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CASCADING DISASTERS: EARTHQUAKES, FLOODS AND GRONINGEN – A COMMUNITY RESILIENCE ANALYSIS

M.Sc. Thesis

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Abstract

Disaster theory recognizes resilience and community since many years ago. However, this research argues that disasters need to be analysed with a holistic view and not as independent hazards. This research will explore the concept of community resilience to cascading disasters. It aims to understand the relationship of earthquake-flood disasters, and the disaster governance influence at community level. Ultimately, it aims to understand how to operationalize community resilience to disasters. This research critically analyse the most important capacities of community resilience related to earthquakes and flood disasters. First, it will analyse resilience, community, and cascading disaster theory to develop a concept of community resilience to an earthquakes/flood disaster. Using the case study material from Appingedam, Groningen this paper illustrates what the community resilience to earthquake-flood disaster means in practice. Appingedam is a town north of the province very close to Delfzijl located between the Eems and Groningen gas field. The town is subjected to earthquakes, suffering several recorded impacts that are directly linked to the gas extraction. The town is located within the Eemsdelta region, with more than 85% of area in flood risk. The research developed a framework based on community capacity creation and the influence of governance arrangements over the community and its relationship to disasters. The research reveals constant changes in the governance structures affecting the town, showing adaptation and a learning process. However, also displays the lack of empowerment of residents, poor participation of local authorities, low community initiatives and creation of action groups, and weakened infrastructure as challenges yet to be confronted by the community of Appingedam.

Key terms: Cascading disasters, community, disaster resilience, earthquakes, flood risk, governance, Appingedam, Groningen

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1 Introduction

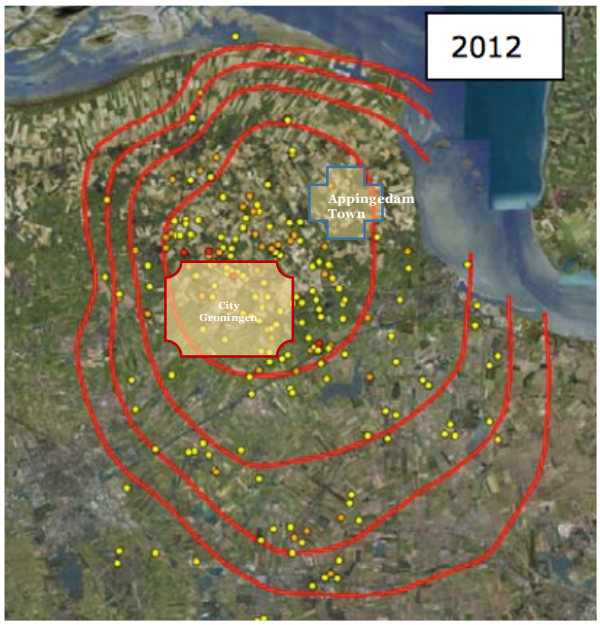
1.1 Background

Floods, together with wind related storms, are considered the major natural hazard in the EU in terms of risk to people and assets (European Environment Agency, 2010). Thus, it is of relevance to adapt urban areas in coastlines and river zones to prevent flooding, or for them to be prepared for floods. In 1993 and 1995 the Netherlands were shocked when the rivers Meuse and Rhine almost flooded and thousands of people had to be evacuated (Van der Brugge, 2005). After this major incident more flood related problems followed, such as large agricultural damages in the western part of Holland due to high water levels in 1998 and flooding in Wilnis in 2003 (Van der Brugge, 2005). Earthquakes are widespread in Europe, yet the most destructive events occurred in the Mediterranean countries. (Earthquakestoday, 2015). With the theory of plate tectonics, it has become evident that most earthquakes occur along the margins of plates, where one plate comes into contact with another, developing shear stresses (UNISDR, 2004). There are, however, examples of significant earthquakes apparently not associated with the plate boundaries but gas extraction as the Groningen Gas field case (van der Voort & Vanclay, 2015).

Consequently, earthquake and floods hazards faced by The Netherlands. The Groningen Province, in the northern part of The Netherlands, has been experiencing an increasing frequency and severity of earthquakes in the region of the Groningen gas field (van der Voort & Vanclay, 2015). At least 1000 registered minor earthquakes have affected the region between 1986 and 2013 (Groeneveld, 2014). Although earthquakes have been accepted as a being a consequence of gas extraction in Groningen since the 1990s, the issue was not widely considered to be of significant concern until September 2014. An earthquake of 2,8 on the Richter scale was felt in a wide area including the centre of the city of Groningen in September 2014, prompting social actions and residents' strong complaints (Koninklijk Nederlands Metereologisch Instituut, 2016). Damage to infrastructure and private property, the decline of housing prices, and social perceptions of insecurity have been the subject of research in recent years in the zone affected by earthquakes (van der Voort & Vanclay, 2015). The level of earthquake risk in damaging the dykes is moderate, and until the present date no major damage has been reported (Deltares, 2014). However, more frequent seismic events will increase the chances of severe consequence (Deltares, 2014).

In the earthquake affected zone, flood defences protect areas from flooding from Lake IJssel (IJsselmeer), the Waddenzee, and the Eems and Dollard rivers (Rijkswaterstaat VNK Project Office, 2011). The primary and regional water barriers are designed upon the basis of stable soil, without the situation of earthquakes or direct external effects. Canals and dykes are susceptible to fluctuating conditions in environment. For example, the flood defences at Elbe River after a year of extreme rain in 2002, was followed by an extreme drought and heat wave, where dykes broke due to excess dryness of the building material in 2003 (Pahl-Wostl, 2007). The reaction of levees under earthquake stress, their technical components as slope stability and earthquake load, was investigated by the consultancy firm, Deltares. It concluded that, a magnitude 5 earthquake could cause significant damage to dykes that meet the current technical specifications for dykes (Deltares, 2013). However, the risk of damage and flooding increased in locations where the dykes were sub-standard, the regional flood defences are required to comply with high water levels scenario (Deltares, 2013). This means some of those protections do not meet the standard of height or volume to contain peak water discharge (1/100 per year) required by the Koninklijk Nederlands Metereologisch Instituut (KNMI), (Deltares, 2014). After a technical review in 2014, the Provincial Executive of Groningen established that 44% of the dykes in the Groningen gas field region did not meet current technical specifications for flood risk protection (van der Voort & Vanclay, 2015).

According to assessment report of State Supervision on Mines in 2013, there exist the probability of a higher magnitude earthquake in the Groningen gas field. The following figure reflects the spatial distribution of earthquakes over the Groningen gas field through time.



The colour coding of the dots indicates the magnitude class: yellow 1.5≤M≤2.0, orange 2.0<M≤3.0, red M>3.0. The red lines indicate the contours of the subsidence bowl as observed in 2008.

Figure 1 Spatial distribution of earthquakes over the Groningen (State Supervision of Mines, 2013)

The current background shows a combination of earthquakes and flood risk, and a potential scenario for a cascading disaster in Groningen. Theory for cascading disaster is vast, but it can be explained as sudden shocks, in which cascading effects increase over time and generate unexpected secondary events of strong impact (Pescaroli & Alexander, 2015). These secondary effects tend to be at least as serious as the original event and significantly contribute to the overall duration of the original disaster's effects (Khalili, Harre, & Morley, 2015). Vulnerabilities are derived from the increasing interdependencies, those described by complexity theory as non-linear interactions that combine with network effects and randomness, sensitive to small changes, in which one event triggers others, creating amplification and cascade effects (Pescaroli & Alexander, 2015). For example, the relationships between communication technologies and financial systems, food and supply chains, or in this research the effect of earthquakes upon dykes for a plausible flooding in an urban area.

Since 1960's, resilience is an evolving concept but it was the ecologist C.S. Holling, that made a distinction between different perspectives of resilience that continue to evolve since then (Davoudi, 2012). Resilience in the context of disasters is explained as "the ability of a social system to respond and recover from disasters and includes those inherent conditions that allow the system to absorb impacts and cope with an event" (Ainuddin & Routray, 2012, p. 26). In the context of flood management, resilience is equal to resisting, recovering, reflecting and responding to flood hazard, although the benefit of the above definition is that change and learning from the past are required to achieve resilience (Djordjevic, Butler, & Gourbesville, 2011). Flood resilience is discussed by Restemeyer et al., (2015), and it aims to minimize the consequences of flooding by focusing on spatial planning strategies and population preparedness. As an example, land-use planning is adapted in order to minimize the damage potential with measures such as elevating housing structures (Restemeyer, Woltjer, & van den Brink, 2015).

For planners, this wide sense of preparing and coping to disasters under the resilience concept has increased its popularity; however, it is not quite clear what resilience means, beyond the simple assumption that it is good to be resilient (Davoudi, 2012). Despite this lack of clarity, there is a growing number of governmental and non-governmental reports

which aim to develop ready-made, off-the-shelf toolkits for resilience-building (Davoudi, 2012). For the statement "it is good to be resilient" (Davoudi, 2012, p. 299) to be valid and useful, knowledge of how resilience is determined and operationalised is fundamental (Cutter, Barnes, Berry, & Burton, 2008). Therefore, this research aims to analyse the concept of cascading disaster theory and its relation to resilience and apply it to community level.

This research has selected Appingedam for a more in depth analysis of community resilience to earthquake-flood disasters. Appingedam is a town north of the province very close to Delfzijl located between the Eems and Groningen gas field. The town of Appingedam has a total number of inhabitants registered in the municipality by January 1, 2015 of 12 006 people and a total area of 2436 hectares of land (Gemeente Appingedam, 2015). The town is subjected to earthquakes, suffering several recorded impacts that are directly linked to one of the main lines of gas extraction passes near the city. According to the Gemeente Appingedam, (2015), the national gas company operates between the Eemskanaal and Schildmeer where currently major pipeline repairs are carried out. According to the Vergouwe (2015) the centre and most sites in the town are located on high risk zone flooding. The town is located within the Eemsdelta region and next to Delfzijl, in a very sensitive zone to storms and rising water levels. For example, on the night of October 31, 2006 the northern Netherlands faced a very severe storm recorded in history as the All Saints Flood of 2006. During this flood seawater in Delfzijl reached a record high water level of 4, 83 m above sea level (Rijkswaterstaat, 2007, p. 9). Due to the previously described elements, the community of Appingedam is a relevant region to develop a case study in order to analyse community resilience and its relationship to earthquake/flood disasters.

This research will analyse the concept of community resilience to cascading disasters (CRD). It aims to understand different capacities of community resilience related to earthquakes and flood disasters. These will be evaluated within a community and the response of some residents and institutions of Appingedam to an earthquake-flooding condition. It contributes in an accurate appraisal of the preparedness, reaction and knowledge to disaster from local level perspective (Cutter, Barnes, Berry, & Burton, 2008). Further, the assessment can trace resilience progression towards the ideal of a resilient community, in order to develop plans to enhance resilience at community level. This study overcomes a prominent challenge for planners (Davoudi, 2012), which is how to develop the criteria that can adequately identify the community resilience within the context of disaster at local level response. These research is valuable because it analyses different CRD characteristics and apply a practical qualitative assessment of them. These metrics not only should identify the community resilience to earthquake/flood attributes, but the connection with land use policies, disaster management plans, and risk communication at local levels.

The current research is relevant for the Groningen Province specifically for the town of Appingedam as it positions itself as a first insight to analyse the earthquake-flood risk relationship from a community resilience perspective. Lives of inhabitants are threatened by earthquakes and flood risk. This lives, economic losses and historical heritage can be protected with a proper plan and by enhancing resilience in communities.

This research aims to be useful for municipal authorities, researchers and local community by:

- Providing an understanding of the place where the both events are likely to happen, and its effects on the current infrastructure, society and spatial distribution of Appingedam.
- Providing information to the local level useful to enhance community resilience and prepare to cope a combined hazard effect based on the cascading disaster theory.
- It examines the development of CRD, the multiple trajectories from which it emerges in a specific multi-hazard context. At local level it can reveal why and how people are becoming resilient or not, and what this tells about the power relations in the public, urban, and planning practice environment.

1.2 General objectives

This research will critically analyse the concept of community resilience to disasters (CRD). The theory of cascading disasters will be applied to understand the earthquake/flood disasters and its relationship to CRD. This study identifies components of community resilience towards disasters, by focusing on an assessment tool. The present research will determine CRD capacities and analyse resilience probable indicators on a specific setting of earthquake/flood disaster. Furthermore, it will study the link with cascading disasters, the community response and current initiatives in the town of Appingedam.

It will explore the community reaction to earthquake-flood disasters under the perspective of community resilience in Appingedam by means of a qualitative assessment. The case study aims to provide the information that can be used for understanding the decision making in disaster process that take place in the community at local level. It also aims to understand the governance arrangements and structures that influence the community and thus its relation to community resilience.

1.3 Research Questions

The motivating question for this research is:

How can community resilience to disasters, and the associated governance arrangements, be operationalised for communities at risk from cascading earthquakes-floods disasters?

The previous question also raises additional sub questions, such as:

1. What are the potential effects of earthquakes-floods in Appingedam, Groningen?
   1.1. How can earthquakes-floods hazards combine into cascading disasters and how they differ from single event disasters?
   1.2. How does cascading disaster theory help understand and analyse cascading effects of earthquakes-floods threatening Appingedam, the Netherlands?

2. How can community resilience to disasters be understood?
   2.1. What does community resilience to earthquakes-floods disaster mean in Appingedam, Groningen?
   2.2. What roles does adaptive capacity have in community resilience to disasters?
   2.3. How can community resilience to disasters be assessed in Appingedam?

3. How do governance structures/approaches influence community resilience to earthquakes-floods disasters in Appingedam?
   3.1. What governance approach/structures supports community resilience to earthquakes-floods?
   3.2. How governance approaches can help to enable adaptive capacities of CRD to earthquakes-floods in Appingedam?

2 Theoretical Framework

This chapter explores and describes the cascading disaster concept, and how it relates to the community resilience. Provides a discussion of disaster, governance and resilience and how they all connect at community level. It begins with the explanation of resilience, community and how can the relation of single events trigger major catastrophic results presenting the theory of cascading disasters. It discusses the current models of resilience and establishes the framework through a review of several literatures that addresses the community resilience to disaster concept. Consequently, this chapter also reviews the discussion on how adaptive capacity relates to resilience. This section also reflects on the governance arrangements and their influence to community. Finally, it is explored how community resilience to disaster is composed, and how the adaptive capacities become practical observations at local levels. These reviews not only how if influences community resilience to earthquake/flood attributes, but the connection with spatial planning such as land use policies, disaster management plans, and risk communication at local levels.

2.1 Conceptual Framework

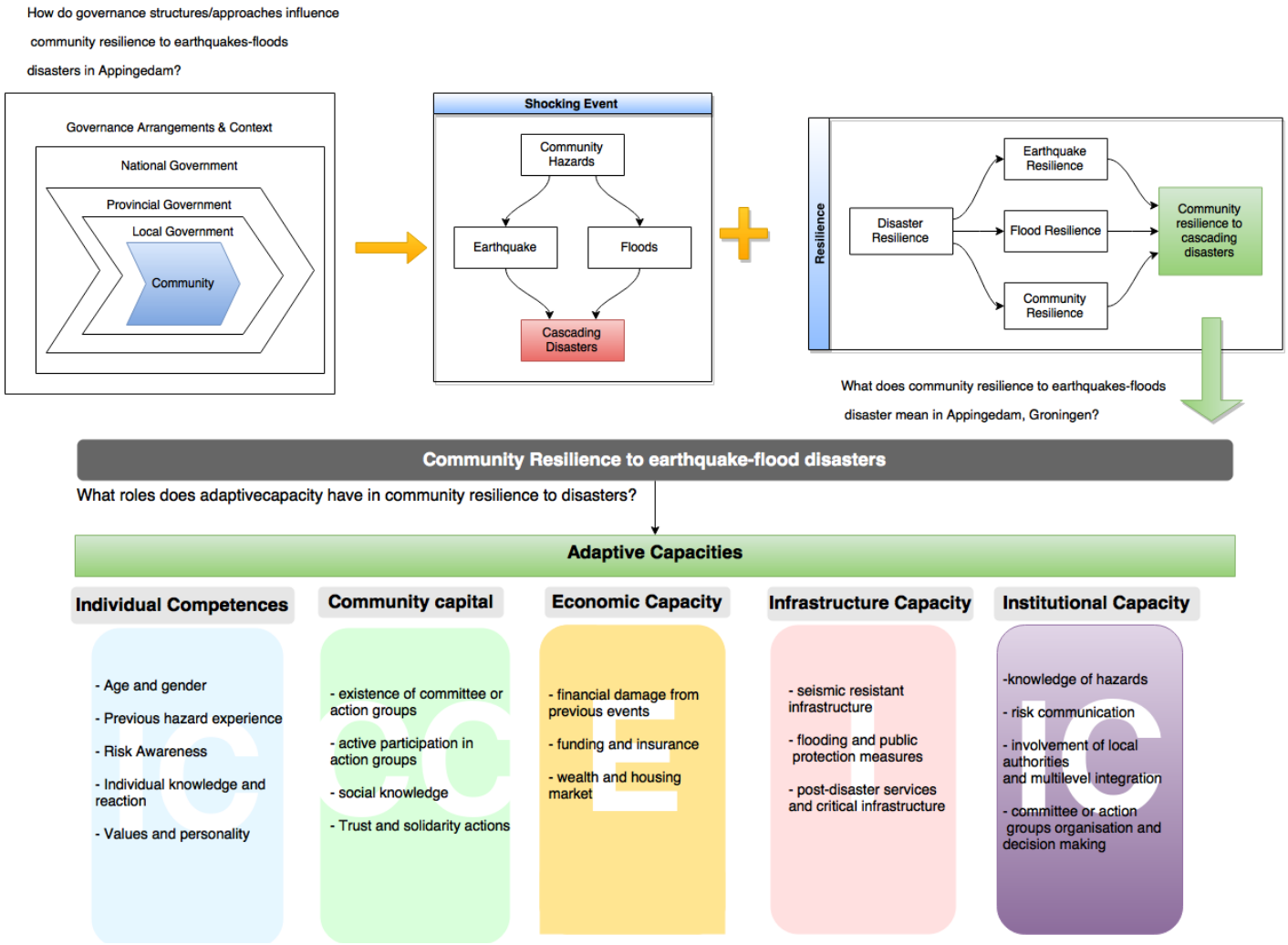


Figure 2 Conceptual Framework (made by researcher)

The previous model relates the theory or governance, cascading disasters and resilience. To have a better understanding of the community resilience to disaster CRD and cascading disasters in Appingedam, the governance theory is reviewed. The national level is a rectangle, it refers to the scale which contains and influence all minor scales into community. This is useful to understand how and what governance arrangements or institutions influence disasters, resilience and community. In Appingedam, Groningen context a strong influence from the national level is present influencing the provincial and local levels, thus is also represented on the current diagram with a peak breaking into the other scales. The theories related to this model begin with the broad concept of disaster resilience, and then it narrows down to community resilience to disasters (CRD). The concept of CRD is analysed and applied to earthquake and flood combined, thus relating cascading disasters became a relevant theory. A breakdown for CRD adaptive capacities is then presented as the five main elements, enclosed in the rectangles the key indicators chosen for each capacity.

2.2 Community Resilience to Earthquakes-Flood Disasters

What is resilience?

