rebuilding the houses, making a budget plan and distributing the allowance to the victims. Insurance companies, lawyers and financial companies can generate useful information from this assessment. However, since the accuracy of this assessment is not very high, and there is a long time between today and May,2000, the actual usage of this assessment might be limited.

5. Answers to questions:

Question1: For the case study: What are the basic elements of the system you are doing your research on? How are they and their interrelationships defined by the goal of the study?
Answer1:
The basic elements are: the residents, the firework accident, the industries which committed the disaster, the government and the companies for rebuilding the city. The residents need life safety and good quality of living

environment. The industries provide jobs to residents and they contribute to the economics of the city. When industries ignore the potential risks, an accident could happen. The accident will have a negative effect on the residents. The life, health, and living conditions of the residents will be influenced. The industries might have to be closed. The GDP of this city will lose contribution from this industry. Homeless residents will increase the burden of the city, which is a negative impact on the city. Government and other relevant departments should provide them financial care, health care and mental care. This is why it is necessary to do this case study.

Question 2: For the case study: What is the purpose (i.e. what are the prospective uses) and who would be the users and stakeholders of the resulting geoinformation product under study? How would you obtain optimal usability of this geoinformation product / tool?

Answer 2:

The purpose of this study is to answer the following two research questions:
1) what is the value of residential buildings which were damaged?
2) how many people are temporarily or permanently homeless?

This study can be used by the following users.
-Government: they need to make a strategy on rebuilding the houses destroyed by the accidence. The 100% destruction zone will draw more attention to the government.
-Financial sponsors and financial department: they need to make a budget plan on which buildings need how many budget.
-lawyers: they need can use this assessment to prosecute the criminal
-Insurance company: they need to provide compensation to the homeless residences.
-House-building company: they need to know which houses need to be totally rebuilt and which houses need to be repaired.
-Companies and department in solving air pollution: they can analyse which areas are likely to contain more harmful particles than the other area.
-Social workers: they can provide some mental care to the homeless residences.
The optimal usability depends on the purpose of usage: who wants to use the product for what purpose. Different users might have different emphasis on the assessment.

Stakeholders: All the data providers are the stake holders. For instance, the government. If the value of each living unit and the number of people in each living unit is correct, then the assessment will be more accurate. If the spatial resolution of aerial photography is higher than the current one, then the assessment will also be more accurate. It would be nice to have some extra data on the location of living unit.

Question 3: Which data is needed within the SDI environment of your information system? What challenges and limitations do you face in the process of data integration? You could think of issues related to scale and resolution, projection, timing and thematic content, as well as data formats. If relevant, which method of change detection or integration of multi-temporal data is the most appropriate for your application?

Answer 3:

In the SDI environment, a city is divided into several layers. Data contains the interpretation_landuse, the blast point, the imagery_before and imagery_after. They all can be used, maintained and edited. GeoIf the frequency of source is updated frequently, then it will hel. If there are more risk information, then the analysis will be… Challenge

Data integration in this case includes: a) converting different projections into a common project. b) mismatching in time. The time of google street maps is 10 year later than the imagery after. When they display different objects in the same location, it is not accurate to detect living units in this way. c) mismatching in resolution:

high resolution in after imagery and low resolution in before imagery. d) merging raster (aerial photos) and vector data (residential polygons).

Method of change detection in this case is visual assessment. I visually compare the imagery before and the imagery after, when digitizing the living unit. Google street map also helps the visual assessment. However, the available data is limited. I have not been to those living units. The image resolution is low. Therefore, errors might occur in the visual assessment.

References

This is Body text style. Use this for the body text.

Guidelines for references.

