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How is the natural gas extraction, conducted by the ‘Nederlandse Aardolie Maatschappij’ (NAM), influencing the living environment of the people that live in the Groningen gasfield area and are affected by the induced earthquakes?



Figure 1. Volkskrant, 2013. Minister Kamp (left) of Economic Affairs visiting a farm that was damaged by an induced earthquake in Groningen.

Bachelor Thesis

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Abstract

This thesis deals with the natural gas extraction, conducted by the 'Nederlandse Aardolie Maatschappij' (NAM), and how it is influencing the living environment of the people that live in the Groningen gasfield area and are affected by the induced earthquakes. The NAM is a Dutch petroleum company that has been engaged in the exploration and the production of natural gas and oil since 1947.

Several interviews were conducted with people that speak from different perspectives in order to get the most holistic view on the subject and available data and afterwards the connection was made with literature and theories like Social Impact Assessment (SIA). One for example was with the spokesperson from the NAM while the another was with a citizen from an earthquake hit village. Statistics from the 'Staatstoezicht op de Mijnen' (SodM) 2013 report show that there is a dependency between amount of natural gas extraction and the amount of induced earthquakes. The way the induced earthquakes are influencing the life of communities in the earthquake hit areas is thus also related to the amount of natural gas extraction.

The information from all concerned parties should be provided at a singular place so it is clear where the information can be found. Concerned parties would include the NAM, Ministry of Economic Affairs, Staatstoezicht op de Mijnen, independent autonomous institution conducting research, Groninger Bodem Beweging (GBB) and the affected people.

Currently there is no such singular place or forum. However, the GBB tries to provide available information to the affected people.

Key words: Nederlandse Aardolie Maatschappij, induced earthquakes, Groningen gasfield, Social License to Operate, Social Impact Assessment, Groninger Bodem Beweging.



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Part I: Introduction

Motivation

The recent induced earthquakes in the Groningen gas field area have drawn considerable public interest and media attention. These induced earthquakes influence a lot of people and therefore the subject has a degree of public interest and should be researched. The interest taken in the subject is proven by the fact that the number of members of the Groninger Bodem Beweging (GBB) has doubled in early February 2013 (Volkskrant.nl, 2013). The GBB is a group that stands up for the safety of the civilians in the induced earthquake hit areas.

The KNMI has data about the first measured induced earthquake in the Netherlands. Assen was the first city to be hit by an induced earthquake on the 26th of December 1986 with a magnitude of 2.8 (see figure 2) (Koninklijk Nederlands Meteorologisch Instituut, 2013).

Geïnduceerde aardbevingen in Nederland

YYMMDD	TIME	LOCATION	LAT	LON	X_RD	Y_RD	INT	MAG.	DEPTH
19861226	074751.00	Assen	52.992	6.548	232,924	556,587	4.5	2.8	1.0
19871214	204951.05	Hooghalen	52.928	6.552	233,266	549,537	4	2.5	1.5
19891201	200914.35	Purmerend	52.529	4.971	126,697	504,593	5	2.7	1.2

Figure 2. KNMI, 2013. NederQuake Query. The figure explains a relationship between the depth of the epicentre (DEPTH), scale of Richter (MAG) and scale of Mercalli (INT). Even though the magnitude was only 2.8 (considered minor) the intensity was still 4.5 (which translates into moderate to strong). This is because the epicentre was only at a depth of 1.0 km.



There is a connection between the amount of natural gas extraction and the amount of induced earthquakes in the Groningen gas field. This connection will be explained further on in the results through figures and statistical tests coming from the SodM 2013 report. This is an important acknowledgement because the NAM has been increasing their annual production of natural gas extraction which is directly related to the increase in the number of induced earthquakes. To give a visualization of the amount of earthquakes in the Groningen gas field area figure 3 has been made. Figure 3 and 4 help creating a definition of researched area for this thesis.