Resilience has many different discipline approaches, referring to all its components, like engineering information (e.g. resilience of building), sociology (e.g. identify the social units and capabilities), and biology (e.g. environmental properties) (Cutter, 2016). Therefore, several meanings and approaches of resilience result in different concepts and methodologies. Whether or not resilience is a desirable aspect of communities depends on the definition of the concept itself. In the following paragraphs the theories for resilience will be critically reviewed, and perspectives will be discussed to establish a concept for the current research.

In a purely mechanical sense, the resilience of a material is the quality of being able to store strain energy and deflect elastically under a load without breaking or being deformed (Klein, Nicholls, & Thomalla, 2003). This first approach was characterized as 'engineering resilience', this perspective focuses on maintaining the efficiency function, constancy of the system, and a predictable world near a single steady state (Lloyd, Peel, & Duck, 2013). Engineering resilience focuses on behaviour near a stable equilibrium and the rate at which a system approaches steady state following a perturbation (Folke, 2006). The focus of resilience was then associated with a linear system of behaviour as discussed by Folke (2006), and could be estimated by a return time, taken for the displacement of decay to some specified fraction of its initial value.

Later, resilience became associated with emergent adaptive ecosystems, management thinking and a broader interest in managing integrated large-scale ecosystems (Lloyd, Peel, & Duck, 2013). As discussed by Davoudi (2012) ecological resilience, is defined not just according to how long it takes for the system to bounce back after a shock, but also how much disturbance it can take and remain within critical thresholds. Ecological resilience focuses on the ability to persist and the ability to adapt (Lloyd, Peel, & Duck, 2013). It rejects the existence of a single, stable equilibrium, and instead acknowledges the existence of multiple equilibria, and the possibility of systems to flip into alternative stability domains (Davoudi, 2012). As discussed by Lloyd et al. (2013) resilience was then adapted to indicate a capacity for renewal, re-organisation and development, in the context of sustainability and began to influence disciplines outside ecology later on.

The social-ecological model approach, is discussed by Folke (2006) as a system that considers to be applied to complex adaptive systems as they involve multiple scales. The social-ecological model operates through feedbacks or non-equilibrium dynamics, and deals with the uncertainty faced through learning and adaptation (Folke, 2006). Social-ecological resilience involves more than an ability to recover from disturbance, but demands adaptive

capacity building and creates innovative responses and new trajectories (Lloyd, Peel, & Duck, 2013). To this approach the degree to which the system can build and increase the capacity for learning and adaptation is vital (Folke, 2006). Under this perspective, resilience is embedded in the recognition that the seemingly stable state that we see around us in nature or in society can suddenly change and becomes something radically new (Davoudi, 2012).

Resilience to earthquakes and flood disasters

Resilience has also been explored from a disaster perspective from the social-ecological approach (Cutter et al., 2008). Disaster resilience refers to the ability of a social system to survive and cope through a disaster with minimum impact and damage (Cutter et al., 2008). This idea is relevant because it reflects on the coping capacity required for survival, however Ainuddin & Routray (2012) explain disaster resilience as the ability of a social system to prepare, respond and recover from disasters. This includes those inherent conditions like preparedness, that allow the system to absorb impacts and cope with an event (Ainuddin & Routray, 2012).

This is also emphasized in Cutter et al., (2008), the combination of pre-event adaptation resources increases the post-event coping capacity. For Cutter et al., (2008), disaster resilience refers to the combination and the use of resources (physical, social and economic) to recover after exposure to hazards. However, all the different resources as Cutter (2016) proposes, require an integration of every discipline that unfortunately is not always successful. Folke (2006) elaborates on the idea that disaster resilience contrasts the top-down or efficiency-based approach. This idea argues that disaster resilience is long term vision, and focus on the capacity a system for renewal, reorganisation, and development with long-term sustainability (Folke, 2006).

This research focuses on earthquakes and flood disasters, therefore seismic and flood resilience will be further explored in the following paragraphs. In Bruneau et al. (2003), seismic resilience is defined as the ability of social units (e.g., organisations, communities) to mitigate hazards and contain the effects of seismic disasters when they occur. It extends to carry out recovery activities in ways that minimize social disruption and mitigate the effects of future earthquakes (Bruneau, Chang, Eguchi, & Lee, 2003). In comparison, other authors refer to it as the capacity to manage, or maintain certain functions and structures, during disastrous events (Twigg, 2007). Operationalising seismic resilience means reducing the probability of infrastructure failure during an earthquake, as well as reducing the consequences from such failures and the time to recover, prevent injuries, and other economic losses (Reinhorn & Bruneau, 2006). According to Chang et al., (2014), seismic resilience relies on robustness and recovery of infrastructure systems. This could be enhanced by strict building codes, transport and energetic redundant networks, and implementing new methods for monitoring and repairing infrastructure (Fragiadakis & Christodoulou, 2014). However, fostering seismic resilience represents three challenges: partial incentives to create redundant infrastructure networks, limited and asymmetric information and authorities experience, and lack of knowledge and collaborative approaches (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014).

In a flood risk management context, resilience can be applied as the capacity of a system, community or society, potentially exposed to flood hazards, to adapt by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure (Djordjevic, Butler, & Gourbesville, 2011). Flood risk management literature commonly differentiates between resistance and resilience strategies, the goal of a resistance strategy is to reduce the probability of a flood hazard, whereas resilience aims at minimizing the consequences of flooding (Restemeyer, Woltjer, & van den Brink, 2015). A resilience approach takes the possibility of flooding into account, therefore, land-use is adapted in order to minimize the damage potential (Restemeyer et al., 2015). For example, by elevating housing structures flood resilience strategies rely on risk management instead of on hazard

control (Restemeyer et al., 2015). Here, building or augmenting physical infrastructure such as sea walls and flood levees is a common adaptation strategy (Davoudi, 2012).

From the two main hazards earthquake and flood, resilience concept has been reviewed. In both cases it is equivalent to responding, resisting, recovering, and reflecting to the event. Planning and preparedness are relevant for both, yet the strategies to plan are prepared reflect differences between flood and seismic strategies. Also the using the adaptive capacities of community's units is key to cope the effects of the hazard. Seismic and flood resilience both care for infrastructure upgrades and technical strengthening, yet seismic resilience emphasises on critical infrastructure. Resilience can be achieved by improving the ability of a community's infrastructure (e.g., energy networks, structures) to perform during and after an earthquake or flood (Reinhorn & Bruneau, 2006). Some differences can be seen between both, for instance the earthquake resilience has major concerns on how the infrastructure qualifies of robustness and redundancy (Fragiadakis & Christodoulou, 2014) . Flood resilience, is related to learn and develop the learning to live with water flooding and prepare communities to respond and not so much of a resistance strategy (Restemeyer et al., 2015). Coping the flood events also reinforce the idea of preparedness, as discussed in Restemeyer et al., (2015), it is it possible to have a strong water management sector and foster informal networks at the same time.

Cascading disaster and resilience

Schmidt et al. (2011) explains that risk is the outcome of the interaction between a hazard and the elements at risk, or the exposure of the community (the people, buildings and infrastructure) that are vulnerable to such an impact. This theory presents risk as result of three components, hazard, exposure and vulnerability (Schmidt, Matchan, & Reese, 2011). As discussed by Schmidt et al. (2011) the elements at risk or assets are spatio-temporal phenomena, valued by human society, and under threat to be damaged by hazards. In other words, the location (necessary to determine exposure to hazards) and characterized by attributes describing their vulnerability relevant to the specific hazard, for example the floor height of buildings necessary to calculate inundation depth from floods (Schmidt, Matchan, & Reese, 2011). In an emergency management context, a disaster is considered to have four phases: (i) planning and mitigation, (ii) preparedness; (iii) response and (iv) relief and recovery (Khalili, Harre, & Morley, 2015) .

In some cases, the effects upon many individuals and communities to natural hazards tends to increase considerably when the hazards of floods and earthquakes combine (Dayton-Johnson, 2006). An example to understand this concept: earthquakes can have catastrophic consequences where infrastructure is weakened, possibly because building codes are not carefully enforced as in Guatemala City in 1976 or Mexico City 1985 (Dayton-Johnson, 2006). As discussed by Dayton-Johnson (2006) two societies might face a similar exposure to natural hazards, but they may have different vulnerabilities to the damages that ensue from the hazard. These hazards are thus essentially external shocks, but the resulting disasters are not, disasters occur when societies are vulnerable to such hazards (Dayton-Johnson, 2006).

Cascading disasters concept comes from a metaphor of a cascade. A stream originates at an isolated point and it increases with a constant flow, creating erosion and paths until force of water is increased by external influences such as gravity, creating a waterfall of strong impact. It refers to the non-linear interactions that can combine with network effects and randomness in increasing sensitivity to small events, in which one event triggers others creating amplification and a cascade effect (Pescaroli & Alexander, 2015). The theory is that disasters begin with a single primary threat and then occur as sequences of events (Valentina, et al., 2016). These sequences of events are most often referred to collectively as secondary hazards, without the provision of additional definition or development (May, 2007). Secondary hazards are caused by the initial hazard event, such as when an earthquake

causes a tsunami, landslide, or dam break. Narrowing the concept to disaster and community context, an initial event would leave a community more susceptible to future, possibly different, hazards, e.g., an earthquake weakening buildings which are damaged further by windstorms (Zschau, 2015).

While the main event is a disaster in its own, the consequent damages should be included in the damage calculations of the initial hazard event, because their occurrence and their consequences are causally related (Zschau, 2015). Loss estimations will include a determination of the extent of direct damages to property and indirect effects on functional use (Pescaroli & Alexander, 2015). A framework to analyse the subsequent events was developed by the European Commission and was named as MATRIX (New Multi-Hazard and Multi-Risk Assessment Method for Europe). The focus of this methodology is on the hazards that (e.g. earthquakes, landslides, storms and coastal flooding) and the interactions at the different levels, such as cascading events and time dependency (Zschau, 2015). However, cascading disaster models are sometimes too simplistic and with weak connections of events, and may be a common mistake to elaborate over the wrong pathways or causes (May, 2007). This models usually can be highly sophisticated and complex based on technical team inputs and model design (May, 2007).

As final comparison, in multi-hazard events in a disaster, the perspective leads to multidisciplinary considerations, experts of each topic work together to find solutions and identify causes, which provides deep insights and understanding of each cause (May, 2007). However, this presents a fragmented approach that can lead to neglecting existing threats in the environment and discard the relationship between hazards (Valentina, et al., 2016). In this perspective, interrelationships are not clearly stated, and sometimes an agreement of what hazard has priority over another is cause of conflict (Valentina, et al., 2016). Cascade model reviews through the branches and different pathways, the different possible breakdowns that can generate chain effects, which is one powerful insight while developing a response action plan. ,

Understanding the relationship of earthquakes and flooding is one of the primary aims of this research, therefore cascading disasters models is the appropriate framework for the current investigation. Literature of disaster resilience models and its relationship to local levels is abundant; it includes disaster resilience from its fundamental definition (Klein, Nicholls, & Thomalla, 2003), up to applications in circumstances such as earthquakes (Bruneau et al.,2003), and flooding (Djordjevic, et al., 2011). Yet the question is how cascading disasters relate to disaster resilience? Considering earthquake resilience or flood resilience as an individual hazard by their own are not sufficient to address resilience of a system related to multiple events.

The cascading disasters model provides a framework to understand the significant patterns and interrelationships of events over time. It demands to view an earthquake and flood disaster with characterizing multi-event resilience, it aims provide a great depth of information to support better disaster planning and preparedness. The key components of both approaches of resilience can be analysed to provide a better resilience interpretation. Cascading disaster resilience can therefore be viewed as the combination of multiple resiliencies within a hazard prone area. This idea has been backed up by some some authors who consider this disaster resilience elements as specific attributes as community capital (Miles and Chang, 2011) or the economy (Rose, 2007), some others networking capacities (Bernard, 2014). Some consider resilience as integration of capitals for example social capital (Khalili, Harre, & Morley, 2015).

In this research the technical infrastructure strengthening from the seismic resilience and the capacity to manage, or maintain certain functions and structures (Ainuddin & Routray, 2012), during disastrous events is vital during cascading events. As for flood resilience, the resistance strategy to reduce the probability of a flood hazard and minimize the consequences (Restemeyer, Woltjer, & van den Brink, 2015) implying land used adaptation is required. Resilience to cascading disasters also demands to explore the use of adaptive

capacities to respond, resist, recover and learn of multiple events, yet planning and preparedness are vital for multi-event disaster. The link of urban physical infrastructure systems with communities is also needed, a link that supports the information and communication, and that directly addresses decision making at the urban scales (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014). In final words, creating cascading disaster resilience also requires community participation, for citizens to recognize their active role in risk management and suggest that planners and authorities should enhance this shift in community (Singh-Peterson, Salmon, Goode, & Gallina, 2014) . Risk management becomes a societal task that calls for cross-disciplinary collaborations (water management, spatial planning and disaster management) as well as the willingness of citizens to actively participate in earthquake and flood risk management (Restemeyer, Woltjer, & van den Brink, 2015)

Community and resilience to disasters (CRD)

Community Concept

This research will focus on the community and social dimensions of disaster resilience, concerning improving community capacity to contest disaster losses, and restore after shock. First, the concept of community resilience needs to be analysed. Community resilience broadly describes the necessary qualities required of a 'community' for it to withstand and recover, or adapt, following a disaster (Bushnell, 2007), the question is then what community means ? A geographical concept of a community subjected to risk is often agreed in literature rather than emphasize the social network and properties of community. For example, as discussed by Cutter et al., (2008) community requires a view as the totality of social system interactions within a defined geographic space such as a neighbourhood, census tract, city, or county.

Norris et al. (2008) explains that community can be understood in different ways, but do not elaborates on this, instead chooses the spatial limited definition. He refers to community as "Not always, but typically, a community is an entity that has geographic boundaries and shared fate" (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008, p. 128) However, as discussed by Cutter et al., (2008) it is recognized that there are many different communities within such geographically defined spaces. This implies that sub-communities may exist and indeed have different levels resilience that could result in recovery disparities (Cutter, Barnes, Berry, & Burton, 2008). The previous presents the problem with the main assumption of a geographical community. Though, limiting community concept to a geographical unit that share the common natural hazard is limited and opaque (Walters, 2015).

Communities are composed of built, natural, social, and economic environments that influence one another in complex ways (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). In other words, the existence of different communities in the same space, implies that the interactions derived from values, institutions, inequalities and existing networks define a community (Walters, 2015). The community in disaster resilience context then has a clearly social component, consisting of shared community values, hazard knowledge, resources and skills and social infrastructure (Buckle, 2006, p. 98). Supporting the previous idea, Walters (2015) argues that is essential to consider the system interactions. The idea that a community behaves or remains constant over time is neglecting the inherent property of community to build social capital, an essential part of local resilience (Walters, 2015). Social capital is described as the benefits that individuals and communities develop from membership of social networks (Walters, 2015). This concept of strong social networks

can be seen during a disaster, it provides physical and emotional benefits in a disaster as a result of collective goals, coordinated action, good leadership and efficiency of effort (Walters, 2015). To conclude, the community concept in disaster context consist of spatial boundaries subjected to hazards, but it emphasizes that this space possesses shared common values, specific social interactions and properties as knowledge and resources.

Community resilience to disasters (CRD)

Norris et al. (2008, p. 131) explains the concept of community resilience as "a process linking a set of networked adaptive capacities to a positive trajectory of functioning and adaptation in constituent populations after a disturbance". To understand the concept, adaptive capacities need to be explored. According to Norris et al. (2008) resilience rests on both the resources themselves and the dynamic attributes of those resources.

Under this perspective the properties of community resilience are: robustness, redundancy, resourcefulness, and rapidity which can be applied to reduce the probability of failures during disasters (Bruneau et al., 2003). The availability of these resources to a community predicts a strong likelihood that the community will both recover from a disaster and be better adapted to future challenges. (Walters, 2015)

Cutter et al. (2008) presented a framework of community disaster resilience of place (DROP). This model is designed to present the relationship between vulnerability and resilience, is amenable to empirical testing, and can be applied to address community scale (Cutter et al. 2008). As discussed by Cutter et al. (2008), DROP framework aims to capture antecedent social factors that occur at the most local levels. According to Cutter et al. (2008), the model begins with the antecedent conditions, which are a product of place-specific multi-scalar processes.

It focuses on antecedent conditions, specifically related to inherent resilience, which is the existing networks, infrastructure, planning/policies and capacity within the community to respond and recover from disaster (Singh-Peterson et al. 2014). The model identifies categories or components of community disaster resilience. The dimensions explored are ecological, social, economic, institutional, infrastructure and community competence (Cutter et al. 2008). The majority of assessment techniques based on the DROP model to asses CRD are quantitative, and use selected indicators that are often difficult to quantify in non-subjective terms (Cutter et al. 2016). Some authors strongly critique this system, because of the subjectivity regarding variable selection and weighting, lack of availability of certain variables, problems with aggregation to different scales, and difficulties validating the results (Luers, Lobell, Sklar, Addams, & Matson, 2003).

As an attempt to solve a problem regarding variable selection, the emBRACE model was drafted with an approach to urban cities context. The framework of community disaster resilience includes case studies of central Europe floods and Turkey's earthquakes. This framework depicts the dynamic interactions across three component domains: resources and capacities, actions, and learning (Jülich, Kruse, & Björnsen, 2014). The actions component refer to the conceptualization of what communities actually 'do' to physically and psychologically maintain or to build their resilience (Deeming, 2015). The learning component ensures an element of social learning in the framework, related to critical reflection and establishing connections to context elements like environmental change, social and technical change, and policy change (Jülich, Kruse, & Björnsen, 2014) .

Finally the resources and capabilities component refer to each community context specific and are directly related to capitals, assets and capacities (Jülich, Kruse, & Björnsen, 2014). These capacities are socio-political, financial, human, and natural or placed-based (Jülich,

Kruse, & Björnsen, 2014). Compared to Cutter et al. (2008) the dimensions explored are very similar, ecological and infrastructure in comparison with natural and placed-based, social description is specified in socio-political, economic dimension is presented as financial capacity. Yet Cutter et al. (2008) suggest specifics for institutional capacity, and community competence that holds social capital as one of the most relevant categories.

Governance and CRD

This section discusses the role of how governments and policymakers frame policy in relation to community resilience to disasters and what governance structures facilitate its adaptation and implementation. A common agreement of the concept refers to governance as the governing styles in which boundaries between and within public and private sectors become blurred (Stoker, 1998). Governance in such a definition, thus includes the formal and informal decision-making undertaken by various actors on different levels, including private actors and corporations, interest groups and NGOs as well as community (Keskitalo, 2009). This integration can occur horizontally and vertically, the latter takes into account expansion of the roles within the public administration and is integration for local, national and supranational powers at different levels (Alexander, 2005). Governance systems are challenged to set a frame for formulating, financing and implementing adaptation strategies at multiple layers, often in a context of ongoing institutional changes such as decentralisation (Brockhaus, Djoudi, & Kambire, 2012).

It is relevant to state that in this research, institutions can be formal and informal and refer to the understood rules, norms or strategies that create incentives for behaviour in repetitive situations (van den Hurka, Mastenbroekb, & Meijerinkb, 2014) One interesting issue as far as community resilience study concerns, is to determine whether the adequate institutional conditions are available to enhance community actions and becoming a more resilient community. The lowest level of governance addresses organizational sub-units and small semi-formal or informal social units, processes and interactions, such as committees, teams, task forces, work groups etc. (Alexander, 2005). Community resilience to disasters requires a risk governance structure that sets direction and provides services, and a built environment that supports the community's social institutions (UNISDR, 2012). The built environment is the foundation of recovery, governance sets the direction, financing governs the pace, and the community provides the support and will to make improvements (UNISDR, 2012).