- *This section lists the sources of information sources that you refer to in the text of the report. This includes books, journal articles, lecture notes, and URLs of websites.*
- ***You are required to include at least:***
  - *one ISI journal paper: original research or review*
  - *one book or e-book; or a chapter of one of these*
  - *one reliable web page (not a digital version of a journal paper or book) – this must include the access date.*
- *Each citation in the text must appear in this list and each reference in this list must appear in the text.*
- *You must use a consistent forma(**APA-6th style**), with enough information for the reader to locate the original source.*

Example:

1) *Quintero, R., Guzman, G., Menchaca-Mendez, R., Torres, M., & Moreno-Ibarra, M. (2012). An ontology-driven approach for the extraction and description of geographic objects contained in raster spatial data. Expert Systems with Applications, 39(10), 9008-9020. doi: 10.1016/j.eswa.2012.02.033*

2) *Thenkabail, P. S., Lyon, J. G., & Huete, A. (2012). Hyperspectral remote sensing of vegetation : e-book. Boca Raton: CRC.*

3) *Ngene, S. M., Skidmore, A. K., van Gils, H. A. M. J., Prins, H. H. T., Toxopeus, A. G., & Douglas-Hamilton, I. (2012). Walk or stride? a question for roaming herds of elephants in Marsabit, protected area. In M. Aranovich & O. Dufresne (Eds.), Elephants : ecology, behavior and conservation (pp. 173-192). New York: Nova publishers.*

4) *Katz, R. (2011) Extremes Toolkit. Retrieved July 20, 2012, from http://www.assessment.ucar.edu/toolkit/*

Appendix 1. Title

This is Body text style. Use this for the body text.

Guidelines for chapter 4.

- *You can place any further material that is essential for a full understanding of your report but as such not required by a causal reader in a series of* ***numbered appendices****.*
- *Make sure that all appendices you list here are referred to in the main text of the report.*

Example:
Appendix 1. Data
In this appendix you can list for instance all remote sensing data and their specifications you used .

Appendix 1. Data Description

Data Type	Image name	Spatial Resolution	Acquisition Date	
Land use	Interpretation_landuse		Interview data after the disaster	
Imagery Before	m1998_188 (digital aerial photographs)	0.24 meter	30-3-1998	Sun angles are different
	m1998_270 (digital aerial photographs)	0.24 meter	30-3-1998	
	po_7966res	Pan: 1 meter, b,g,r,nir: 4 m. Pan: 1 meter, b,g,r,nir: 4 m.	3-4-2000	Not geo referenced. Resampled to 1m image: b1, blue; b2, green; b3 red; b4 NIR; b5 pan.
Imagery After (digital aerial photographs)	Ens 7107 cor	0.12 meter	May 2000 (After May)	
	Ens 7108 wcor	0.12 meters	May 2000 (After May)	
	Ens 7109 wcor	0.12 meters	May 2000 (After May)	
	Ens 7110 wcor	0.12 meters	May 2000 (After May)	
Google Street Map	("Roombeek - Google Maps," n.d.)	Panoramic views from positions along streets	Around 2010	
Supporting spatial data (Top 10_34fn2 vector maps)	Roads, plots, large houses.		Fieldwork 1995 Publication 1998	

REFFERENCE

ADPC. (2011). Multi Hazard Risk Assessment_Rakhine State.

Enschede Fireworksdisater 13 mei 2000 - Visit Enschede. (n.d.). Retrieved November 29, 2017, from https://visitenschede.nl/know/fireworksdisaster

Explosion of a fireworks warehouse Enschede The Netherlands THE FACILITIES INVOLVED. (2000). Retrieved from https://www.aria.developpement-durable.gouv.fr/wp-content/files_mf/FD_17730enschede2000_ang.pdf

Involved, T. H. E. F. (2009). Explosion of a fireworks warehouse Enschede The Netherlands. *French Sustainable Development Ministry*, (17730), 1–14.

Roombeek - Google Maps. (n.d.). Retrieved November 30, 2017, from https://www.google.nl/maps/place/Roombeek/@52.2330824,6.8898128,15.58z/data=!4m5!3m4!1s0x47b813f38a36ad4d:0x4ba7935a1627d146!8m2!3d52.2285125!4d6.8821704?hl=en