Amount of induced earthquakes in the Groningen gasfield area

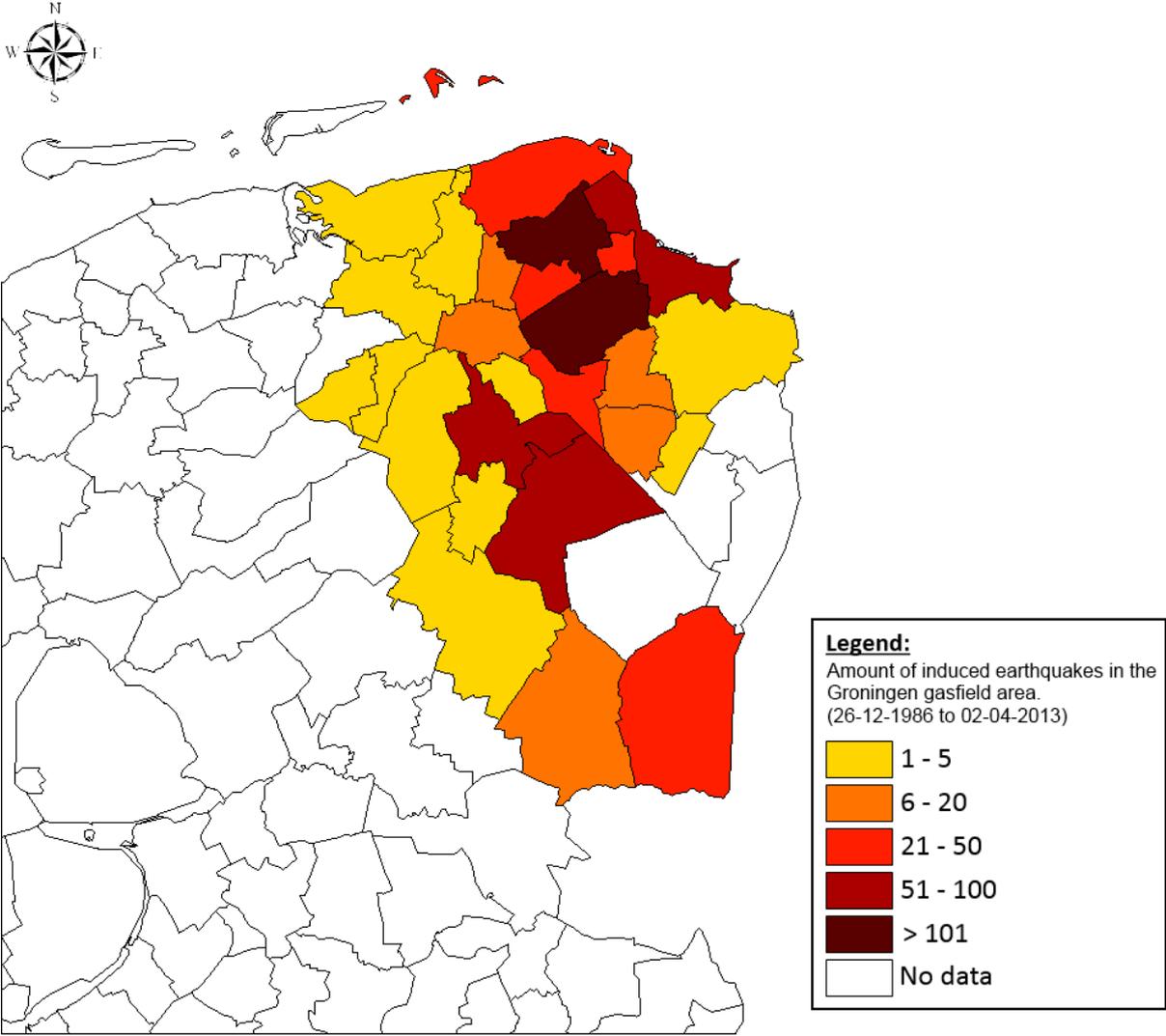


Figure 3. Map based on the NederQuake Query from the KNMI (2013). This figure depicts the induced earthquakes in the period of December 1986 until April 2013 in the Groningen gas field area.



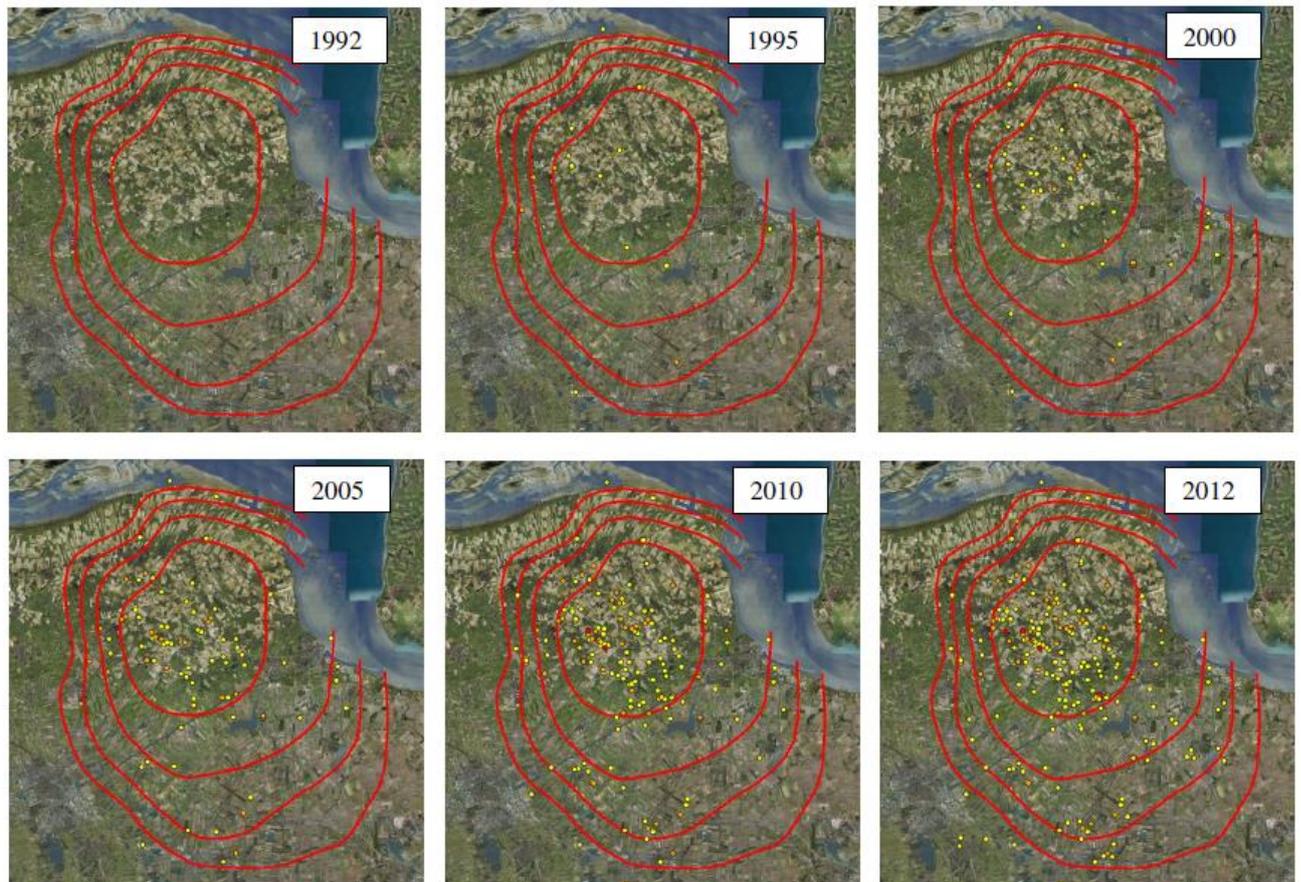


Figure 4. SodM, 2013. Spatial distribution of earthquakes over the Groningen gasfield through time starting with the first measured earthquake in 1991. The dots indicates the magnitude class: yellow $1.5 \leq M \leq 2.0$, orange $2.0 \leq M \leq 3.0$, red $M > 3.0$. The red lines indicate the contours of the subsidence bowl as observed in 2008. More earthquakes are occurring with a higher frequency and a higher magnitude over time.