The focus in this research is placed on how local stakeholders, action groups and community themselves understand and create adaptive capacity and adaptations. Starting from a local level, is necessary to understand the context of decision-making at multiple levels (UNISDR, 2012). That is to review to what extent adaptation is determined by processes on other levels, including the national level, and to which extent local actors are able to draw upon or influence governance networks at other levels in order to increase their own adaptive capacity (Keskitalo, 2009). Applied to CRD to earthquakes and flood, it is important to acknowledge the existence of complexity, multiple stakeholders, existing governance and planning processes, in which many of the infrastructure systems are privately owned or operated (Chang et al., 2014). For CRD governance perspective is necessary to have understanding of civil society as a future key player in decision-making (Brockhaus, Djoudi, & Kambire, 2012). However, in the Netherlands, the fact that enormous investments of public actors have been made in the physical safety (dikes and dams) has not only led to an institutional dominance of the flood resistance paradigm, but has also reduced the urgency to take measures in new governance models involving community (van den Hurka, Mastenbroekb, & Meijerinkb, 2014).

CRD Capacities and indicators

Community resilience to disasters of earthquakes and flood present a challenge, that is to understand which capacities and which resources are the most representative. Cutter et al., (2008) proposed general dimensions for CRD, Bruneau et al., (2003) explored a seismic approach of CRD, and Norris et al., (2008) reviewed social and community elements. The three authors suggested similar capacities.

These capacities are:
Norris et al., (2008) proposes as dimensions or resources (i) social capital, (ii) economic resources, (iii) community competence and (iv) information/communication. According to Bruneau et al. (2003) community resilience encompass four interrelated dimensions: (i) technical, (ii) organisational, (iii) social, and (iv) economic that can be applied to disasters. Cutter et al., (2008) present the (i) ecological, (ii) social, (iii) economic, (iv) institutional, (v) infrastructure and (vi) community competence dimensions.

Yet each framework has one capacity not comparable with the other in terms of disaster. Bruneau et al., (2003) emphasized for technical measures to prepare for disaster. Norris et al. (2008) reacts to communication as key for community, while Cutter et al., (2008) advocates for the institutional role. Based on a thorough comparison of the previous models of an extraction of the most relevant capacities to CRD earthquakes-flood disaster was made. Figure 3 shows the suggested capacities used for this research, it is composed for five main capacities.

In the following lines the CRD selected capacities are discussed. Consequently, the section includes a discussion for CRD indicators and how can CRD assessment methods.

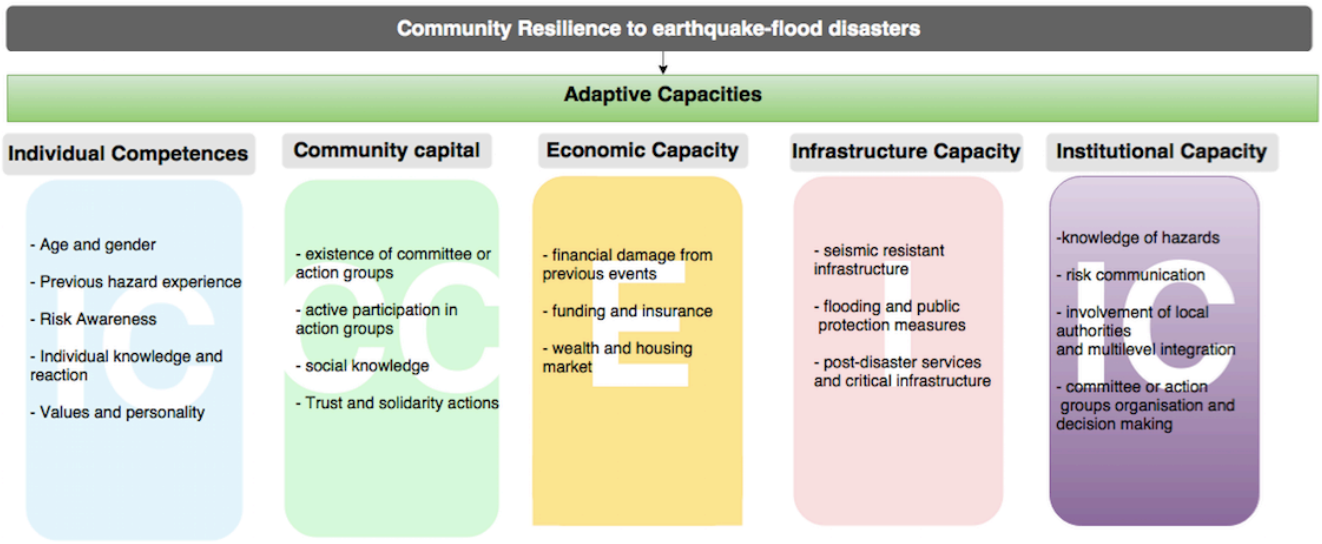


Figure 3 Proposed community resilience to disasters capacities (made by researcher)

- Individual competences

In this classification, general properties of the individuals are relevant in reaction to earthquakes and flood disaster. This dimension reflects the socio-demographic data of a community: age, race, class, gender, occupation (Cutter et al., 2008). Socially vulnerable populations have a decreased ability to avoid or absorb potential harm. For Singh-Peterson et al., (2014) language competency is relevant to assimilate warnings and risk. Researchers have identified many people as being socially vulnerable because of factors associated with the individual conditions, such as being children or older adults due to mobility (Martin, 2015). The age and gender within the Appingedam community will be review to identify vulnerable populations.

According to Norris et al., (2008) post-disaster support interventions furnish participants with knowledge, attitudes, and skills that can be analysed. Properties such as the knowledge of institutions and organisations people should attend to in case of an event, individual's previous hazard experience, individual's reference to the attachment can be identified (Ainuddin & Routray, 2012). Both authors agreed that individuals previous experience, individual knowledge and reaction are key for individual capacity, thus this are indicators to identify CRD in Appingedam. Also is important to reckon that some committees originate themselves from cohesion of individuals sharing same beliefs and values such as religion (Cutter et al., 2008), this values will also be analysed within the community. Finally, risk awareness and the psychological effects of hazards can affect community resilience (Norris et al., 2008), yet these are experienced in each individual way thus this will also be analysed in Appingedam.

- Community Capital

Community capital is described as the benefits that individuals and communities develop from membership of social networks (Walters, 2015). This concept of strong social networks can be seen during a disaster, it provides physical and emotional benefits in a disaster as a result of collective goals, coordinated action, good leadership and efficiency of effort (Walters, 2015). This consists of measures specifically designed to lessen the extent to which earthquake/flood stricken communities and governmental jurisdictions suffer negative consequences.

It is moreover described as performing activities in ways that minimize social disruption and mitigate the effects of future flood, storm or any other disaster (Khalili, Harre, & Morley, 2015). In comparison with social capital, the basic idea is that individuals invest, access, and use resources embedded in social networks to gain returns (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). This capacity then includes resources and actions such as network structures and linkages, social support, and community bonds, roots, and commitments (Norris et al., 2008).

Community communication refers to the creation of common meanings and understandings of the earthquake/flood risk and the provision of opportunities for members to articulate needs, views, and attitudes (Norris et al. 2008). Narratives provide an insight into how communities see themselves and others, then members' shared view of reality contribute to a sense of place, connectedness and preparedness (Norris et al. 2008).

Indicators are based on: sense of community, and citizen participation, local understanding of risk (Singh-Peterson et al., 2014) and (Cutter et al., 2008). Citizen participation is significant, the engagement of community members in formal organisations, e.g. resident associations, neighbourhood watches, and self-help groups can help in preparedness and social support (Norris et al. 2008). It can be noticed that there is a need then for community organization into creating groups as part of social cohesion (Norris et al. 2008). All authors agreed on the need for action groups and for the citizen participation in action groups or any form of association, these two elements will be used as indicators to analyse community capital in Appingedam.

This dimension also reflects on the social knowledge and communication, during an emergency people need accurate information about the danger and behavioural options, and they need it quickly (Norris et al. 2008). As a key part or this capacity, the social knowledge will be used as indicator in Appingedam. Also shared information, social support actions and trust are vital indicators (Khalili, Harre, & Morley, 2015). To Norris et al., (2008) the sense of community' is an attitude of bonding represents trust and belonging with other members of one's group or locale. Therefore, as both authors suggest, the trust and mutual solidarity actions should be also researched within Appingedam.

- Economic Dimension

This dimension refers to the capacity to plan, prepare, adapt and recover to both direct and indirect economic losses resulting from earthquakes/flood (Bruneau, Chang, Eguchi, & Lee, 2003). As discussed in Singh-Peterson et al., (2014) economic vitality of the communities and the diversity of the local economy are relevant, both of which indicate the stability of livelihoods. The income or wealthy of the zone, and its distribution is important. Land and raw materials, physical capital, and employment opportunities create the essential resource base of a resilient community (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008).

Past disaster research has shown that participants of lower socio-economic status (SES) often experience more adverse psychological and physical consequences than do participants of higher SES (Norris, Stevens, Pfefferbaum, Wyche, & Pfefferbaum, 2008). Poor communities not only are at greater risk for death and severe damage because have less robust infrastructure, but they often are less successful in mobilizing support after disasters (Norris et al., 2008). Further related to wealth, this explores for the local financial capacity as municipal funds to carry on preparedness or recover activities or budgets for disasters at local levels (Cutter et al., 2008).

Cutter et al. (2008) discuss mostly quantitative that indicators of economic resilience can be employment, value of property, wealth generation and Municipal finance/revenues, and the purchase of insurance. Singh-Peterson et al., (2014) presents other ideas to evaluate the economic dimensions, as housing capital, single sector employment dependence, income and equality, and health access. Both authors agree on value of the housing market and properties as an indicator for economic capacity, according to van der Voort & Vanclay (2015) Groningen earthquakes had an impact to the housing market. Thus this is an indicator that will require further investigation in Appingedam.

Compensation for damages for natural disasters methods are also a measure to cope events (Dayton-Johnson, 2006), but also relates the financial compensation for damage from previous induced hazards such as earthquakes in Groningen. The financial damage then will be used as characteristic to analyse the economic capacity in Appingedam.

Finally, the personal economic capacity, strictly to prepare for disasters is relevant, as for example people with flood hazard insurance for homes in flood risk zones (Djordjevic, Butler, & Gourbesville, 2011). Therefore, funding capacity and home insurance to disasters will be investigated in Appingedam.

- Infrastructure dimension

This dimension refers to the ability of critical infrastructure (including their interconnections and interactions) to perform to acceptable levels when subject to disaster (Bruneau, Chang, Eguchi, & Lee, 2003). According to Bruneau et al., (2003), the acceptable level refers to sustain critical lifelines such as water and power and critical facilities after an earthquake impact. These critical facilities are the backbone for community running, are the ones that enable to respond and provide for the well-being of their residents (Bruneau et al.,2003). In other words, the properties of infrastructure that enable them to cope a disaster, securing resilience often includes engineering alterations to proposals, such as the materials used or building design (Davoudi, 2012).

Flood resilience requires robustness, it means that a community has to be strong to withstand a flood event, for example by building and maintaining dikes, sluices and storm surge barriers (Restemeyer et al., 2015). The strategy is to reduce flood probability by improving infrastructure (e.g. technical and financial resources) and spatial measures (social acceptance and political support) (Restemeyer et al., 2015). Adaptability is crucial when frontline protection fail, it implies that the hinterland is adjusted to flooding so that a flood event may come without leaving substantial damage. The strategy is to reduce consequences

of flooding by discourage vulnerable land usage, early warning systems, flood proof building codes and constructions (Restemeyer et al., 2015).

Some indicators for this category are discussed in Cutter et al., (2008), her research uses transportation network as reference for connectivity and mobility. Residential housing stock and infrastructure age as indicators of infrastructure robustness Cutter et al., (2008). It means in practice, ageing infrastructure, new threats as earthquakes, water levels and climate change represent challenges for robustness of infrastructure (Bruneau et al.,2003). The existence of a community early-warning system and the number of households subscribed to it, can help mitigate consequences of disasters (Cutter, Burton, & Emrich, 2010)

Indicators of this based on characteristics such as construction code complying, or seismic resistance design (Bruneau et al., 2003). This is highly relevant for earthquakes; thus this will be analysed in Appingedam.

Singh-Peterson et al., (2014) proposes to review the sheltering needs, and in terms of public buildings, or concurred sites buildings should count with protective measures. Cutter et al., (2008) also reflects on coastal defence infrastructure which applies to the overall protection of the community and is reflected in flood protection measures such as dykes, levees, pumping stations. Hence, the second indicator to be used in this category will be flooding and public protection measures.

Finally, Singh-Peterson et al., (2014) discusses the post disaster services and critical infrastructure as indicator. It is needed to understand the potential for available support, where the community is located in relation to assistance services, e.g. how far to capital cities and critical services and infrastructure available (Singh-Peterson et al., 2014).

- Institutional Dimension

The category intends to recall the characteristics that relate to the capacity of organisations that manage facilities and community leadership, and have the responsibility for carrying out critical disaster-related functions (Bruneau, Chang, Eguchi, & Lee, 2003). It focus to their capacity to make decisions and take actions that contribute to achieving the preparedness for earthquake-flood disaster (Bruneau, Chang, Eguchi, & Lee, 2003). In comparison with Norris et al. (2008) some of this topics are covered by the community competence. It has to do with collective action and decision-making and the capacities that may support collective empowerment (Norris et al. 2008).

Is important also to determine whether the adequate institutional conditions are available to develop community actions (Norris et al. 2008). Bruneau et al., (2003) argues that the most important is in terms of response to catastrophic event, for example the capacity of hospitals to attend victims, or police and firefighter reaction and decision making.

As an indicator of institutional capacity the knowledge about risk and communication can be assessed. Cutter et al., (2008) and Singh-Peterson et al., (2014) both agree in the same indicators, that the participation in hazard reduction programs and developing of hazard mitigation plans enhance resilience and reflect institutional risk knowledge. This also relates to the social learning process, it includes both the capacity building of organisations and transmitting this knowledge, as well as the creation of relational qualities and social capital (Pahl-Wostl, 2007).

The policies, plans and governance are reviewed, thus the involvement of local authorities and multi-level integration will be analysed as a second indicator in Appingedam. Singh-Peterson et al., (2014) proposes this also as a link to disaster governance and institutional

integration, by reviewing political fragmentation through the number of governments and institutions involved. To contribute to achieving the properties of community resilience outlined above, local institutions should be able to keep a decision making capacity and be analysed under adaptive capacity (Gupta & Hurlbert, 2015).

Finally, societal institutions presence such as action groups is also important. Cutter et al., (2008) relates to the existence of organisations such as committee or emergency response group, or the presence of a third sector emergency coordination body or citizen groups as indicator. Cutter et al., (2008) argues that the presence of this community groups will increase emergency preparedness, response, recovery, and reconstruction by incorporating community in developing the programs.

CRD Assessment

In order to analyse communities, CRD assessment methods had been developed. In practice there are two main forms of assessment tools: community based participatory assessment tools and top-down assessment tools (Singh-Peterson et al. 2014). Top down assessment tools are typically applied by one institution or stakeholder whereas, community driven participatory tools are applied by the community in question (Singh-Peterson, Salmon, Goode, & Gallina, 2014). A participatory method are scorecards in use for different aspects the resilience and also different information required from government agencies to which cities may have to respond. These scorecards are widely used in USA and Europe (UK, Portugal and Sweden), and Australia (Jülich, Kruse, & Björnsen, 2014). The advantages of the scorecard system is that it provides a perspective on a city's total disaster resilience posture, and it intends to strengthen financial capacity as well to pursue resilient urban development and design (New South Wales Government, 2012). The disadvantage of this methods is that lacks of community understandings, is absent of personal communication and rather relies on "one size fits all" evaluation (Singh-Peterson, Salmon, Goode, & Gallina, 2014).

The top-down tools are often simpler to apply, quicker and cheaper which may result in an ongoing monitoring program becoming more achievable to implement (Singh-Peterson et al. 2014). It is also argued that top-down tools can be small scaled, and community narrowed allowing to determine insights and issues which are important to that community's resilience (Singh-Peterson et al. 2014). However, the downside of this method is the amount of participation and representation achieved compared to the participatory method. It is also discussed that this method requires an oversight body and external expertise, like a government office or an academic entity (Cutter, Burton, & Emrich, 2010).

Some researchers in the field emphasise that research on measuring community resilience is still in the early stages of development (Becker, Schneiderbauer, & Forrester, 2015). No single or widely accepted method exists so far, and the current approaches mainly draw on quantitative indicators (Becker, Schneiderbauer, & Forrester, 2015).

Several criticisms of the quantitative indicator approach have been noted by researchers, including subjectivity regarding variable selection and weighting, lack of availability of certain variables, problems with aggregation to different scales, and difficulties validating the result (Cutter, Barnes, Berry, & Burton, 2008). However, a positive impact of quantitative indicators is that they aim for reducing complexity, mapping, and setting priorities that makes them an important tool for decision makers (Cutter, Barnes, Berry, & Burton, 2008).

Resilience indicators can contribute in a community's assessment, they are also useful by establishing baselines for monitoring progress and recognizing success in community work (Cutter, 2016). However, indicators are typically used to assess relative levels of resilience, either to compare between places, or to analyse resilience trends over time (Cutter et al., 2008). In this case, by measuring resilience of a community in a certain moment, it becomes

a snapshot of the community response in time, it has a temporal limitation and is not an absolute measure (Singh-Peterson et al., 2014).

In determining and measuring disaster community resilience, and as presented DROP model evaluates the inherent conditions of community, and most of the analyses is focused in the antecedent conditions (Khalili et al., 2015). As examined in Cutter et al. (2008), the criteria for indicator selection include validity, sensitivity, robustness, reproducibility, scope, availability, affordability, simplicity, and relevance. The most important of these is validity, which speaks to the question of whether the indicator is representative of the resilience dimension of interest (Cutter et al., 2008). The CRD presented framework consists of indicators that represent the categories of economic, infrastructure, individual, community and institutional resilience following support in the literature to suggest a capacities framework (Singh-Peterson et al., 2014), originating in the community development sector and aims to frame community resilience (Cutter et al., 2008). The indicators proposed are a suite of key themes present in the community resilience literature (Singh-Peterson et al., 2014), in this way the criteria for validity, robustness and availability of Cutter et al., (2008) are ensured.

2.3 Spatial planning and community resilience to disasters

Spatial planning has gone through different changes over time, from a very centralized point, to a view of consensus seeking (De Roo, 2006). In the beginning, planners assumed that controlling the physical environment on the basis of technical, instrumental and procedural expertise was the way to go (De Roo, 2006). This has extended also to disaster management, and disaster policy making (Chang et al., 2014). Within spatial planning community resilience has been most commonly discussed as a concept to build capacity to manage specific risks, including climate change, flooding and drought, and economic and regional decline (White & O'Hare, 2014). However, it is argued that is resilience within a technical framework when regarding to disaster management. An example is in moments of disasters, political leaders tend to make the decisions and relegate community actions (Wisner, Blaikie, Cannon, & Davis, 2003). This planning systems exert a high degree of top-down, strong rational and functional control that are now obsolete or improbable to achieve (De Roo, 2006).