Research problem

The NAM is a Dutch petroleum company that has been engaged in the exploration and the production of natural gas and oil since 1947 and is 50% owned by Shell and 50% by ExxonMobil. (Nederlandse Aardolie Maatschappij, 2013). The natural gas extraction has been causing pressure differences in the Groningen gasfield which in turn causes induced earthquakes.

This thesis is dealing with the consequences of these induced earthquakes and the way the people are compensated for the physical damages they experience. Perhaps also if the NAM could do anything to improve this.

To be able to investigate these issues there are several questions have been formed that need answering:



Main question:

How is the natural gas extraction, conducted by the ‘Nederlandse Aardolie Maatschappij’ (NAM), influencing the living environment of the people that live in the Groningen gasfield area and are affected by the induced earthquakes?

Sub questions:

- *What do the people that are affected by the earthquakes think of the information they are provided with by the NAM?*
- *How does the NAM feel towards the damages they cause to the affected people?*
- *What could be done against the earthquakes caused by the natural gas extraction?*
- *Would these affected people still see themselves living in the same house in the future or do they think their village will be unliveable and move away?*

Structure of the thesis

This paper is structured as follows, in part II the relevant concepts and theorems are explained to gain a better understanding to the subject. Part III provides a guideline system for solving the research problems and explains methods used. Part IV presents the results of the research conducted and they are discussed and summarized in part V.

Part II: Theoretical framework

To answer the questions stated in the research problem, this thesis reviews several different articles that prove that there are both physical as social consequences due to the natural gas extraction. This thesis compares the physical consequences to the social and environmental impacts and thereby provides insights into how much the physical consequences of the natural gas extraction are influencing the daily life of affected communities. The concept of ‘Social Impact Assessment’ (SIA) is used to research these influences. To define what SIA is we look at the definition of Vanclay: “Social impact assessment (SIA) can be defined as the process of assessing or estimating, in advance, the social consequences that are likely to follow from specific policy actions or project development, particularly in the context of appropriate national, state, or provincial environmental policy legislation. Social impacts include all social and cultural consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs, and generally cope as members of society” (Burdge & Vanclay, 1996; Vanclay, 2002, p. 190). When conducting a SIA one would be able to identify impacts ex-ante and thereby adapting plans to minimize the impacts on the people influenced by a project (Vanclay,



2003). It can “help individuals and communities, as well as government and private-sector organizations, understand and better anticipate the possible social consequences for human populations and communities of planned and unplanned social change resulting from proposed policies, plans, programmes and projects” (Burdge, 2003, p. 84).

It should be noted that measuring and assessing a project along with its social influences is difficult to do without variables or notions to take into consideration, the Interorganizational Committee on Guidelines and Principles for Social Impact Assessment (1994) recommends a list of SIA variables under the general headings of: population characteristics; community and institutional structures; political and social resources; individual and family changes; and community resources. These variables can function as a guideline to follow while doing an assessment, they are defined below:

1. “*Population characteristics* means present population and expected change; ethnic and racial diversity, influxes and outflows of temporary residents as well as the arrival of seasonal or leisure residents”.
2. “*Community and institutional structures* refers to the size, structure and level of organization of local government to include linkages to the larger political systems. They also include historical and present patterns of employment and industrial diversification, the size and level of activity of voluntary associations, religious organizations and interest groups and, most importantly, how these institutions relate to each other”.
3. “*Political and social resources* refer to the distribution of power authority, the identification of interested and affected parties as well as the leadership capability and capacity within the community or region”.
4. “*Individual and family changes* refer to factors that influence the daily life of individuals and families, including attitudes, values, perceptions, family characteristics and friendship networks. These changes range from attitudes toward the policy to an alteration in family and friendship networks to perceptions of risk, health, and safety”.
5. “*Community resources* include patterns of natural resource and land use; the availability of housing and community services to include health, police and fire protection and sanitation facilities. A key to the continuity and survival of human communities is their historical, archaeological and cultural resources.

Under this paradigm of SIA variables, the committee also considered possible changes for indigenous populations and religious sub-cultures” (Burdge, 2002, p. 7).

“Social Impact Assessment includes the processes of analysing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions



(policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment” (Vanclay, 2003, p. 5). SIA can assist developers in predicting, identifying, understanding and dealing with social impacts of new developments and should be given equal weight in regards to environmental issues because the effects of proposed developments also have an impact on people. SIA provides guidelines, recommends strategies to try and find a socially acceptable outcome. SIA also suggests mitigation and monitoring programs to try and reduce some impacts. All of this should help developers to bring their project to a success (Burdge & Vanclay, 1996). While conducting SIA, one can choose to inform and ask questions directly to the people that live in the influenced area and by doing so one would be able to achieve a ‘social license to operate’ from the community before starting a project. A ‘social license to operate’ (SLO) is considered by Pike (2012) as the acquisition and on-going maintenance of the consent of local stakeholders to specific local projects. The theorem of ‘free, prior and informed concept’ (FPIC) is also important to consider. FPIC can be a process to protect consumers by providing relevant information for them to make informed choices, and it is a tool to provide developers with a SLO (Goodland, 2004). Together with Public Involvement (PI), which is the giving of a voice to the public in the process, these concepts can greatly help the affected community in making informed decisions while having an actual voice in the process.

A comparison has been made between the physical consequences of the earthquakes and the social impacts they have: firstly how they change the direct living environment and have impacts on the social environment, and secondly how people perceive these impacts. To be able to make such a comparison a foundation of data on the physical consequences of earthquakes is necessary. This data is obtained from articles and reports and will be discussed in the methodology.

Part III: Methodology

The choice was made to stick with in-depth interviews instead of surveys because “the construction and administering a survey that has the potential to generate credible and generalizable data is truly difficult”. “[Surveys] can be a thorny and exasperating process, particularly if you want to do it right” (O’Leary, 2010, p. 183). Generating particular data can also be a challenge when conducting a survey. Meant with this particular data is: in-depth data; a representative sample; getting answers to the questions you have thought to ask; going back to your respondents if more data is required (O’Leary, 2010). The interviews conducted were semi-structured because this method allows one to be flexible during the interview and ask appropriate questions to the situation. Each respondent provides



different answers due to the different backgrounds. Therefore each interview had adapted questions for each respondent to make sure of a fitting interview and thereby gaining the most knowledge (See appendix A). These respondents with different backgrounds were chosen because they could provide the most holistic view to the subject, due to opposing one another it is made possible to hear both sides of the story.

Four semi-structured in-depth interviews were conducted in total (chronological order):

- The first interview was with a PhD Geo-Energy from the Rijksuniversiteit Groningen (RuG) whom helped explaining the general workings of the underground and participating in a discussion about what could be done against the induced earthquakes.
- The second interview was conducted with a woman living in Stedum, an earthquake hit village. She had personally felt the earthquakes and experienced damages to her house. She gave insights on how the people are affected by the earthquakes and how they feel about the information the NAM provides them with. She also gave her point of view to the matter of liveability of her village in the future.
- The third interview was held with a participant from the Groninger Bodem Beweging (GBB). He provided insights on how the general population in the affected area is influenced by the earthquakes and how they perceive the information given to them by the NAM.
- Fourth and last interview was with the spokesperson of the NAM. He answered questions about how the NAM feels towards the damages they cause due to the natural gas extraction. He explained how the NAM handles main problems; how processes within the company go; to whom the NAM has to answer to; how taxations of damages are processed; how they handle the effects of the earthquakes. While talking about the latter he stated the NAM does everything they can to give the affected people the proper amends.

Through these in-depth interviews and supporting it by literature it was made possible to answer the questions asked in the research problem. Several types of literature have shown useful: books, articles, journals, official publications, newspapers and websites have shown valuable for reviewing backgrounds and obtaining contextual information to the main subjects of the research questions.

Sources for reports, journals and official publications were for example the 'Koninklijk Nederlands Meteorologisch Instituut' (KNMI), 'Rijksoverheid' (Central government) and the 'Staatstoezicht op de Mijnen' (SodM). The KNMI is best known as a government institution that provides weather forecasts and warnings in the Netherlands. The KNMI is also the national data and knowledge centre for the weather, climate and seismology. It is roughly translated as Royal Dutch Meteorological Institute.



SodM translates into State Supervision of Mines. The SodM monitors the compliance with laws applicable to the detection, extraction, storage and transport of minerals.

Main theory used to answer the questions and analyse the data received from the interviews was Social Impact Assessment (SIA). SIA is used to investigate the influences the natural gas extraction exert to the affected people. Conceptual models to visualize the impacts were made with the Sootweg model as foundation (figure 5).

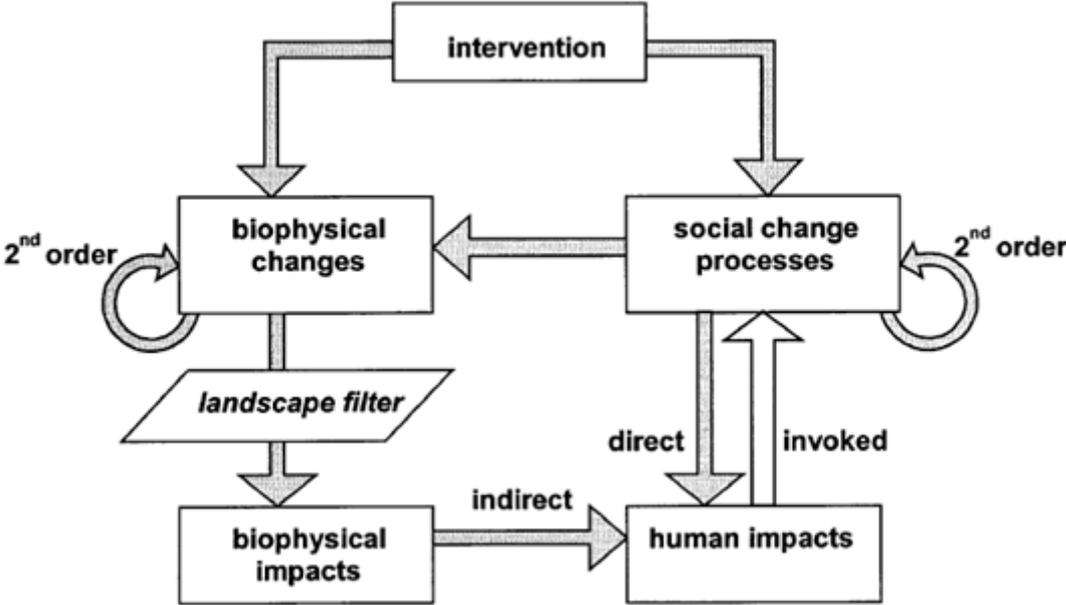


Figure 5. Sootweg et al., 2001. Pathways to derive biophysical and human impacts. This figure shows how the biophysical changes have biophysical impacts and indirectly have an impact on humans.