Frequently, emergency response fields relate to command and control methods. As discussed by White (2014), both the risk-based approach and the common disaster response, cycle of recovery, mitigation, and preparedness help to cast planning as reactive. This last refers to the common command and control modes to face disasters, where basically risk is not averted into the public diminishing awareness and involvement, and in its place contingency and recovery plans are developed (White & O'Hare, 2014). Mostly reactive policies exist, they respond to a technocratic definition and construction of the risk of disasters and flood (Gupta & Hurlbert, 2015). This forces the acceptance of the limitation that policies are based on steady-state thinking, instead they should aim to designing incentives that stimulate the emergence of adaptive governance (Folke, 2006).

Collaborative planning is a position to recognize the importance of understanding complexity and diversity, in a way that planning does not collapse into isolated analyses individual achievements (Healey, 2003). In planning practice many groups are involved, and they influence the policy agenda and the outcomes of planning processes by means of their competence, status, legitimacy, knowledge, information, and money (De Roo, 2006). In disaster management complexity is also increasing, many stakeholders are involved, sometimes both responding and affected at the same time (Van Den Homberg & Neef, 2015). These stakeholders can select from a wide range of political, military, economic, social,

information, and infrastructure related disaster management activities with often varying intentions and influence (Van Den Homberg & Neef, 2015).

The planning and risk management literatures have long emphasized the conceptual merits of collaborative approaches to decision making, often involving civil society groups, as well as technical specialists and agency staff (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014). The role of technical specialists with understanding of specific infrastructure systems is crucial when considering earthquake and flood resilience but civil society also plays a major role (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014). Community resilience to disaster promise risks can be alleviated, and where shocks are experienced, a society can cope with rapidity and efficiency (White & O'Hare, 2014). This perspective into disasters approach demands a change in policy structure from a reactive policy into proactive policies. Proactive policies come up from a medium to long term vision and aim to an adaptive and transforming environment (White & O'Hare, 2014). One notable aspect of collaborative planning is the appropriate role of technical specialists who provide and share technical information regarding potential alternatives and their consequences to address a policy question (Chang, McDaniels, Fox, Dhariwal, & Longstaff, 2014). They relate to mitigation and adaptation policies, that should be also the cornerstone to adaptive capacity. Is necessary to increase adaptability of a system through collective action, and also the transformability as the capacity of people to create new social conditions as response (Folke C, 2005). According to Folke (2006), recent advances include understanding of social processes like, social learning, social memory, adaptive capacity, transformability and systems of adaptive governance that allow path to create resilient communities.

More essentially applied to cascading disasters and community resilience, it transforms the risk management paradigm from command and control view, into dealing with complexity, multi-level interdependence, and uncertainty (Cutter, 2016). Complexity applied to planning is a concept that integrates both approaches, hard sciences and social sciences, born as an integration for geography research (Portugali, 2006) and prepare the scenarios for a more real understanding of reality (Byrne, 2003). For example an event, such as Chile's 2015 earthquake can cause a cascade behaviour, like tsunami alerts, infrastructure damage, evacuations and mobilizations (Zamorano, 2015) and can cause short and long term impacts. Complexity is reflected in all of these events that break the static system, they might trigger changes that are demanding or even impossible to reverse, but can't be avoided since those events are totally outsiders to the system (Duit & Galaz, 2008). The question is then: is it possible to plan for complex change? moreover is it possible to plan for cascading disasters? (Duit & Galaz, 2008).

It could be argued that planners can work with complexity, they should integrate multi-level interdependence and uncertainty by means of designing development plans, or in this case disaster management plans, with enough flexibility (Rauws, Cook, & van Dijk, 2014). A combination of strategies are suggested by Rauws et al., (2014) by simplifying or fragmenting plans in smaller scales or fragmenting in scopes, investments, and timeframes uncertainty is significantly reduced, and risk is limited. According to Djordjevic et al, (2011) some possible urban planning strategies can provide disaster mitigation measures and enhance resilient communities. Preparing better the infrastructure and communities for disasters, like improving flood resilience of buildings, and improving communications and technical measure (Djordjevic, Butler, & Gourbesville, 2011) For example, the use of source control or sustainable drainage systems (SUDS) measures to infiltrate flow locally, or to store and reuse water in case of rising levels of water. Regarding earthquakes, an strategy can be encouraging local governments to develop their seismic hazards assessments to inform community serves to cope disasters (Wisner, Blaikie, Cannon, & Davis, 2003). One step to connect authorities of planning and CRD is by elaborating a hazard assessment in a participatory process, including representatives of all sectors of community and expertise from authorities (Wisner, Blaikie, Cannon, & Davis, 2003) .

3 Methodology

3.1 Approach

This research will use a qualitative method, more specific applied to a case study, to identify categories and indicators of community resilience. The selection of the case study used a GIS approach to limit the geographical scope of the research to a community threatened by earthquake-food hazard located in the Groningen province. The qualitative perspective argues the value of depth over quantity and works at inquiring into social complexities (O'leary, 2009). It explores in depth the interactions, processes, lived experiences, and belief systems that are part of individuals, institutions and cultural groups (O'leary, 2009). It focus on the understanding of the social world through an examination of the interpretation of that world by its participants (Bryman, 2012).

The approach to be applied falls under the category of qualitative interviewing. A semi structured interview process with a local representatives involved in governmental authorities, policy makers, and community groups, and regular inhabitants is selected as a key method to identify community resilience. Semi-structured interviews typically refers to a context in which the interviewer has a series of questions that are in the general form of an interview schedule but is able to vary the sequence of questions (Bryman, 2012). The questions are somewhat more general in their frame of reference, allowing individuals to a give sense to their social world (Bryman, 2012). Also, the interviewer usually has some latitude to ask further questions in response to what are seen as significant replies (Bryman, 2012). It focus is on uncovering the rules that direct ordinary life, in other words it concentrates on how interactions are performed (O'leary, 2009). However, the approach can also be critiqued, it can turn out weak on the outcomes, if the questions addressed proves not significant for the research (O'leary, 2009). It also claims that it discards some aspects of non-verbal communication during interviews, because is too focused on verbal communication and the interpretation of this insights (O'leary, 2009).

3.2 Case study selection using GIS

GIS software has various applications concerning modelling and evaluating geographical information. GIS are important as they can allow decision makers to model scenarios and interact with the spatial dimension of a disaster (Zerger & Ingle Smith, 2003). GIS allows analysing environmental conditions related to flood risk and earthquake hazards in the province of Groningen, as well as identifying prone areas to disasters. Throughout the application of GIS techniques, it is possible to overlay various datasets of layers that contain characteristics in zone affected by earthquakes. Thus different benchmarks of comparison were applied: map of affected zones for earthquakes, past earthquake's epicentre location, flood risk maps, canals and waterways, medical attention, police stations and power generation plants, and finally a map for population density was overlaid. The town of Appingedam was selected, it has 85% of urban area in a flood risk zone, the town is divided by the Eems waterway, lack of medical facilities and has a very dense populated centre.

Overlapping layers of information was the first step for delimiting the scope of this research. For the analysis in the present research, the software ArcGIS version 10.2.2 by ESRI was used. The base for this maps was the geodata gathered beforehand by the University of Groningen in the department of Geoservices, the procedures, comprises all the set of GIS toolboxes, techniques and methods for analysing the datasets. The procedure and selection of tools requires skilled technicians as well as the interpretation of both the input and the output datasets, this labour was done with the support of GIS experts from the University of Groningen.

However, this also contains challenges such as compatibility of database, software, hardware, data capture, outdated figures, fitness-for-use and the hazard modelling itself. The GIS figures used represented data for earthquakes up to 2015, and a flood risk assessment

for 2012. It represents a limitation of the physical measures (Zerger & Ingle Smith, 2003). For example, the successful establishment of warning systems that might have changed, new land use mitigation strategies (Zerger & Ingle Smith, 2003) are not reflected on the current review. For example, the improvements to the Eesmkanal as the new locks and dike park in Ten Boer made 2015 will not be display in the flood risk and waterways layers (Noorderzijlvest, 2015).

Case Study and Instrumentation

After selecting a case study, the following step was to develop a CRD analysis tool. Cutter et al. (2008) DROP framework was analysed, however not entirely seemed coherent or available to apply in the town of Appingedam. The application of indicators as Cutter et al. (2008) and Ash et al. (2010) suggest in their models seemed not so appropriate for the Dutch context, mostly due to differences in community distribution, different policies (for example risk management policy) and governance in spatial planning system. After a review of literature (Becker, Schneiderbauer, & Forrester, 2015) from the embrace framework and (Khalili, Harre, & Morley, 2015) some of this indicators were replaced to have useful assessment tool. After applying selection criteria suggested by Cutter et al. (2008) like utility, validity, sensitivity, reproducibility, availability, and relevance the indicators were defined.

Then a semi-structured interview guide was developed, the questions that will be used to inquiry in each aspect of of CRD. Then interviews were structured according to the dimensions of resilience, indicators and the participant classification. A detailed section of the questions, dimensions and specifics is presented in the Appendix 2. Interviews were designed to reflect the five dimensions discussed in the framework of community resilience, and each question is grouped per dimension. They address directly in the case of disaster event about critical infrastructure, communication, risk knowledge and reaction. Nevertheless, dimensions of resilience cover also governmental aspects such as the coordination of local government, institutions involved. Finally questions for disaster response and management, and activities or engagement of local groups of citizens, and grass-root organisations were developed.

3.3 Sampling Procedures

A qualitative study usually involves identifying and locating participants who have experienced or are experiencing the phenomenon that is being explored (Rudestam & Newton, 2001). The research will use the snowball technique to identify participants. Snowball sampling uses a small pool of initial informants to nominate, through their social networks, other participants who meet the eligibility criteria and could potentially contribute to a specific study (Khalili, Harre, & Morley, 2015). Also key areas were identified in the process, such as institutions who play a major role in the community, as well as an academic's point of view of the topic.

The participants should be experts, or have experience with the phenomenon (Rudestam & Newton, 2001), thus the sample is not randomly chosen nor big number. Rudestam & Newton (2001), discuss that theory evolves as the data are collected and explored and it may be neither possible nor advisable to establish the precise sample size beforehand. Also as recommended by Rudestam & Newton (2001) more objective, directed questions can be used to obtain clarification of background actions, governance and context. This then created the necessity for 3 different types of target groups: residents, institutions or government representatives and finally academics or researchers. As the aim of the research is to understand community resilience, the core of the interviews focuses on regular inhabitants of the town, institutions or action groups within the town and academics with expertise on the topic.

A number of 15 participants constitute a reasonable sample for the present research, a participant description can be found in table 1. This number was selected for three reasons: Qualitative samples must be large enough to assure that most or all of the perceptions that might be important are uncovered, but at the same time if the sample is too large data becomes repetitive and, eventually superfluous (Mason, 2010). There is a point of diminishing return to a qualitative sample as the study goes on more data does not necessarily lead to more information, after interviewing 13 participants the answers became repetitive (Mason, 2010). Finally, because qualitative research is very labour intensive, analysing a large sample can be time consuming and often simply impractical (Mason, 2010).

Table 1 Participants Classification Table

	Institutions	Residents	Academics
Description/ Importance	Key informants of political and public institutions are described below. This group is selected to provide insights for the social and community actions developed. The government agencies selected will provide valuable information for the governance structure, roles and responsibilities.	General Residents to understand the public perspective of disasters and participation. Then community resilience can be analysed. This is the most relevant group to provide insights.	Academic researchers from university are selected due to their expertise in the topic relating earthquakes, social issues and sustainability in the region. Also are leade in researching the earthquake effects and have great knowledge background informatio
Participants	**Interviewee A: Employee of the Groningen Province Earthquake Dept.** The province government house represents the immediate superior political level above municipalities, therefore their insights, policy objectives and lobbying are directly connected to local guidelines.	• **Interviewee E:** Female Age:78 Retired Researcher • **Interviewee F:** Female Age: 22 Student • **Interviewee G:** Female Age: 67 social geographer teacher • **Interviewee H**: Male Age: 73 social geographer teacher (retired)	**Interviewee M: Earthquake Social Impacts expert** Board member of KADO, initiative for the Earthquake knowledge centre at RUG.
	Interviewee B: Employee at Appingedam Municipality Planning Department relevant informant to provide the explanation of local perspective over recovery and preparedness actions and policies. Also the role of the municipality, and critical infrastructure topics.	• **Interviewee I:** Female Age:59 musician • **Interviewee J:** Male Age: 67 doctor • **Interviewee K**: Male Age: 62 farmer • **Interviewee L**: Female Age: 57 Art history professional	**Interviewee N: Land value expert** Expert in land value and policy context in Groningen earthquake affected region.

Participants	**Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager** represents the water board, it is a public company for safe and sustainable water management. Appingedam is linked to the Eemskanal, a very sensitive water barrier for flooding and recently therefore their preparation and response can be a good input of knowledge into the research.		**Interviewee O: Disast governance expert** Researcher of disaster governance , bottom u initiatives and action groups in different disasters and now Groningen.
	Interviewee D: Groninger Gasberaad Representative Stands for the association of a number of civil groups in the earthquake area. Act as civil counterpart and react to policies. They aim to maximize involvement of the residents and organisations and that the area retains its character and identity.		

3.4 Analysis Description

The next step of the research focuses on analysis techniques. Every interview was recorded, and the data was then accurate transcribed (Rudestam & Newton, 2001). Records and transcripts will be held for each interview, this will be referred to field materials (Flowerdew & Martin, 2005).

Coding is the starting point for most forms of qualitative data analysis, although some writers prefer to call the process *indexing* rather than coding. (Bryman, 2012) The task of editing and coding field materials centres on checking the logic of different sets of responses and the creation of codes. Open format questions require categorizations, and direct association with questions and variables (Flowerdew & Martin, 2005). The coding and category will refer to the capacities of CDR proposed by the author, and relate to the indicators figure 3. Further details of the coding scheme are presented in Appendix 3.

To manage qualitative data analysis, a computer tool was used. Atlas.ti software was used to manage the process of qualitative analysis, the transcripts, tapes and other relevant field data was introduced into the platform. Organisation of interviews and coding the data was done just after the data collection, in the process a reducing to relevant themes will be key, as suggested by (O'leary, 2009). A final discussion was elaborated out of the coded quotes. Validation of the answers was done through triangulation of the answers from resident, academic and institutions answers. As discussed by Bryman (2012), being used to refer to a process of cross-checking findings deriving from different observations resulting in greater confidence in findings.

3.5 Constraints, positionality and reflexivity

Appingedam town was selected as a case study for CRD, however the context of this town requires a unique assessment method and as discussed before, will display earthquake-flood disaster resilience as a snapshot in time. The time frame to perform the data collection was May to June 2016, yet the organisation of the National Coordination Groningen (NCG) in Appingedam was just presented in March, and have not executed projects so far. The NCG is the national institution in charge of seismic strengthening programmes at local level. The dates for data collection represent a limit because some people could not be reached during this period, such as the NCG who are in the middle of planning process and could not be interviewed. Constraints in such access to organisations are admitted, just one department in the municipality or the representatives of the earthquake action group, Groninger Boden Beweging (GBB,) could be accessed, due to availability of its members. This specific timeframe was relevant for reflecting on the current institutions, political decisions and overall community reactions to the events and governmental responses.

It is also acknowledged that positionality and reflexivity may have impact social research (Bryman, 2012). Considering positionality is relevant to the current process, is key to reckon the power relationships between the informants and myself. It is discussed that social interviews conducted between researchers and participants who share a same linguistic, cultural, national or religious heritage can turn closer, and more dynamic (Flowerdew & Martin, 2005). In this research specially because as a foreigner and student, I do not share background or identity with the informants (Flowerdew & Martin, 2005) some participants may not be keen to share or express as much as they would with an insider. However, this position grants the research more objectivity and reduces biased results (Flowerdew & Martin, 2005). Some of the interviewed people may hold the position of power, since they are relevant public servants or experienced academics (Flowerdew & Martin, 2005), therefore to avoid strong influence over the research process, neutral places as cafeterias, city centre public spaces or general university facilities were agreed for the interviewing process (Bryman, 2012, p. 399). Although sometimes a non-equal position was held, during the process interviews were held in private offices or workplaces of some busy participants.

Reflexivity is employed by ethno methodologists to refer to the way in which speech and action are constitutive of the social world in which they are located (Bryman, 2012). It entails a sensitivity to the researcher's cultural, political, and social context. As such, 'knowledge' from a reflexive position is always a reflection of a researcher's location in time and social space (Bryman, 2012). Thus, language and culture, are also recognized to be a limitation for the researcher. When a language barrier exists between qualitative researchers and their participants, the research becomes a cross-language qualitative study with unique challenges related to language (Squires, 2009). The targeted interviewees are inhabitants and officials whose main language is Dutch and by forcing interviews to be conducted in English, accuracy in their thoughts and expression can be lost (Squires, 2009). Considering that the researcher has different background some of the insights and expressions could be misunderstood or details can be lost. Also the community can consider outsider influence or research unwelcomed (Flowerdew & Martin, 2005). As action is revealed in talk and as such talk must be analysed in terms of its context (Bryman, 2012). This means that we must seek to understand what someone says in terms of the talk that has preceded it and that therefore talk is viewed as exhibiting patterned sequences (Bryman, 2012). But when different languages are intertwined during a conversation, analysis becomes less accurate and some ideas can lead to misinterpretation (Bryman, 2012).

3.6 Ethics

The data collection of this research is significantly through participants who share in form of interviews as well as direct review of documents. Questions about the information about risk, communication, economic impact, and the process of recovering from damages, but also about management plans, and community action groups were asked. Principles of ethics were applied during the research. All participants were introduced to the research, and its objectives before any interview. This was done by an introductory explanation of the research in previous phone calls, emails and face to face. Al participants were asked to give their consent to being recorded, prior the interview and their where asked to sign a consent form for it. A view of consent agreement can be find in Appendix 1. Second, the principle of risk was established and presented that there are no anticipated risks in this study. Thirdly also participants were explained that the nature of this research is a thesis, and what the information will be used, therefore participants' answers will be kept anonymously. All responses will be treated confidentially and the anonymity will be ensured. This means that the identities and records of individuals should be maintained as confidential (Bryman, 2012). This command also means that care needs to be taken when findings are being published to ensure that individuals are not identified or identifiable by using pseudonyms and avoiding specific personal details (Bryman, 2012). Finally, I detailed that the participants could retire, quit the interview or skip questions if desired, however this never happened all participants answered all questions. At last all participants can trace the information or contact me to answer any questions they might have regarding this research, now or later in the course of the study.

3.7 Case Study: Groningen – Appingedam

Dutch governance system and spatial planning

The Netherlands is divided into 12 provinces: Drenthe, Friesland, Flevoland, Gelderland, Noord-Brabant, Groningen, Limburg, Noord-Holland, Overijssel, Utrecht, Zeeland and Zuid-Holland, which are again subdivided into 431 municipalities. Each province is administered by an elected province council with the Commissioner of the Queen (CdK) as its head (European Comission, 2015). The CdK is appointed by the Majesty the King of the Netherlands. Each province is further subdivided into municipalities with an elected council (European Comission, 2015).