Part IV: Results

The interviewed PhD Geo-Energy from the RuG explained that the earthquakes are caused by pressure differences in the Groningen gasfield due to the fact that the gasfield contains many different compartments. The homogeneity of the field, as perceived until recently, is false. The pressure differences need to be approached with caution, decreasing the natural gas extraction at a certain place might make the pressure differences in the field even larger and thereby increasing the intensity of the earthquakes. As can be seen in figure 6, the layers are not aligned and there are faults in the underground which causes the field to be separated into different compartments with each a different pressure level. Mapping out the different compartments is necessary when attempting to even the pressure throughout the field. Calculations can then be made where to extract which amounts.



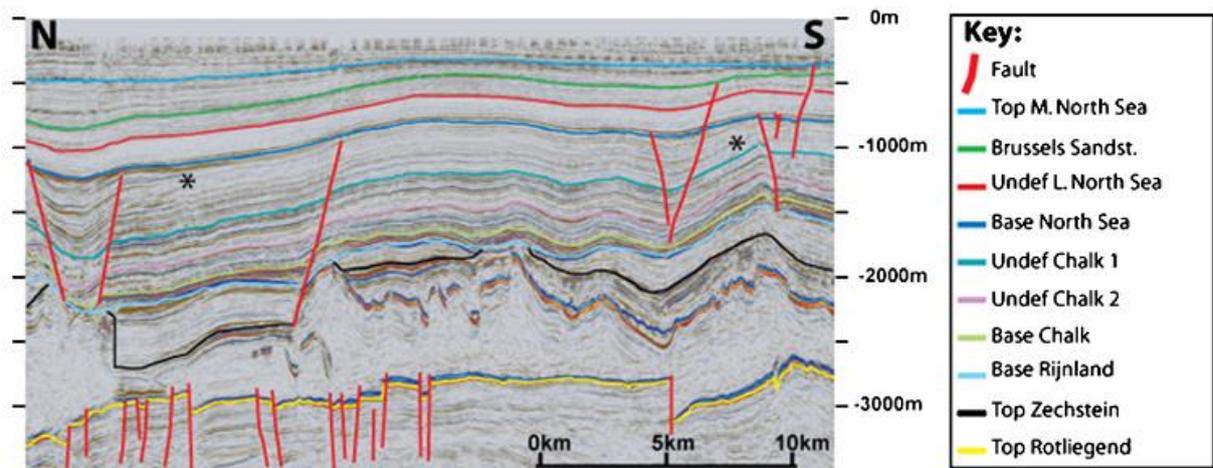


Figure 6. Tectonophysics, 2009. Representative interpreted seismic inline from the Groningen area.

The in-depth interview with the woman living in Stedum provides a lot of useful information. In the interview she stated that the earthquakes influence her in such a way that she is often worried about her future and how it would be if the earthquakes would intensify. Her anxiety for the future had also been enlarged by the SodM report 2013, the media and hearsay in her village. According to her direct sources the report explains that a magnitude of 5.0 on the scale of Richter could be achieved and with such a strong earthquake the churches and old houses in Stedum would collapse. Emulated situations like these frighten her on a daily basis, whenever she sits in her garden enjoying her house and neighbourhood she cannot help but wonder what the future brings and thereby deteriorating her living experience. She cannot get peace of mind in these circumstances. 'Peace in general is inner freedom, silence and tranquillity'. 'Lacking the ability of having peace induces our mind from positivity to negativity' (Oca et al, 2012). Not being able to have peace of mind will make your mind tend towards the negative in life instead of the positive, making one less able to enjoy his or her direct environment. Negative thinking also brings along negative effects like stress, and other health impacts. According to Teasdale (1983) negative thinking appear to produce depression, which conversely, increase the probability of thinking negatively which will cause further depression. The participant from the GBB has claimed that the NAM does nothing at all to compensate for the psychological effects the affected people suffer from due to the earthquakes. People are found in the Groningen gasfield area whom suffer from stress, sleeplessness and restlessness due to the induced earthquakes.

The concept place attachment is important for creating a feeling of 'home'. It is "a positive affective bond or association between individuals and their residential environment" (Schumaker & Taylor, 1983, p. 233). It is a symbolic relationship formed by people giving meaning to places (Low, 1992).



When a person does not have a positive bond or a symbolic relationship with their home then the feeling of 'being at home' will also be missing.

Looking at the biophysical environment and the way it is being influenced by the natural gas extraction is necessary for making a comparison between the physiological and the social consequences. Thus the effects of the natural gas extraction on the social environment of the people that live in the Groningen gasfield area. Based on the Sloopweg model (figure 5) an adapted conceptual model was created about the topic this thesis is researching (see figure 7).



How is the natural gas extraction, conducted by the 'Nederlandse Aardolie Maatschappij' (NAM), influencing the living environment of the people that live in the Groningen gasfield area and are affected by the induced earthquakes?