National planning in the Netherlands is basically composed of three different hierarchical levels. The different tiers of government here have to cooperate, negotiate, and seek compromises, but they remain interdependent from each other (Roodbol-Mekkes & van der Valk, 2012). These tiers are state, provincial and municipal level, with a separate hierarchy position for the waterboards. The national level is responsible for a broad strategic lines of spatial policy, the implementation of European Guidelines and develop the land use plans which becomes legally binding documents for the other tiers (Roodbol-Mekkes & van der Valk, 2012). The national level draws a vision of the desired future spatial configuration and offers guidelines on how to realise it, rather than providing a detailed roadmap (van der Valk & Roodbol-Mekkes, 2012). Van de Valk (2012) also discuss that the provincial level focuses on developing the regional strategic plans and comprehensive land use plans that legally binds to the local government. Yet in the past years a more market oriented development has lead the planning initiatives (van der Valk & Roodbol-Mekkes, 2012). The local level is responsible for implementation of the land use plans, it has the power to allocate and responsibility to control local usage of land and developing a municipal structure plan (Janssen-Jansen & Woltjer, 2010).

As discussed by Janssen-Jansen & Woltjer (2010) the national government and the provinces are dependent on local authorities for the adoption of binding planning documents. The municipalities, in turn, cannot afford to ignore the strategic guidelines of higher authorities as it is the national government that held the directions (Janssen-Jansen & Woltjer, 2010). The Spatial Planning Act (WRO) legally safeguards the spatial planning framework, it is a piece of procedural legislation in that it pertains to the general rules and links to laws which are relevant to land-use planning (van der Valk & Roodbol-Mekkes, 2012).

Dutch disaster management structure

In the Dutch system of crisis management, each ministry is responsible for crisis management within its own specific area, but the overall responsibility rests with the Directorate General for Public Order and Safety within the Ministry of the Interior (European Comission, 2015). The Ministry of the Interior coordinates crisis management preparedness and is responsible for public order and safety. This includes, among other things, the responsibility for fire brigades, disaster management and the organisation of medical assistance in the event of disaster (European Comission, 2015).

As discussed by the European Commission (2015) a National Information Centre, also within the Ministry of the Interior, handles public information and if a crisis occurs, a crisis centre for decision-making will be set up within the ministry concerned. Apart from the minister concerned, the Prime Minister may call upon other ministries to become part of the Prime Minister's crisis decision-making structure (European Comission, 2015). In this case, a National Coordination Centre will be set up, yet the responsibility for disaster relief and safety in general rests with the municipalities. The European Commission (2015) also mentions that in the event of a disaster the municipalities will cooperate regionally, and if regional assets should prove insufficient, assistance can be requested from national level.

The breakdown of this disaster hierarchy is shown in figure 4. At national level, each ministry is responsible for crises and disasters within its policy area. The National Crisis Centre (NCC) operates as national coordination unit when crises in connection with disasters affect several policy areas. At regional level, the 25 safety regions of the country are in charge of civil protection issues in municipalities which belong to their territory. Several organisations with crisis-related tasks, like fire brigades and public health institutions, are organised within the security regions. Next to the safety regions there are 25 police regions and one national police corps (KLPD) (European Comission, 2015). The safety region Groningen (VRG) is a common system for all municipalities in the region of Groningen (Veiligheidsregio Groningen, 2014). The activities focus on increasing security in the region and work together with the Firefighter department of Groningen (GHOR), and medical assistance organizations in the region and the municipalities (Veiligheidsregio Groningen, 2014). The board consists of the mayors of all municipalities in Groningen and has four levels of coordination and control of crisis occurs (Veiligheidsregio Groningen, 2014). At each level includes a scale-up phase according to the coordinated regional incident control procedure and authority (Veiligheidsregio Groningen, 2014). At local level, each municipality has a division which is in charge of civil protection issues, but also private and public participation of locals is encouraged.

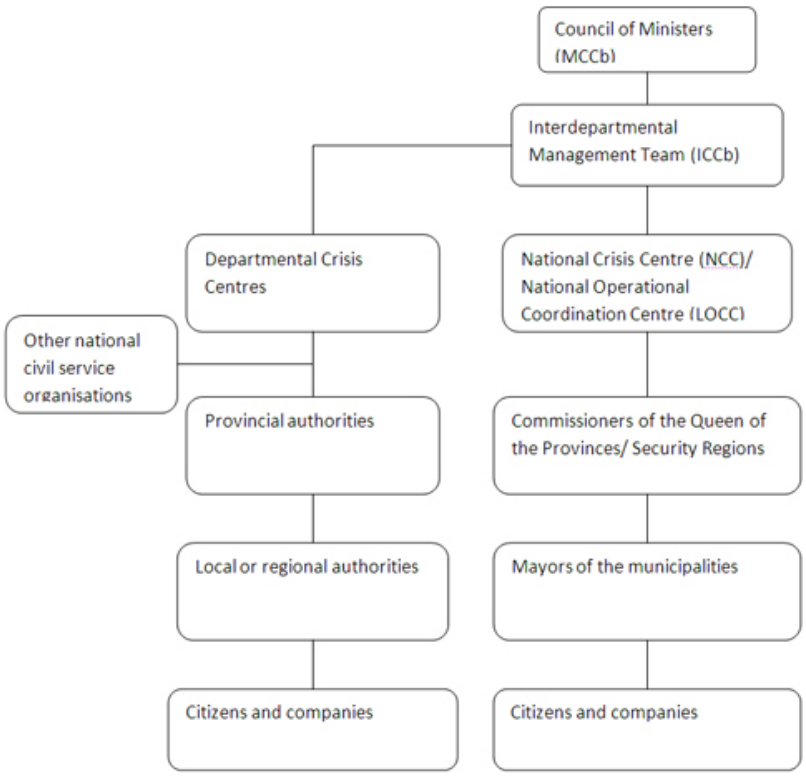


Figure 4 Organisational chart for disaster management (European Comission, 2015)

Earthquake and Flood in Appingedam, Groningen

The past few years demonstrate that the hazards have increased on the province, as an example on 16 August 2012 the village of Huizinge in the province of Groningen was shaken by an earthquake with a magnitude of 3.6 on the Richter scale (van der Voort & Vanclay, 2015). It was the worst earthquake caused by gas extraction that had been observed thus far in the Netherlands (Dutch Safety Board, 2015). The gas reservoir is located approximately 3 km below the surface in a porous layer of sandstone but as the gas is extracted, the sandstone compresses (van der Voort & Vanclay, 2015). This exacerbates the effects of earthquakes for 3 mains reasons, i) shallow gas earthquakes can release more energy to the surface causing greater impacts ii) frequent small earthquakes cause constant effects iii) the zone in quake zone consist of soft clay which disseminates energy with a resonant rise effect for underground to surface (NAM B.V., 2008). The gas field covers approximately 39% of the land area of Groningen and approximately 190,000 people live within the gas field (van der Voort & Vanclay, 2015). As discussed by Vanclay & van der Voort (2015) the Groningen gas field is located in the eastern part of the province, it covers approximately 900 km2 and it is now known that it contained 2800 billion m3 of gas when production commenced.

Appingedam is a town located in the north-eastern part of the province of Groningen, The Netherlands, Figure 5 shows its location in reference to the city of Groningen. Although there is no certainty as to the exact age of Appingedam, historical research evidence that the city would eventually be built had been inhabited for over a millennium (Gemeente Appingedam, 2015). Appingedam is located very close to Delfzijl, and between the Eems and Groningen gas field. The town of Appingedam has a total number of inhabitants registered in the municipality by January 1, 2015 of 12 006 people and a total area of 2436 hectares of land (Gemeente Appingedam, 2015).

Appingedam is subjected to earthquakes suffering several recorded impacts that are directly linked to one of the main lines of gas extraction passes near the city. As noticed on the Figure 6, at least seven earthquakes had been registered in Appingedam, and it is completely surrounded by the earthquake zone (Figure 7), causing then high effects on the current infrastructure. According to the Vergouwe (2015) the centre and most sites in the town are located on high risk zone flooding.

In the following maps, the risk for flooding is also marked in Figure 8, suggesting more than 85% of the total area in Appingedam lies over risk zone of flooding.

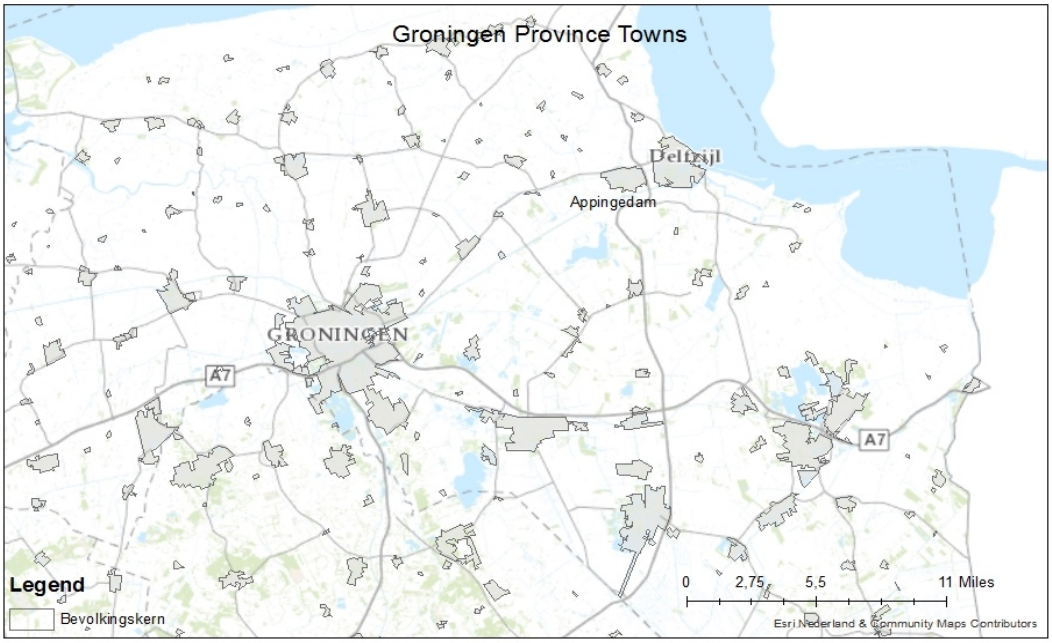


Figure 5 Groningen Province town (image edited by researcher)

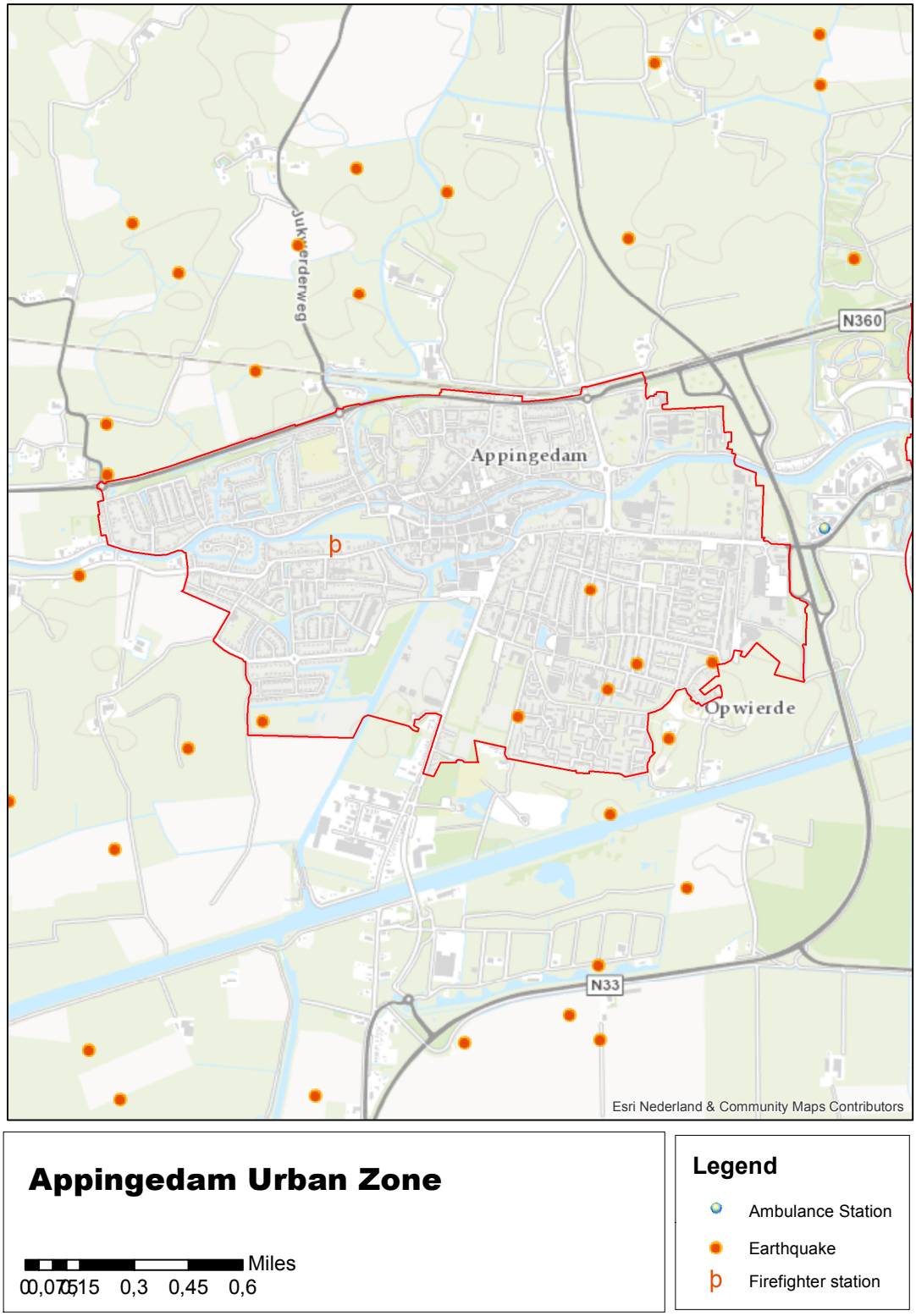


Figure 6 Appingedam Town (edited by researcher)

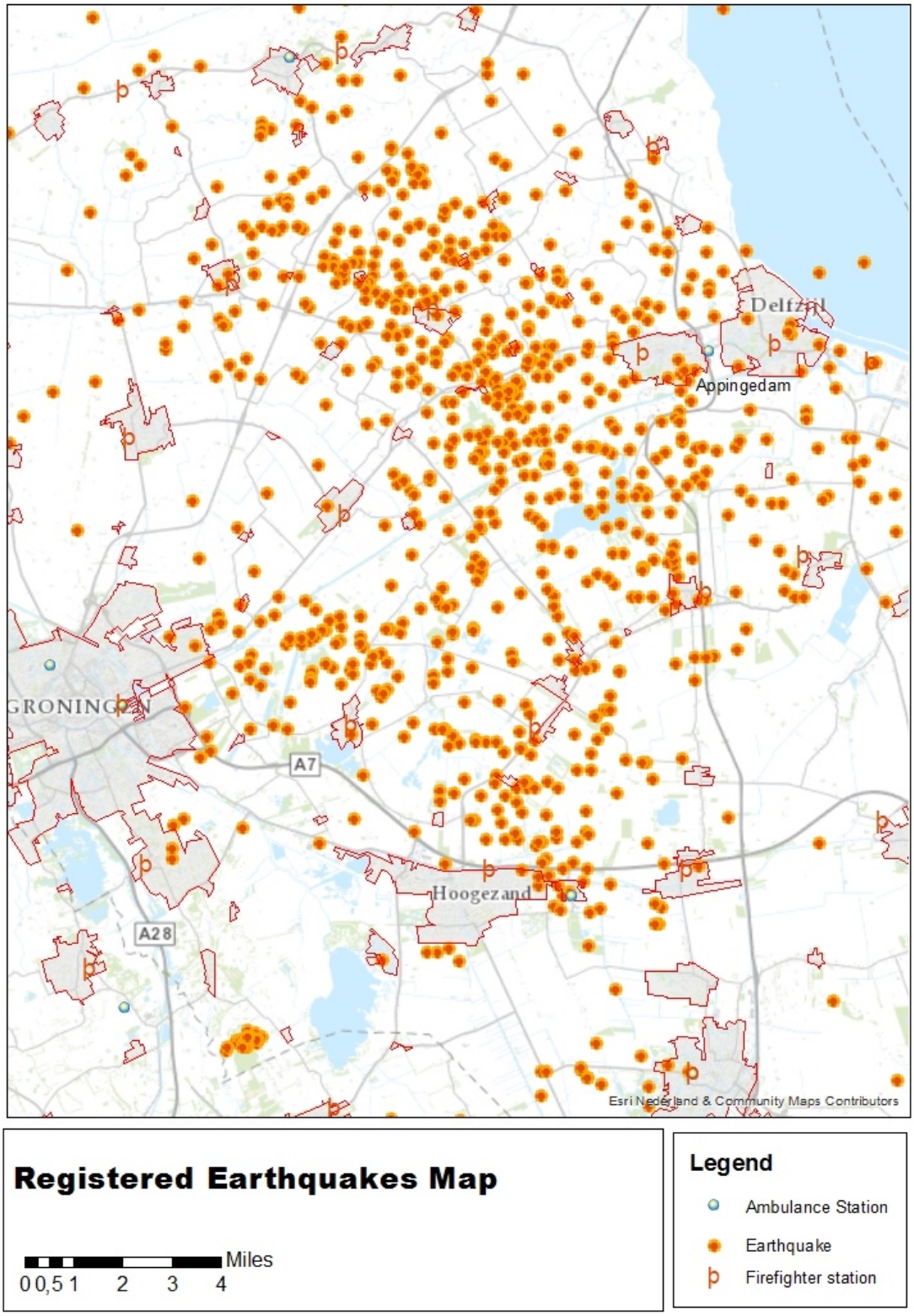


Figure 7 Map of earthquakes in the province (edited by researcher)