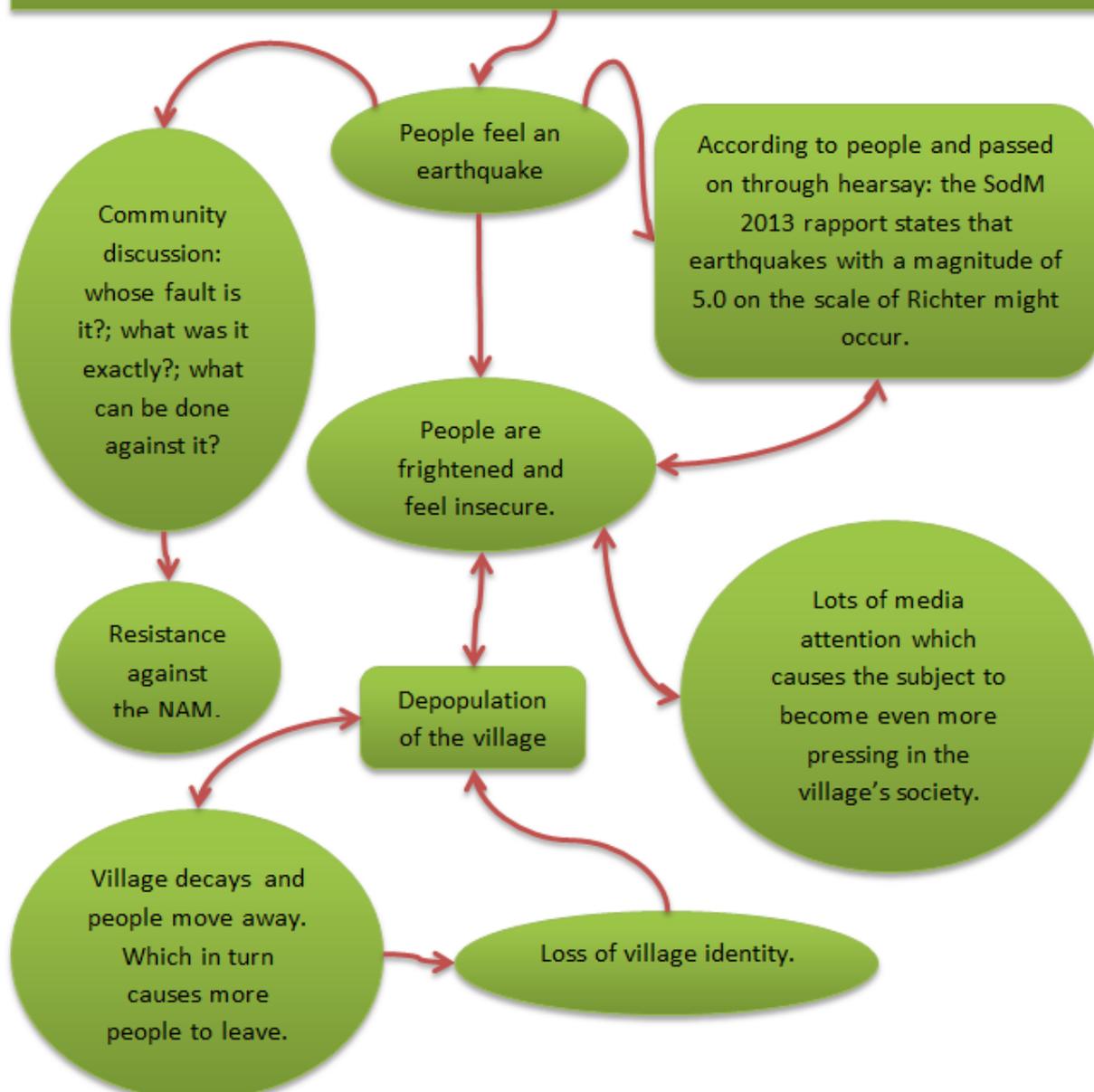


Figure 7. A model based on figure 5 about what possible effects the natural gas extraction could have on the living environment of the people that live in the earthquake hit areas.

Figure 7 shows what processes could be at the basis of the depopulation of a village: fear of earthquakes; decay of the village; loss of identity of the village.

All those above factors are joined together by the induced earthquakes. These impact the social, the economical and the psychological environment of an affected village and cause depopulation.

People get scared because of the earthquakes and would like to move out of their village. However, due to the damages and the recent earthquakes outsiders no longer wish to live in these areas. The



value of the houses have plummeted and the current citizens are unable to sell their houses and move away, they are stuck in a situation they do not wish to be in. Wanting to move away but unable to do so.

As explained above, the feeling of 'place attachment' is important when one wishes to feel at home. 'Place attachment' however is the positive bond one has associated with a place. Once the negative feelings over take the positive, the feeling of place attachment falls into decline and people will no longer 'feel at home' in their own home. The social impacts in this case influence a lot of people, in a large area, and place them into a position they do not wish to be in. However, a way out has not yet been offered to them. The NAM is collaborating with the Ministry of Economic Affairs to value the devaluation of the real estate in the area and they expect to have completed this in June 2013 (Rijksoverheid, 2013).

As for the woman from Stedum, even though all the bad things happening to her she still wishes to live in her own home in Stedum. If the NAM would be able to provide safety solutions for her she would be quite satisfied. Safety solutions could imply strengthening her house so it would be able to withstand earthquakes of a higher magnitude or replacing her house altogether.

The effects of the natural gas extraction conducted by the NAM are considered in the variables of SIA as defined in the theoretical framework.

Whereby firstly population characteristics are influenced by the fact that the village is depopulating. Secondly, for the community and institutional structures it is not as black and white to say. Where the community structures such as the GBB are growing (Volkskrant.nl, 2013) and becoming more pro-active, the institutional structures are shrinking. The interviewed woman from Stedum said that the amount of facilities in the village have reduced. They used to have a main-street with stores, a butcher and a drug store but all that has left Stedum since approximately 1995.

Thirdly, political and social resources. The identification of interested and affected parties has become more clear. Most of the affected people subscribed to the GBB. The latter has grown in leadership capability and capacity within the Groningen gasfield area and has doubled in memberships in early February 2013. Due to this increase in memberships they are able to offer more influence on the NAM and government (i.e. Ministry of Economic Affairs).

Fourthly, the individual and family changes. The interviewed woman from Stedum has explained that she is influenced in her daily life, namely that she worries about her future. She wonders if she will be able to stay in her own home or will be forced to move away. She is afraid her own house and the churches in Stedum will collapse when a stronger earthquake occurs.

Fifthly and lastly, community resources. This is the least affected SIA variable. The natural resources and land use have not really changed in Stedum over the years. Only one farmer has left Stedum and



only one farmer has changed land use from agricultural company to village garden where people can rent parts of fertile ground and plant their own products from the period 1981 to present (see appendix B).

The figure below explains how a SLO can be obtained ex-ante and also what should be done ex-post if a SLO had not been obtained from the community.

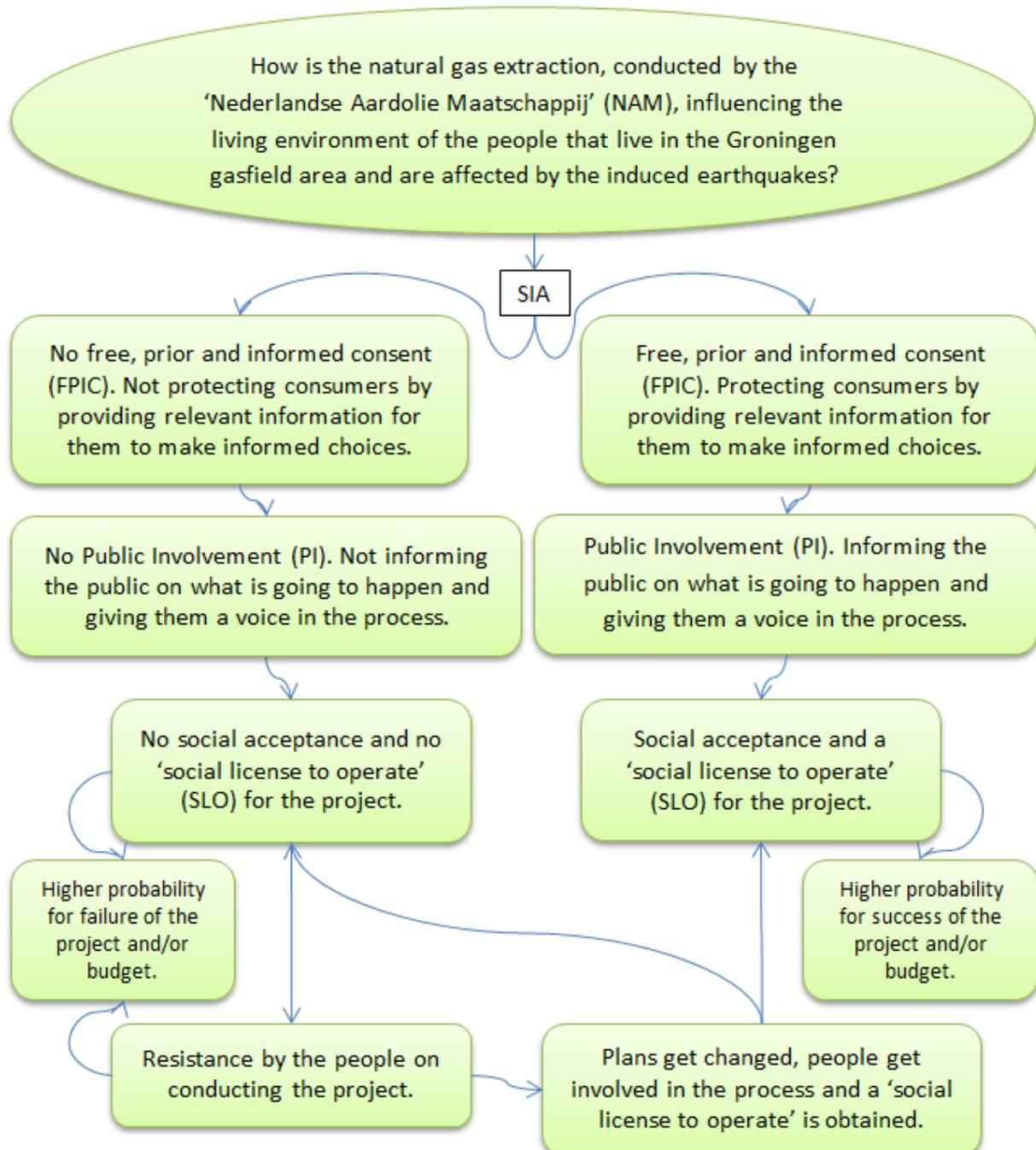


Figure 8. A SLO can be achieved ex-ante by providing FPIC to the affected community and also PI. These provide the community with relevant information for them to make informed choices and giving them a voice in the process. SLO can be achieved and the project has a higher success chance.



An example of the importance of a SLO is the Conga Mine case in Peru, where the Newmont Mining Corporation wanted to set up business. “The key allegation of the local community is that the mine will pose [an] irrevocable risk to a number of watercourses and lakes which provide irrigation for local agriculture”. “In 2004, Newmont Mining was forced to halt development work at its Cerro Quilish concession near the current flashpoint of Minas Conga, and ultimately remove it from its reserves because of a number of clashes with the local community over risk to the local water supply and job creation.” “The case of Minas Conga is particularly interesting because Newmont has been able to successfully operate one asset in Peru for almost twenty years without significant problems, while it has major problems with both the Cerro Quilish and Conga Mine projects”. “Newmont faced violent protests over the potential damage that could occur to the water supply and the fact that the mine was proposed on a mountain that held religious significance to the local community. Ultimately Newmont backed down and admitted that it had not always acted with the consent of the local community. This [example] seems to highlight the importance of local issues with regard to license to operate and the challenge of adapting processes that may have been successful in the past to meeting the novel requirements of new locations” (Pike, 2012, p. 4).