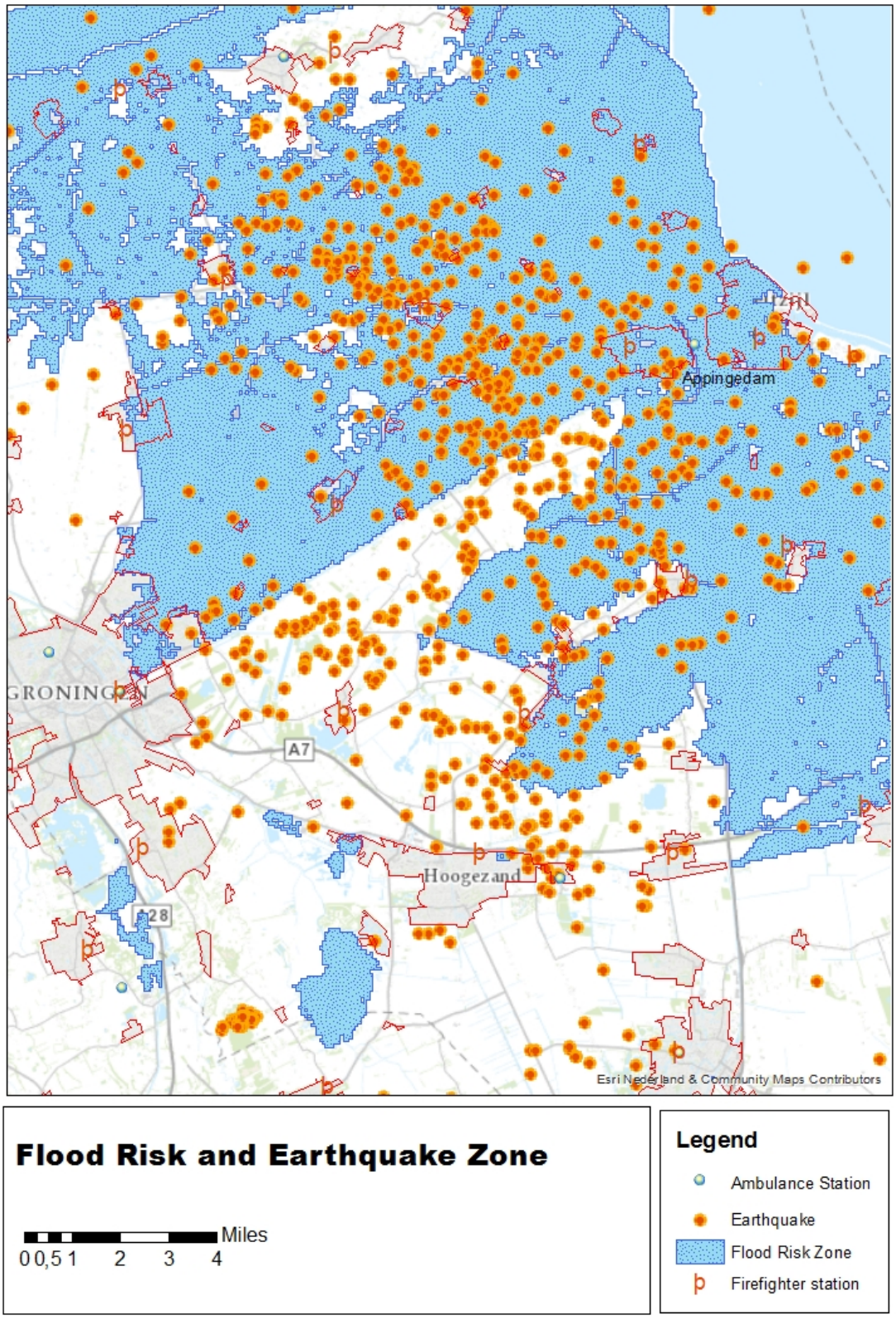


Figure 8 Flood Risk of Groningen Province (edited by researcher)

4 Data

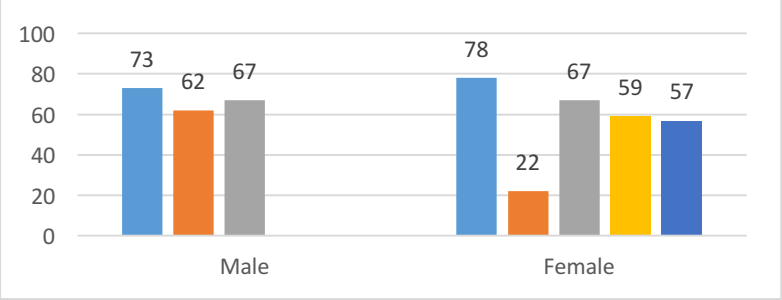
In this chapter the results of the interviews with Appingedam residents, academics and institutions representatives are presented. The complete set of questions addressed can be found in Appendix 2. The results are structured according to five capacities of CR and governance influence themes; it goes as follows:

1. Individual capacity and competences
2. Community Capital
3. Economic capacity
4. Infrastructure capacity
5. Institutional capacity
6. Governance

4.1 Individual capacity and competences

General individual attributes as age and education create a characterization of the town. The gender and age distributions of residents that participated in the research are presented in the table 2. As it can be noticed, and 7 put 8 participants have more than 55 years old.

Table 3 Residents Age and Gender



Appingedam is facing aging population and shrinking population issues. This two factors present a problem clearly affecting spatial urban planning, with an inactive real estate market, housing abandonment, and people to move to more central locations that leaves the peripheral zones less densely populated (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016). But age is also directly linked to disasters, in the sense that response of the people, knowledge, mobility, it becomes critical for preparedness (Interviewee B: Employee at Appingedam Municipality, 2016). When consulting to the municipality about the individuals they recognized that now elderly homes are a very critical point, and argue that the main issue is mobility and the amount of elderly homes in the town (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016).

When residents were interviewed about their individual experience, past reaction and earthquake risk and flood risk perception, different outcomes were noticed. Earthquake awareness is higher than flood risk awareness. Over earthquake risk all residents are aware of the earthquakes, they expressed to have felt and earthquake in the past and 5 residents mentioned they had earthquake damages in their house (Interviewee E, G, H, K, L; Appingedam residents 2016). These five residents had a higher earthquake awareness, and mentioned to be more informed and alarmed. Damages include broken chimneys, cracked floor and fissured or broken walls. One participant mention his house needed to be demolished, currently it has seismic reinforcing in walls and that this increases his own awareness but also his neighbours commented about it (Interviewee K: Appingedam resident, 2016).

However, when asked about flood risk only 2 residents would express high awareness and interest (Interviewee I, L; Appingedam 2016) the rest of the residents described very low importance, and a mentioned not to be concerned about any water related problem. These two residents described and event in a nearby town Woltersum, which is very near to Appingedam. This same event was considered a warning to the waterboard, there people were evacuated in 2012, because the dykes were not strong enough (Interviewee C: Waterschap Noorderzijlvest, Appingedam 2016) .

Participants were asked to picture a scenario were earthquakes and floods combine. When concerning personal earthquake-flood risk awareness, it is important to note that 4 of 5 residents with previous earthquake damaged houses had a bigger scope of the damages and consequences of plausible earthquake effects (Interviewee E, G, H, J; Appingedam residents 2016). However, the other half of the residents were careless and the interviews showed low risk awareness.

"*know that when the dykes are breaking that is a possibility as an earthquake, then the water of the sea the will come until our houses, we can go on the top floor"* (Interviewee J: Appingedam resident, 2016).

The second indicator used to identify the individual capacity relates the individual knowledge and reaction to earthquake, flood and possible earthquake-flood disasters. For the residents with higher earthquake risk awareness, interviews revealed they had a better understanding of the gas extraction process, they express to be more careful with their properties and the earthquake news (Interviewee E, G, H, K, L, J; Appingedam residents 2016). Interviews demonstrated regarding flood, residents are informed of the improvements to flood defences and and how to react in case of high water levels (Interviewee E, G, H, K, L, J; Appingedam residents 2016)

Regarding individual reaction in case of disaster, various responses aroused as informed reaction procedures in earthquake case (Interviewee E, G, H; Appingedam residents 2016). Yet 5 residents, 3 females and 2 male, revealed spontaneous replies that demonstrated low importance given to the matter, and poor knowledge on how to react. Residents were asked about how will they react in an earthquake-flood scenario, just 2 residents considered it could be possible (Interviewee F, L; Appingedam residents 2016) but none of participants had a response on how to react to such an event.

> *"don't care, we don't have a plan of where to go or what to do" (Interviewee L: Appingedam resident, 2016).*

The last indicator for individual capacity relate to individual beliefs and values. While doing the research it also seems that the value of independency and personal character aspects of the individuals aroused in their response (Interviewee E, H, I, G, L; Appingedam residents 2016). This makes and important component for further creation or not creation of solidarity actions. At an individual scale residents seem to be affected at different psychological effects, for example stress and anxiety (Interviewee E, G, K, L; Appingedam residents 2016). Yet this seems to be not enough to trigger collective actions.

> *"Well I like to have my own plan to do what is necessary to me and my wife, so it is not by joining any group or going to companies I prefer my own plan" (Interviewee K: Appingedam resident, 2016).*

When consulting about this to academics they seemed to have a similar perception. They refer that strong personal feelings are shared such as anger, frustration, the results were isolated responses (Interviewee O: Disaster governance expert; 2016). Not that much self-organisation or protest groups were formed and they relate this to the character of the individuals of the northern communities of the Groningen Province.

4.2 Community Capital

Community capital questions aimed to understand community action groups present in Appingedam and refer to the participation of residents within this groups as indicators. Residents were asked about which groups they knew, or if they belonged to any community organisation and if they actively take social actions. 7 of the residents responded that they would be keen to it. The desire of people to become involved in sharing experiences and earthquake knowledge was noted. These seven residents revealed common thoughts, they were describing the Groninger Bodem Beweging (GBB) as a club or group were they find support for earthquakes problems (Interviewee E, F, G, H, I, J, L; Appingedam residents 2016). The GBB is the biggest action group, many people middle class are member of the organization which has about 3000 members (Interviewee N: Land value expert, 2016). They are very active as a lobbying citizen group trying to get good information and comments on any measure taken and that is a very important group representing the people, not connected to any political party (Interviewee D: Groninger Gasberaad Representative, 2016).

Action groups present were actually few, most of the people knew of the association of the (GBB) and the Groninger Gasberaad. In the community some isolated initiatives are present, they mostly focus in raising awareness. Sometimes in crowdfunding in order to support the groups, for example races or walks, special care with damaged monuments or creating art with earthquake risk topics (Interviewee E, Appingedam residents 2016) (Interviewee O: Disaster governance expert, 2016).

Participants were asked about their involvement in the action groups, 7 residents were members of the GBB, unfortunately, 4 people felt like their involvement is not required or see the risk as a very distant issue, thus they do not participate in active way. These residents simply expect to receive a regular newspaper without attending any meetings or volunteering at any activity. Interviews revealed some insights about why they do not like to participate, such as the minor magnitude of earthquakes lessen the will to be involved (Interviewee F, Appingedam residents 2016). When participants were asked about flood groups, they referred that is was not a citizenship problem rather than a governmental responsibility, and then having flood groups was pointless (Interviewee J, Appingedam residents 2016).

The three residents actively participating, have suffered bigger damages in their houses as consequence of the earthquakes, the damages encouraged them to have more involvement in the GBB. Volunteers can join the boards, they distribute themselves tasks in their in free time and no one pays for them (Interviewee L: Appingedam resident, 2016). Residents like to share experiences about earthquakes with other members and try to do something to help each other in the community (Interviewee E: Appingedam resident, 2016).

There are also some other minor groups, with stronger actions as demonstrations and stronger agendas. This groups manage to assemble the feelings and nonconformity of some people for different actions as demonstrations, information meetings and raising awareness.

> *"I went once to a demonstration in Groningen and also in front of parliament. We never protest since we were young, never done it before but if we do not do it who is going to pay attention" (Interviewee H: Appingedam resident, 2016).*

Community capital also relate to the social knowledge and risk understanding as other indicators. When participants were asked about their understanding and information they also related on how they received this information. 5 of the the participants mentioned that the newspaper has a primary role in their information and knowledge broadcast, yet some participants mentioned that the information available is quite scarce (Interviewee E, G, I, J, K, L, Appingedam residents 2016). Interviews revealed that residents acquire their knowledge about earthquake and flood risk through two main sources: i) newspapers ii) talking to experts (Interviewee K, Appingedam residents 2016).

As a counter measure to this limited information access, the GBB for example has a system of creating knowledge related to earthquakes and local policies, and broadcast it to its members. Most of the time they broadcast through internet, but any member can attend the group meetings and learn there (Interviewee H, Appingedam residents 2016).

Finally, the last indicator for community capital section refer to the trust and solidarity actions that neighbours present to each other and to local institutions. Six residents mentioned the communication with the neighbours was good, they even help each other whenever it was required. Then these residents were asked to express what kind of help you request to your neighbour, and answers such as caring in sickness, or small repairs inside the house, to sharing tools or equipment were received (Interviewee I, L, K Appingedam residents 2016). Interviews reflect that the neighbours will be close to each other, show empathy and support themselves in some degree. These 6 residents mentioned to trust their neighbours and had a good relationship most of the time, in fact social support actions can be noticed. 3 neighbours mentioned they had constant communication, even help each other with housing repairs. Participants elevated trust between neighbours can be appreciated, they understand a degree of trust even for flood disaster moments if required (Interviewee E, H, Appingedam residents 2016). On the other hand, when someone had an earthquake damaged house, the problem was solved independently and was not commented with neighbours or friends (Interviewee K, Appingedam residents 2016).

At a different scale, trust in the provincial and national authorities is weakened due to the NAM influence on decision making process of earthquake related topics. Municipality have gained the trust of the people a local level residents felt supported by their municipal efforts (Interviewee E, H, K, L, Appingedam residents 2016). The community does not trust higher authorities such as the Province government or recovery agencies as the NCG (Interviewee A: Employee of the Groningen Province Earthquake Dept., 2016). Province level and recovery agencies such as the (CVW) Centrum Veilig Wonen and (NCG) National coordination Groningen have a weak perception from 4 residents (Interviewee N: Land value expert & Interviewee E, G, K, L, Appingedam residents 2016). CVW is the executive office the Groningen gas field company were residents of the area report damages which they believe to be caused by an earthquake. CVW also committed to strengthening and, where possible, build sustainable homes and buildings in the area. This was discussed at the province level, and the programmes aim now to recover the community's trust (Interviewee A: Employee of the Groningen Province Earthquake Dept., 2016).

"Of course, our mayor is very trustful, very outspoken" (Interviewee L: Appingedam resident, 2016)

"And the CVW, is not independent organisation it depends on the NAM, so there is a lot people that don't trust the CVW" (Interviewee K: Appingedam resident, 2016)

According to the Province of Groningen, they are aiming to restore the trust and taking actions to gain the goodwill of communities (Interviewee A: Employee of the Groningen Province Earthquake Dept., 2016). The programs and communication is now shifting to be closer to the local and community level (Interviewee A: Employee of the Groningen Province Earthquake Dept., 2016). The national government want to restore the trust in Groningen's communities, so they developed the National Coordinator Groningen and they have a plan to restore the trust by repairing earthquake damages and aim to build seismic reinforced houses (Interviewee A: Provincie Groningen representative, 2016 & Interviewee O: Disaster governance expert, 2016). To academic researchers, this topic of trust has differed views and supports the data found in the participant's discourse. The degree of trust on national and provincial levels and authorities is very weak, and is directly linked to the involvement of the NAM. The national level is so much involved in the economic, gas business revenue that they are experienced as an opponent and non to be trusted (Interviewee N: Land value expert, 2016).

4.3 Economic Capacity

This was analysed in terms of the pre-established indicators of economic capacity to cope effects earthquake-flood disasters. Interviews asked questions about the funding for investments in both earthquake and flood protection. Specific questions about the financial damage from previous hazards, existing funding and insurance support were discussed with the residents, but also economic specifics of wealth and housing market were discussed with academics and institutions.

The first indicator reviewed with residents was the financial damage from previous events. Appingedam participants were asked to express about their previous experience with earthquakes and floods and to mention if they had economic losses from those events. None of the participants have been affected by flooding in the past. However, most of the houses in Appingedam have had some sort of damage due to earthquakes (Interviewee B: Appingedam Municipality Planning Department, 2016). This represents and an ongoing negotiation with different organisations to fund their repair.

So far, the main economic impact has been done by earthquake damage, were various houses had to be abandoned, lost their value or need major repairs (Interviewee N: Land value expert). This damages must be repaired by the NAM, the national gas company, since the phenomena is a consequence of gas extraction. The economic support process takes long time, various institutions are now involved and each case is treated individually (Interviewee D: Groninger Gasberaad Representative). The gas company has three levels of damage which they categorize the damage, it can be none earthquake related, real earthquake cause, or it can be complex damage combined with weak sub soil for example, which makes the foundations of the building easily collapsed or weak (Interviewee N: Land value expert). 5 Participants explained the funding for repairs as a struggle, NAM do not cooperate, and so many inhabitants have been relocated due to strong damages (Interviewee E, H, K, L, Appingedam residents 2016). The repairs funded by the CVW cover certain amount of value, in some cases houses are so much damaged that repairing and strengthening this places is too expensive and residents are force to sell their houses (Interviewee H, Appingedam resident 2016).

The second indicator reviewed in the town was related to the economic funding and disaster insurance. As a funding strategy, the NAM had supported the inhabitants who had minor earthquake caused damage with an economic compensation, of 4000 euro, this funding was a relieve for some participants but for others was a minor fund (Interviewee J, Appingedam resident 2016) & (Interviewee M: Earthquake Social Impacts expert, 2016). This measure was discussed with researchers of what effect might bring to community, according to them more research is needed (Interviewee M & N, Academics, 2016). This money can be imagined in a scenario in which this 4000 is perceived as blood money or somehow evaluated negatively by people, on the other hand many people taking that money and using it to improve their houses (Interviewee M: Earthquake Social Impacts expert, 2016). Different uses were assigned to this money, 3 participants with minor damages have expressed to be satisfied about it, but also depends on each individual case and difficult to generalize (Interviewee I, J, L, Appingedam residents 2016). These uses include energy improvement in the houses, as implementing solar panels or double glazing windows, or do some new heating system (Interviewee I, Appingedam residents 2016). In all cases, not one participant counted on a personal fund for cases of disaster, and is not something they have ever considered important.

Participants were asked if they had a personal house insurance over disaster damage. All replied they had a regular insurance but that earthquakes and their effects are not covered. However, for three residents the insurance provided a funding for a legal advisor that helped people to establish a legal process against the NAM Interviewee E, G, I, Appingedam residents 2016).

When referred to a public scale of infrastructure damages or prevention like the Eemskanal flood defence, different actors are involved but the funding is similar, the task is being performed by Noorderzijlvest (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager, 2016). The reinforcement of the canal required research of new extra seismic measures and new technical solutions during job execution. This additional measure requires a higher investment, which funding now represents a dispute between the waterboard and the NAM (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager). The extra measures taken to ensure safety in the canal are to be paid by the gas company according the waterboards. There exist a previous informal arrangement involving the ministry economic affairs, the waterboards and the NAM that established the funding will be provided by the NAM, yet the funding is not yet available (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager).

For the society associations the funding must come from the volunteer activities, and some support from the NCG. The amount of economic support at the moment is not enough, so the NAM is also a source of funding now (Interviewee D: Groninger Gasberaad Representative, 2016). This aim to keep an open dialogue and associations functioning. Some people argue that this kind of funding bias the opinion and work of the associations. However, this is a required financing specially because they were about to shut down and then there wouldn't be a societal counter power left (Interviewee D: Groninger Gasberaad Representative, 2016). When authorities and organisations where consulted for their funding to carry their activities, they mentioned that budget now is a limitation (Interviewee A: Employee of the Groningen Province Earthquake Dept.). Different economic funds are managed, but at local authorities level the funding relates the provincial and national support, at the moment they do not have independent funding for any activity related to disasters (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016). Municipalities support a common fund for the NCG, where the earthquake projects are managed while the other organisations for earthquakes as the CVW depend if the NAM economic support (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016). On the other hand, the provincial government role is to provide the arguments for the budget to be assigned from national level and then executed at local level, yet this is an ongoing negotiation (Interviewee A: Employee of the Groningen Province Earthquake Dept, 2016)

Finally, participants were asked about housing market and wealth of the institutions to prepare for earthquake-flood disasters. As a consequence of the increased risk in the zone, the real estate market showed a loss of value for the houses in region (Interviewee N: Land value expert, 2016). Inhabitants expressed themselves with anger and frustration because this affect the sales opportunitie and their current wealth (Interviewee E, F, I: Groninger Gasberaad Representative, 2016).

> *"They lost value not only because they are damaged but also because nobody wants to live here anymore. No one in his right mind comes from outside, you can't sell the house and you are stuck here" (Interviewee F: Appingedam resident, 2016).*

Academic studies are being developed to identify to what extend the properties have lost their original value (Interviewee M: Earthquake Social Impacts expert, 2016). According to the research this also depends on which method is used to assess the economic impact, but the value loss of the house stock market is estimated in almost 1 billion Euro and affects almost 90,000 houses (Interviewee N: Land value expert, 2016)

4.4 Infrastructure Capacity

Regarding infrastructure capacity CRD, participants were questioned about seismic resistant infrastructure. Interviews revealed how infrastructure has been reinforced or innovations are helping to become seismic proof. The municipality explained that they are working to improve the future constructions and strengthening the public buildings, specifically schools (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016). Also, an amendment to the municipal building code will be applied and this will require that seismic conditions are considered in the design of public facilities (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016).

However, the residents' critic this improvements, and argue that they are just done for political attention and not intended for helping to housing seismic improvements (Interviewee E, H, I, Appingedam residents 2016). This revealed community dissatisfaction to the actions carried regarding home infrastructure. According to 3 residents the programmes from the NCG to strengthen houses, damage recovery and house selling lack of enough capacity and work too slow (Interviewee E, F, L, Appingedam residents 2016). This reveals that there is a connection between the national level and the community, and they are working to reinforce infrastructure (Interviewee L, Appingedam residents 2016). For example, a participant is involved in the pilot projects but states they are already overcrowded. This project intends to fund strengthening measures but giving the freedom for owners who want to carry themselves the measures to their home or building. In the pilot project, the NCG grants 50 owners the opportunity to perform as a private client strengthening measures and any other alterations to their homes.

In terms of infrastructure and flood, institutions and residents where asked about how are they being transformed/reinforced and the risk they represent. These questions intended to understand the second indicator about flooding and public protection measures. Different answers were obtained, half of the residents interviewed will not care about flood protection measures and argue that they rely on the waterboards and that is their responsibility.

> *"not our problem, there is money going to that, because the waterboards are responsible for that" (Interviewee G: Appingedam resident, 2016).*

The other half mentioned to recall activities being done in the dykes and canals to have a stronger infrastructure (Interviewee E, F, I, L, Appingedam residents 2016). When consulting the waterboard it was corroborated a technical redesign on the Eemskanal strengthening and reinforcing for stability and height of the defence (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager, 2016). They are sort of increasing height levels but they are also taking measures of retention areas, to take off a some of the water, but also the control flood risk (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager, 2016). The waterboard was also consulted about the scenario that flood defences will be affected with an earthquake. The point of view of waterboards is that they don't want damage failure during earthquakes, so the safety standard now increased and the flood defence should be able to cope with a scale 5 Richter scale earthquake (Interviewee C: Waterschap Noorderzijlvest Eesmkanal Project Manager, 2016).

The last indicator used to understand the infrastructure capacity, was post-disaster services and critical infrastructure. Elderly homes represent the vulnerable population of the community. Elderly people are concentrated in non-seismic resistant facilities, thus plausible damage and flood risk are high, and at individual level they depend on medical care, guidance and lack of rapid mobility (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016). When Municipality was consulted about the critical facilities the town has no hospitals, no power generation in site and one train track, yet mobility also by roadway is also possible (Interviewee B: Employee at Appingedam Municipality Planning Department Appingedam, 2016). 5 residents expressed very confident to get post-disaster aid, even when there was no hospital, but they refer that aid infrastructure is accessed in

short time and they don't preoccupy about aid services (Interviewee E, G, H, K, L, Appingedam residents 2016). According to the municipality the most critical infrastructure should be schools, large offices and elderly homes (Interviewee B: Employee at Appingedam Municipality Planning Department, 2016).

4.5 Institutional capacity

The institutional capacity of CRD was questioned with academics and institutions representatives. The first indicator was about knowledge about earthquakes and flood and also the communication of this risk from the institution to society. The access and creation of knowledge was expressed as a common weakness for the province and societal organisations (Interviewee D: Groninger Gasberaad Representative & Interviewee A: Employee of the Groningen Province Earthquake Dept.) According to academics, the information about earthquakes is very limited, and is not available from everyone and the one who suffers most is the municipality who must make decisions with limited information (Interviewee N: Land value expert, 2016)

Municipalities have not recorded or documented any process related to earthquake damages or flood risk, there is no such thing as records, damage description or database at all, knowledge and learning is very limited (Interviewee B: Employee at Appingedam Municipality Planning Department). The Province level express that they require more independent research and knowledge building, none biased by the NAM in order to make better decisions (Interviewee A: Employee of the Groningen Province, 2016). The Gasberaad express their need also to get involved in the information sharing and that a key a role is sharing knowledge but nowadays the process is very limited (Interviewee D: Groninger Gasberaad Representative, 2016).

In order to create more knowledge about earthquakes a research centre (KADO) organized by the RUG and in the Sustainable Society initiative was created. KADO is a knowledge centre that brings together all the researches in university who are interested in the impact of earthquakes or gas extraction on human population (Interviewee M: Earthquake Social Impacts expert). It aims to collect a variety of knowledge, and is in constant communication with institutions and society to share their progress, KADO also seeks for the integration of different institutions and share their findings with them (M: Earthquake Social Impacts expert).

Public institutions were consulted about their understanding for cascading disasters, in all cases they expressed themselves as if they have not considered this major disaster scenario and that is not their role to review about it (Interviewee A: Employee of the Groningen Province, 2016) & (Interviewee B: Employee at Appingedam Municipality Planning Department). To academics, this demonstrates that disaster plans have not been made involving multiple institutions and clearly the community participation is also missing (Interviewee M: Earthquake Social Impacts expert, 2016)

The second indicator reviewed for institutional capacity was to understand the roles and involvement of local authorities. This extends also to review the multi-actor and multi-level integration regarding earthquakes-flood plans and agendas. When consulting to each institution about their role and the scope of their organisation in earthquakes disasters each explained their past role and changes within the last two years (Interviewee A: Employee of the Groningen Province, 2016). Sometimes, the changing roles caused a blurry scope of their actions (Interviewee D: Groninger Gasberaad Representative, 2016). The best explanation comes from an academic view, the institutions do not know themselves much, everyone is doing really the best for its own group that they represent. Municipalities are looking for their people the Province doing for province agenda, and so there are many different

organisations but is also all new, still to find out what their role is it in relation with other governments (Interviewee O: Disaster governance expert, 2016). When the Province representatives were consulted about their role and decision making process related to earthquakes and risk, they explained that they are in charge of coordinating agendas, lobbying, supporting local governments and are the link to the national government (Interviewee A: Employee of the Groningen Province, 2016). At a different level the national government have created the National Coordinator Groningen, a national level acting at local level to improve the actions for earthquake response (Interviewee O: Disaster governance expert, 2016). When consulting the municipality of Appingedam, about their role and how they work together with the NCG they explained that there is not a linking figure yet but they expect to have an officer dedicated to link municipality, community and NCG programmes (Interviewee B: Employee at Appingedam Municipality).

The third indicator of this capacity refers to role and decisions making of action groups. The interview with the residents revealed that all of the participants knew at least one earthquake related group. The societal participation was generally oriented to respond to earthquake damages, and to form a union of people who can legally take actions over the NAM (Interviewee E, Appingedam resident, 2016). The Groninger Gasberaad is the association representing the societal part in the dialogue with the NCG (Interviewee D: Groninger Gasberaad Representative, 2016). As explained by themselves, they also try to shape a vision for the region and aim to develop a sustainable development in economy, environment and energy (Interviewee D: Groninger Gasberaad Representative, 2016). This association is relevant because it shows structure and self-organisation within the different societal groups. Societal organizations respond to the Gasberaad leadership and the communication and agreements flow through it (Interviewee D: Groninger Gasberaad Representative, 2016). One of the major action groups is the Groninger Boden Beweving, it has the biggest amount of members and has an active influence in the community (Interviewee N: Land value expert). However, smaller scale action groups were not detected in the community, none of the participants mentioned a different relevant group at community or neighbourhood level.

4.6 Governance

Governance was reviewed in relationship, roles and responsibilities of institutions and community participation. The institutional capacity shows the current roles of each major actor and the data reflects that community action is limited. In the Netherlands, there exists a transition to decentralisation, so lot of more rules and responsibilities are going from central level to local level, so the municipalities tend to have more tasks (Interviewee O: Disaster governance expert, 2016). Consequently, from this general trend it can be seen in Appingedam local level is very important, municipalities have residents' trust, and are including new figures to coordinate earthquakes activities and link them community (Interviewee B: Employee at Appingedam Municipality). For the 6 residents, municipality is the most important government body, local level is doing the most and having the most prominent position in the local area regarding earthquake and flood information (Interviewee E, F, H, J, K, L, Appingedam residents 2016).

Most legislation comes from the national level, they decide on the frames in which the local and provincial government should act, they decide on the amount of gas extracted, they decide and then local level is executing (Interviewee A: Employee of the Groningen Province) & (Interviewee O: Disaster governance expert). Now exist the NCG, which is from the national level at local scale, and it is not yet decided whether if it is going to have the power to take these decisions themselves, or if it is more coordinating, between all other groups (Interviewee O: Disaster governance expert).

5 Discussion and Conclusion

The conceptual model reflects how governance influences community resilience and explains how CRD is composed. Applied to earthquakes and flood, it is important to acknowledge the existence of complexity, multiple stakeholders, existing governance and planning processes (Chang et al., 2014), and in Appingedam the multilevel approach requires specific attention. This was reflected in the conceptual model and in practice, one cannot focus in just the community itself without reflecting in the overall governance context. This shaped the data collection process, integrating different sources, the different levels of government, societal institutions and residents. To answer the question of how can community resilience could be assessed, five capacities with suggested indicators of CRD were proposed and then tested. The data gathered also reflects the conceptual model in the dimensions of community resilience to disaster. The data gathered demonstrates that the dimensions of CRD chosen in theory were successfully operationalized and be grouped according several qualitative indicators. These dimensions proved to be relevant in the process of determining community resilience in a useful qualitative tool. However, this assessment requires high investment of time, participants and analysis.

In order to answer the first set of sub-questions, theory and Appingedam context were reviewed. Consequently, this was compared to the data collected to prove that the selected theory was coherent with the case study. This questions are:

1. What are the potential effects of earthquakes-floods in Appingedam, Groningen?
   1.1. How can earthquakes-floods hazards combine into cascading disasters and how they differ from single event disasters?
   1.2. How does cascading disaster theory help understand and analyse cascading effects of earthquakes-floods threatening Appingedam, the Netherlands?

According to the spatial distribution of Appingedam, the town urban concentration comes along the Eemskanal. When comparing figure 6 and 7, the past earthquake epicentres were close to the canal border, yet more than 85% of the total area in Appingedam lies over risk zone of flooding. This demanded the holistic view of hazards, however disaster management plan discussed with authorities in the municipality and province, at the moment contemplate only isolated events. Disasters can be analysed by different points of view, the fragmented model by multi-hazard perspective and a more holistic view through cascading disasters network. Isolated event approach means that earthquakes have been considered separately from floods and never see a plausible flood as consequence of earthquake, this creates individual response plans and isolated efforts to cope with disasters one at the time. In Appingedam, mostly reactive policies exist, they respond to a technocratic definition and construction of the risk of earthquake and flood as discussed in Gupta et al., (2015). The current perspective does not focus on the possibility of subsequent events after an earthquake, however flood risk as consequence of earthquake can be possible, specifically in the urban development next to the Eemskannal.

The cascading disaster model tracks progression and magnitude of events within a system, such as the existing earthquake hazard and flood danger relationship, adding value by providing track of the amplification over time (Pescaroli & Alexander, 2015). For Appingedam it means that the main difference is considering the subsequent effects of earthquakes into infrastructure, public services and buildings, but specially flood defences to prevent a plausible flood. The only institution in Appingedam that minds the holistic view of risk is the waterboard Noorderzijlvest. Concerning flood protection, the Eemskanal flood defences are the most relevant for the town. Improvements in defence are being done, measures are taking to ensure that the canal can cope with and earthquake of scale 5 in Richter scale with normal water levels and prevent dyke of breaking down. The technical redesign reinforces stability and height of the defence, deeper metal poles and also retention areas are being expanded. This is a seismic and flood risk technical measure that improves

the CRD of Appingedam, however the transformation of the buildings or houses alongside the Eemskanal is not yet part of any programme. Future measures could consider a cascading disaster view of risk and can be combine with the shrinking problem of the town and apply spatial measures for cascading disaster risk in the new urban planning. This means that seismic reinforcement can be combined with flood risk adaptation alongside the canal by changing the land use or the buildings design for the section right next to the water, and take advantage of spatial measures to diminish the risk of cascading disasters.

The answers to the second block of sub questions will be provided in the following paragraphs. The theories used for the research refer to how can cascading disasters shape the concept of CRD. This questions are:

2. How can community resilience to disasters be understood?
   2.1. What does community resilience to earthquakes-floods disaster mean in Appingedam, Groningen?
   2.2. What roles does adaptive capacity have in community resilience to disasters?
   2.3. How can community resilience to disasters be assessed in Appingedam?

In this research I argue that community resilience to disasters refers to the process of linking adaptive capacities to prepare, function, adapt, recover and learn from disaster. It demands an understanding of which adaptive capacities are desired under the context of the hazard threatening the community (Bruneau et al., 2003). One finding is that in order to be useful a CRD model should be viewed with qualitative approach, rather than viewing statistics and value appreciations as presented by Cutter et al., (2008). In other words, the framework developed in this thesis presents a different approach to a resilience assessment tool, it helped to understand insights and actors of a community rather than score a geographical zone with a value of characterization. Assessments which provide insights and detailed considerations deliver an accurate baseline and understanding of a community situation, than quantitative estimations that can provide distant values for a scorecard (Singh-Peterson, Salmon, Goode, & Gallina, 2014). The developed framework grants an approach able to operationalize CRD, but it could be noticed that CRD is a place specific process, that depends on the hazards and the governance influence.

Community resilience to disasters of earthquakes and flood present a challenge in Appingedam. With two hazards combined, CRD in Appingedam demands to view a resilience with earthquake and flood disaster multi-event hazards, that is to combine the seismic and flood resilience at community level. To Appingedam's community this means that technical infrastructure strengthening from the seismic resilience and the capacity to manage, or maintain certain functions and structures (Ainuddin & Routray, 2012), during disastrous events is vital. But also demands for flood resilience, the resistance strategy to reduce the probability of a flood hazard and minimize the consequences (Restemeyer, Woltjer, & van den Brink, 2015) implying land used adaptation is required.

Adaptive capacity and resources are the cornerstone for community resilience to disasters. According to Folke (2006), this include understanding of social processes like, social learning, social memory, transformability and systems of adaptive governance that allow path to create resilient communities. CRD focuses on antecedent conditions of communities, specifically related to inherent resilience, which is the existing resources, planning/policies and capacities within the community to respond and recover from disaster (Singh-Peterson et al. 2014). The model presented in this research identifies five categories of capacities for CRD. I argued for elaborating the capacities of CRD to earthquake/flood cascading disasters and are shown in figure 2 of the conceptual framework. These five capacities are (i) individual capacity (ii) community capital (iii)economic capacity (iv) infrastructure capacity (v) institutional capacity.

The data collected showed to what extend characteristics of each capacity were present or not in Appingedam. Relevant finding will be discussed to answer the third sub question of how can CRD can be assessed and what it means in Appingedam.

(i) Individual capacity

Individual experience of any flood alarm or earthquake damage seemed to be relevant to enhance risk awareness. This explains that there is a relation from past experiences with individual assimilation and understanding of the consequences and risk awareness. In Appingedam the people who have not suffered any damage in their houses due to earthquakes, have less interest on informing themselves about the earthquakes and disasters. However, all of them expressed high trust on the water management system, and expressed themselves confident to how their houses will resist flood. This is also related to the fact the trust residents have on the waterboard as an institution and the flood defence technical improvements. Residents and waterboards have good communication, the residents seem to understand what job is being done and the reason why this is being executed. This represents a combination of elements from different capacities, it can be noticed the individual component of risk awareness and knowledge about floods, but also the trust in the institution of water management and the fluent communication. This last, intertwine indicators of institutional capacity, and social trust of community capacity.

Cutter et al., (2008), discuss that committees and action groups originate themselves from cohesion of individuals sharing same belief and values. In the case of Appingedam, it was noticed in the answers from residents the tone of anger and frustration feelings against the fact that earthquakes were induced by gas extraction. It has created trust conflicts, and shared value of independence and isolation instead of unity creation. Even when people share the feeling, they do not seem to create organisation of neighbours, or community cohesion at any level. As discussed with academics, this can be part of the nature of the character of the people in the region, they come from a history of hard working fishermen and farmers used to hard work and less complaining. However, the psychological effects of hazards have affected the community experienced in each individual way. People preoccupied, anxious, frustration affect the quality of life of people in Appingedam. Yet, this topic could be further explored in another research, the current assessment was limited to analyse whether this was influencing community resilience. In Appingedam it has proven that sharing beliefs, values and common feelings does affect the formation of committees or action groups, however sharing same values not necessarily impact in a positive way. The sense of belief in keeping it down to earth, very independent result in isolated initiatives even when more or less same damage and the risk is shared by a large amount of residents. From the previous it can be inferred that the individual capacity dimension is relevant for CRD but also strongly relates to other capacities as community capital and institutional capacity.

On the other hand, the people who experienced earthquake damages in their houses, were also aware of the damage that seismic movements might cause on the dykes and were not surprised that a possible flood may happen. This also triggered better disaster response ideas, however most of them had very poor responses towards an earthquake and less idea with a combination of events. Most of the people would not know how to react, they have no knowledge of emergency plans, not a recognized shelter or safe place inside their homes. Their reaction also revealed that the disaster emergency plans from the town were not communicated to an individual level. Residents then will wait for the news or instructions upon the moment, revealing the command and control methods of disaster management and not a proactive policy in the community. Most of the people will have a spontaneous, probable unsafe reaction according to their description to run away or just stand still somewhere. Few of the residents have a plan on how to react, they know how to check on gas and electricity on the house and take shelter. As for flood, all of the residents know how to react and what procedure to follow, however no one is really prepared or expect that to happen. It can be concluded that people will have careless reaction to earthquakes, and this will exacerbate the risk when a combined event earthquake-flood happens.

(ii) Community capital

Community capital dimension as a dimension was evaluated, in the case of Appingedam some relevant issues of trust, knowledge and public participation were found significant. It is important to analyse that in the community exist a gap between being member of an action group and the active participants in the group. This can be seen as a discrepancy in the resident responses, all of the residents knew at least one group, almost all mentioned to be members of the GBB but they lack of an active role in it. Even when participants mentioned they were keen to share experiences and being part of the GBB groups, they do not involve themselves in the activities. This gap requires further research, one can think there is a link to those people who are actively involved in the groups, like experience from past, damaged earthquake house, similar jobs, etc. Sometimes residents who had a previous experience with damages in their properties of the earthquakes had an active role. But this was not always the case, people who also had lost their house completely also were not keen to participate in any activity.

The creation of social learning is a core element of community capital (Jülich, Kruse, & Björnsen, 2014), and in Appingedam this task has been related to the community groups. A few residents were involved as volunteers spoke that now the main benefit to join an action groups is knowledge, and this opinion is shared by academics and societal associations. The desire to share experiences and communicate to others is a reason people most people joined to the GBB. Few other joint initiatives have been developed in the community, like a theatre play used to raise awareness over the issue no action groups were detected. This is also what academics have found in the previous research and it has not changed since then.

The Groninger Gasberaad explained that communication is limited because of time and resources to develop the material to be shared. Residents feel themselves poorly informed and the most common method to communicate was written newspapers. As recognized by the Groninger Gasberaad more efforts should be done to increase knowledge and awareness.

When discussed issues of trust inside the community, trust between neighbours has a high degree, sometimes they gave examples for solidarity actions. The community does not trust higher authorities or recovery agencies. Municipality have gained the trust of the people, yet the province level and recovery agencies such as the CVW or the NCG have a weak perception from the residents. This was discussed at the province level, and the programmes aim now to recover the community's trust. The high degree of trust of residents into their local authorities provide a window of opportunity to improve communication within community, municipality and include the province level to regain trust, but also to empower local municipalities.

(iii) Economic capacity

The economic dimension of resilience in Appingedam is limited regarding to the funding and financial capacity to plan, prepared, react and cope to earthquake-flood disasters. It is relevant to note that most of the funding for activities related to earthquakes is provided by national government through the NCG and the budget given by the NAM. This reflects limitations of the local financial capacity as municipal funds, to carry on preparedness or recover activities for disasters at local levels. As discussed in Cutter et al., (2008), local and community finances and wealth should have a budget to elaborate in CRD activities that is not available in Appingedam. At residential scale, the negotiations for funding damages caused by earthquakes are described as bureaucratic, penny-pinching, and tense. Some people argue they had to invest more than their financial situation allowed the in to strengthen and repair houses. This is because in the damages evaluation, the damages were qualified as none related to earthquakes, hence the CVW will have no financial support to fix them. This demonstrates financial capacity in residents to some extent, seen in minor investments as windows replacement, or minor fissures in walls facing repairs, but not seismic reinforcement on current infrastructure. On the other hand, some people will receive

certain amount of money for repairs, others more money for similar damage and other nothing, this could also be a probable cause of disagreement between neighbours. It requires further research, but residents' comments revealed unfair treatment and that they did not like to talk about this with their neighbours with similar damaged houses.

When questioning residents about the personal house insurance over disaster damage, people responded that this was not necessary. In Appingedam, as the nature for the earthquakes comes gas extraction then the company causing this issue will be responsible for the payment of all damages. When it comes to flood risk, the taxes people pay to the waterboards state a government agency is responsible to protect population from flood risk, this becomes a public good. This both elements relate to the idea that having an insurance that covers earthquake-flood disasters is not necessary and people are not keen to have such a service.

The economic dimension of institutions is also relevant, when organisations where consulted for the funding sources most of the them are related to national oil company. All referred to the lack of economic capacity to do fulfil their task. There is now the institution of the NCG, this is funded by municipalities common fund to some extent, but is also the NAM and the national government who are funding the projects. The CVW depends completely in the NAM economic support. Also the societal organization, Groninger Gasberaad requires funding from the NAM to operate. The economic dimension of institutions then is weak, the damage recovery of the present situation is a very slow process, the strengthening projects are limited and all of them, they depend on the same actor for funding.

(iv) Infrastructure capacity

Regarding infrastructure dimension of CRD, the municipality has taken a big step to strengthen and preventing further disaster by the implementation of a new building code. This demonstrate how urban planning can influence through a policy document the outcome of disaster response (Bruneau, Chang, Eguchi, & Lee, 2003). The new building code will require that seismic conditions are taken into account for constructions, specially emphasizing safety in public buildings. However, they also mentioned that the investments of the past 2-3 years will need now to be updated and reinforced.

As a response to housing infrastructure, different opinions can be found and perhaps future research can be done. The programmes of NCG, "Strengthening Appingedam" involves a vision to strengthen houses, repair damage and mitigate the negative impact of market value. It is important to notice that here the community level and national level merge into creating infrastructure resilience. CRD requires technical adaptations and measures to prevent disaster, hence the strengthening of houses to prevent future damage is a step to resilience. However, the projects described by the community are not exclusive for Appingedam, but the 12 municipalities affected by the earthquakes and this reduces the chances that something will be done in the town. So it can be concluded that the projects even when they present a step forward towards CRD, the limited capacity of the projects due to the small scale they will have little impact in Appingedam.

The flood protection in Appingedam has been tested several times. They were tested in 2011, and they did not meet the standards they were too low and not strong enough (Deltares, 2014). After the review of 2011, the waterboards realise that the weak state of the dykes, and then when earthquakes got heavier and was a coincidence According to Bruneau et al., (2003), the acceptable conditions critical facilities such as the dykes after an earthquake impact require technical modifications and infrastructure robustness. This has been incorporated in strengthening programme of the flood defences, enhancing CRD. This programme works on technical innovations and construction code improvements for seismic urban zones of the flood defences such as Eemskanal in Appingedam.

(v) Institutional capacity

The institutional capacity first indicator was about knowledge about earthquakes and flood risk. The access and creation of knowledge was expressed as a common weakness for the province and societal organisations, it can be argued that the learning capacity of institutions is not well developed. Public institutions were consulted about their understanding for cascading disasters, in all cases they expressed themselves as if they have not considered this major disaster scenario and that is not their role to review about. This is relevant because it suggests lack of integration in risk management plans. To academics, this demonstrates that disaster plans have not been made involving multiple institutions and clearly the community participation is also missing but also reveals that the subsequent events have never been considered as a possible disaster scenario. The societal organizations also express their need also to get involved in the information sharing and that a key driver for their participation was sharing knowledge but now the process is very limited. It is also important to notice that at the local community level then there is gap, and they do not seem connected with the institutions, none of the residents or authorities mentioned neighbour committees or similar groups in the process.

The second indicator reviewed for institutional capacity was to understand the multi-level relationship and involvement of local authorities regarding earthquakes-flood plans and agendas. Institution's constantly keep changing their role and the scope of their organisation in earthquakes disasters each explained. The municipality of Appingedam is adapting itself to cope with the national level actions in the town. It is very positive that they will include another figure to link municipality and community issues in their planning office. At the same time, the role will include the coordination with the NCG programmes in the town. This demonstrate the recognition of their limitations, yet there is another big limitation at local level which relates to the learning process and knowledge. At the moment there is no record of earthquake damages, risk maps or water impact specific for local level. It could be argued that this is a step down of being the authority of a small town and with small population, yet it is important when such high risk can affect the community, more important this learning process and knowledge are key for creating CRD.

The third indicator of this capacity refers to decisions making of action groups. The interview with the residents revealed that all of the participants knew at least one earthquake related group. The societal participation was generally oriented to respond to earthquake damages, and to form a union of people who can legally take actions over the NAM. It is important to notice the nature of the organizations, the groups now are focused on dealing with the effects of damages in houses in the community, yet they do not focus on flooding risk rebuilding the community. In Appingedam residents are frustrated because the fact that they are occurring earthquakes, and that is the main driver of the action groups, not because they are responding to a big disaster or try to rebuild the community. This can be one of the reasons why smaller scale action groups such as neighbourhood committees were not detected in the community, none of the participants mentioned a different relevant group at community or neighbourhood level.

Governance was reviewed in relationship, roles and responsibilities of institutions and community participation. The answer to the section 3, the questions about governance are discussed in the following section. This questions are:

3. How do governance structures/approaches influence community resilience to earthquakes-floods disasters in Appingedam?
   3.1. What governance approach/structures supports community resilience to earthquakes-floods?
   3.2. How governance approaches can help to enable adaptive capacities of CRD to earthquakes-floods in Appingedam?

Singh-Peterson et al., (2014) proposes a link to disaster governance by reviewing political fragmentation through the number of governments and institutions involved. To contribute to achieving the properties of community resilience outlined above, local institutions should be able to keep a decision making capacity and be analysed under adaptive capacity (Gupta & Hurlbert, 2015). The institutional capacity shows the current roles of each major actor and the data reflects that community action is limited. During the interviews it was discussed relationship of local authorities in a multi-level governance approach. In the Netherlands, there exists a transition to decentralisation, so lot of more rules and responsibilities are going from central level to local level. It can be argued that it is a process of learning by doing, and adaptation at all levels to cope with combined hazards such as earthquake-flood threats.

The institutions related now in the process of Appingedam resilience show flexibility, they are currently adapting to new roles and have a long term vision contributing to CRD (Gupta & Hurlbert, 2015). However, this is process of learning by doing tends to set the responsibilities blurry as discussed by Stoker (1998). Now the local government, province and national authorities have not clear the scope of their task and creates uncertainty between institutions. This was discussed with academics and the institutions themselves, answers were similar. Each institution is working at their best, yet the incorporation of the national government at local level with the NCG places other institutions on hold awaiting to know exactly what the National Coordination Groningen will do. Unfortunately, representatives of the NCG in Appingedam could not be interviewed, they recently installed their offices in the town and not big communication about their role has been made. This intertwined level of decision making is a unique case in the Netherlands, were the National level blends at local efforts. The unique nature of the governance model allows no comparison with other cases, hence research in the future will be required to determine the outcome of this new model.

Conclusion:

How can community resilience to disasters, and the associated governance arrangements, be operationalised for communities at risk from cascading earthquakes-floods disasters?

Community resilience to cascading disasters can be viewed as the combination of multiple resiliencies, made of various factors relevant to the hazards threatening each particular community. This research presented a view of earthquake and flood disaster with characterizing multi-event resilience, it aimed to provide a great depth of information to support better disaster planning and preparedness. Within this, community resilience to disaster can be considered at different levels such as individuals, communities, institutions, emergency organizations and different scales national, province, and local.

This research has provided a different approach for characterizing community resilience of communities prone to earthquake-flood hazards and disasters. This framework builds on community capacity creation and the influence of governance arrangements over the community. In this framework of community resilience to earthquake/flood disaster the essential dimensions were identified from previous similar studies. Community resilience to disasters in the past was studied specifically to one disaster, yet the combination of different qualitative key indicators for earthquake and flood resilience were identified through a review of the existing assessment methods. A combination of elements from different capacities, was noticed the individual component of risk awareness and knowledge about floods, but also the trust in the institution of water management and the fluent communication were intertwined indicators of institutional capacity, and social trust of community capacity. This shows that in Appingedam various elements of CRD are present and is beginning to shape a resilient community.

There is is a seismic and flood risk technical measures being take, as the Eesmkanal upgrade and housing seismic reinforcing that improves the CRD of Appingedam, however the transformation of the buildings or houses alongside the Eemskanal is not yet part of any programme. Future measures could consider a cascading disaster view of risk and can be combine with the shrinking problem of the town and apply spatial measures for cascading disaster risk in the new urban planning. This means that seismic reinforcement can be combined with flood risk adaptation alongside the canal by changing the land use or the buildings design for the section right next to the water, and take advantage of spatial measures to diminish the risk of cascading disasters

It is important to note that the disaster risk governance influences every aspect of CRD. All components, need to be set within this, the contextual domain of laws, policies and responsibilities of each community. The experience in conducting this research also points to a gap in governance for disaster management in terms of communication with residents and community groups in Appingedam. Although emergency response is a standard activity for governance in the Netherlands, there are isolated efforts to help coordinate security measures for local levels with the safety regions. However, I detected no governance link that addresses issues of cascading disasters and their implications for communities in Appingedam. This can require further research, the fact that this thesis had interviewed a limited number of residents might have have kept smaller groups undiscovered.

Lastly, it seems that there is a process of learning by doing and the current governance structure is changing. However, the change is not empowering local level, but instead the national level with the NCG is acting and executing at local scale regarding the earthquakes and their consequences. This causes that the province and local authorities to have not clear the scope of their tasks and creates uncertainty between institutions. However, this provides an opportunity for community groups to act and to be heard with a more direct communication and to be involved in decision making process. Findings indicate that the action groups face the need for greater information sharing among different levels of governance. This governance structure gives an opportunity for Appingedam's community groups to have direct communication with national level. However, it comes at expense of municipals authority's empowerment because the national government is committed to plan and execute at local level. Consequently, it is very much likely that the current governance structure influence negatively into Appingedam's community resilience to disaster within local institutional capacity, since this governance structure does not enhance local learning and restrains local authorities of actions.

6 Reflection

The current research was made in Appingedam, a small town in which most participants were elderly people with limited English communication skills. In the section of constraints (p. 30), I discussed the counter effects of doing social interviews when researchers and participants who share a different linguistic, cultural, or national heritage. Under the previously mentioned conditions, accessing residents of the town to participate in the data collection process was a hard task. Fortunately, everything worked out really well in the process, but intercultural communication can sometimes be confusing and limits the dialogue. Thus, I would encourage further research of this topic just if the researcher has a fluent communication in Dutch.

Availability of the organizations to be interviewed in the process of CRD assessment was very limited. It required in most of the cases from 4 to 6 weeks to schedule meetings with the current busy agendas of each organisation. Thus, the executing timeframe for data collection had to be extended, and resulting in later submitting dates. In the future research, I would encourage to have the organisations contacted and scheduled during a 10-week timeframe and not so ambitious as I had previously planned.

Regarding the data obtained, the insights captured from the residents of the community were interesting and difficult to generalise. Yet found the most relevant the low risk awareness and lack of information of a group of residents. People preoccupied, anxious, frustration affect the quality of life of people in Appingedam. Yet, this topic could be further explored in another research, the current assessment was limited to analyse whether this was influencing community resilience. In Appingedam it has proven that sharing beliefs, values and common feelings does affect the formation of committees or action groups, however sharing same values not necessarily impact in a positive way. In the future, it will be interesting case to analyse the results of the current governance arrangement and what is the influence of national government acting at local scale to the existing local authorities.

Finally, the current framework could be seen as a useful approach for any community that faces earthquake-flood hazards. The approach describes a qualitative interpretation of community resilience indicators that can be read within different contexts. The framework offers the opportunity to change the threatening hazards of the community and analyse different types of cascading disasters.

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Appendix 1 Ethical Agreement

Informed Consent Agreement

Please read this consent agreement carefully before you decide to participate in the study.

I (please write your name in the following space)

hereby consent to be a participant in the current research performed by

Edgar Illescas Castellanos

The purpose of the study is to understand the relationship between earthquakes, floods, disasters and resilience in communities.

An interview with some questions regarding my understanding and community reaction to disasters will be done. Questions about the information about risk, communication, economic impact, and the process of recovering from damages, but also about management plans, and community action groups will be asked.

The current study will last approximately 30 minutes. At the end of the study, upon my request the researcher will explain to me in more detail the research outcomes used in the thesis project.

My responses will be treated confidentially and my anonymity will be ensured. I agree to be recorded during this interview, for matters of further analysis. Hence, my responses cannot be identifiable and linked back to me as an individual. I understand there are no anticipated risks in this study.

The researcher will answer any questions I might have regarding this research, now or later in the course of the study.

Date:	Signature researcher:

Date:	Signature participant:

Appendix 2 Semi-structured interview questions

Theme	Specific Indicators	Questions
Individual Capacity	Gender	Observation
	Age	What is your age?
	Education level/Work	What do you do for a living?
	Knowledge of institutions and organisations people should go to in case of an event	Have you ever contacted organisations that will help you in the case of disasters or damage recovery?
	Previous hazard experience	Have you ever experienced earthquakes before? Have the earthquakes affected your house? Have you ever experienced big storms or flood alarms in the past?
Community capital	Place Attachment	Did you ever considered moving to another town for jobs, or education or family? You would also say, you mentioned something before to the ties to the place, when there is common feeling among the citizens to move out from this town subjected to earthquakes or hazards or they still be not considering resettle?
	Knowledge/Learning capacity	Does this organisation rely on the RUG research for some guidance or orientation? Is your organisation developing research or collecting information about the risk and past experiences?
	Active Participation on action groups	Do you participate on the group? How was your first approach to the support organisations or why you contacted them and joined them?
	Risk Communication/Information	What communication network, channel, or social media to explain risk have you used? - So are there official networks or communication channels for citizens to ask for information?
	Solidarity actions	In the case of you got affected somehow, would you go to your neighbours and ask for help? What kind of help would you ask for?

Economic Resilience	**Wealth generation**	**What influences your investments and how is wealth created?**
	Financial damage from previous hazards	Have you experience financial damage from previous hazards? (a earthquakes and b floods)? The economic support you have face so far, is it enough to recover from the damages faced?
	Funding	How is the funding for your organisation developed? Do you think there is any additional resources the institution will need to increase or accelerate the preparedness?
	Insurance	Do you have any type of hazard insurance? As for floods? Would you say that any type of hazard insurance for housing and infrastructure will help to mitigate, or has it ever been considered?
Infrastructure resilience	Seismic Resistant infrastructure	Has your house been through the process of repairing damages? Has your house been through the process of reinforcing the structure? And how is the new technical innovations being done? with specific companies or research?
	Does public buildings count with protection measures	In relationship to building safety, how are you coping with it? Does the reinforcement has to do with infrastructure solutions o also extend to other characteristics as: (urban transformation, reduction of number of floors, increase in the number and quality of construction materials) ? The public buildings are already being transformed to become seismic resistant and hazard resilience and in any case this building considered as shelter?
	Having an effective system for the provision of post-disaster aid and services	What about medical facilities in the village?

Institutional resilience	**Knowledge about hazard risk communication**	**Have you ever received risk and advising communication from your local authorities?**
	Awareness about hazard risks and vulnerabilities in the area	Is the risk approach of your organisation a coordination for entire province or just specific risk areas? Is there any action the municipality has for training for preparedness and reaction for the people in disaster or something similar?
	Existence of a committee or action group	Do you know if any committee or action group that reacts in disasters exists in your town or neighbourhood? How is this group organized? Do community action groups have formed as a reaction to access the risk information and to react just in case any disaster?
	Flexibility of agendas and multi-level integration/ Policy	According to province agenda What actions are coordinated together and the connection you have with them? Will you say that local policies are oriented to enhance resilience or have a different approach to risk?
	Involvement and support of local authorities	Have you ever received communication from your local authorities? In case of any disaster, what would be the role of the institution?
	Existence of hazard mitigation plan	Do you know in case of any disaster if there is plan for reaction any guidelines to explain what steps you should take?
	Existence of local policy for disaster risk management	Are you aware of the existence of a community action plan in case of a disaster in your town?

Questions Asked to Residents
Questions Asked to Institutional actors
Questions Asked to Academics

Appendix 3 Code List used in alaysis

Community Capital

6 Codes:

- Action Group
- Active Participation
- Communication
- Community Capital
- Social Knowledge
- Social Support/Solidarity Action

Economic Capacity

4 Codes:

- Economic Capacity
- Funding
- Insurance
- Investments

Individual Competences

7 Codes:

- Charateristics
- Disaster Response
- High Risk Awareness
- Individual Competences
- Knowledge
- Low Risk Awareness
- Place Attachment

Infrastructure Capacity

7 Codes:

- Damage
- Dyke
- Facilities/Utilities
- Infrastructure Resilience
- Seismic Resistant
- Strenghten/Reinforcing
- Warning System/Alarm

Institutional Capacity

6 Codes:

- Authorities
- Decission Making
- Institutional Resilience
- Institutional resources
- Political Agenda
- Responsibility