Not having a SLO can thus create resistance by the people that are influenced by or take an interest in the project. A SLO can be obtained by conducting a SIA and actively involving the community in what is being done and what will happen, and properly inform them on what is going to happen in the future (FPIC). Important also is to give them a voice in the process (PI). PI is an activity within the SIA process that provides the social impact assessor with a means to obtain quantitative information regarding social impact assessment variables (Burdge & Robertson, 1990).

As for the case with the NAM: according to the interviewed woman from Stedum there was no dialogue with the community and she had not been kept up-to-date with the processes of the natural gas extraction. The interviewed spokesperson from the NAM said however that they always kept people up-to-date and that every piece of information can be found in brochures and reports. Now one can wonder whether or not that is enough. Are these reports and brochures published publicly known and attainable enough to the community? The spokesperson said that they never really needed to maintain the dialogue with the people before the Huizinge earthquake (16/08/2012). The public never wanted more information and that is the reason why they responded ex-post to the need of the people for a dialogue with them. The people need this dialogue with the NAM to know what the future might hold for them. The NAM currently does not have a SLO in the Groningen gasfield area due to the insufficient accessible information they give to the people and the increased risk perception after the rumours of a magnitude 5.0 that might hit them. The NAM could obtain a



SLO by putting the minds of the people living in the earthquake hit areas at ease. This could be achieved by conducting research which provides insight into maximum possible magnitudes, and calculating the production levels which minimize risks. By communicating this information actively to the people living in the area, a SLO can be obtained. The connections between production levels and earthquakes are explained below.

The SodM 2013 report gives insights on the dependency between the natural gas extraction and seismic activity in the Groningen gasfield. The report addresses “descriptive statistics of the past seismicity, as well as predictions of future seismicity. The predictions involve two kinds of extrapolation: (a) extrapolation in time, and (b) extrapolation in magnitude” (Staatstoelicht op de Mijnen, 2013, p. 2). Several figures from the SodM report 2013 are explained below. For example figure 9 shows that the occurrence of earthquakes with a magnitude of ≥ 1.5 has been increasing since 1991.

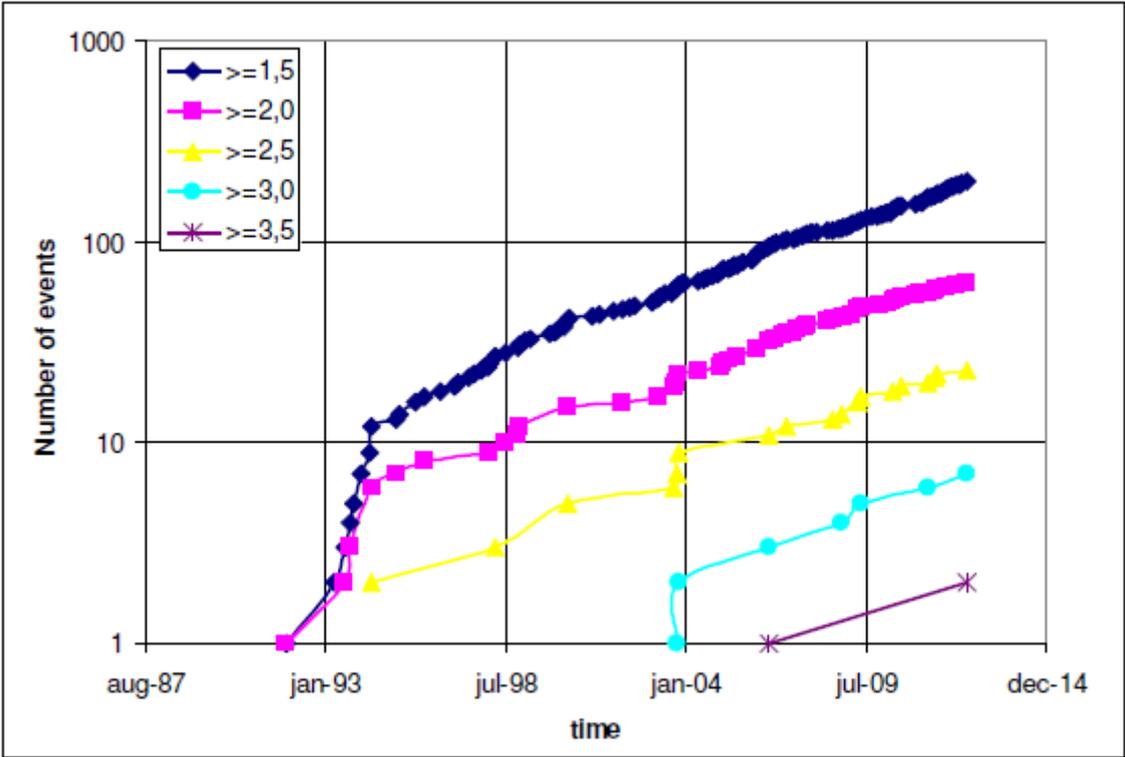


Figure 9. SodM, 2013. Number of earthquakes with a threshold magnitude of 1,5 plotted against time of occurrence. Notice also the increasing density of earthquakes with time, especially for the classes up to $M \geq 2.5$.

The increased number of earthquakes can be explained by the annual increase in production starting in 2003 as shown in figure 10. As can be seen in figure 9 the earthquakes of a magnitude of 3.0 or



higher started to occur since 2004. There is a pattern of a delay of 6 to 9 months between the peak winter production and the earthquake that follows (Staatstoezicht op de Mijnen, 2013).

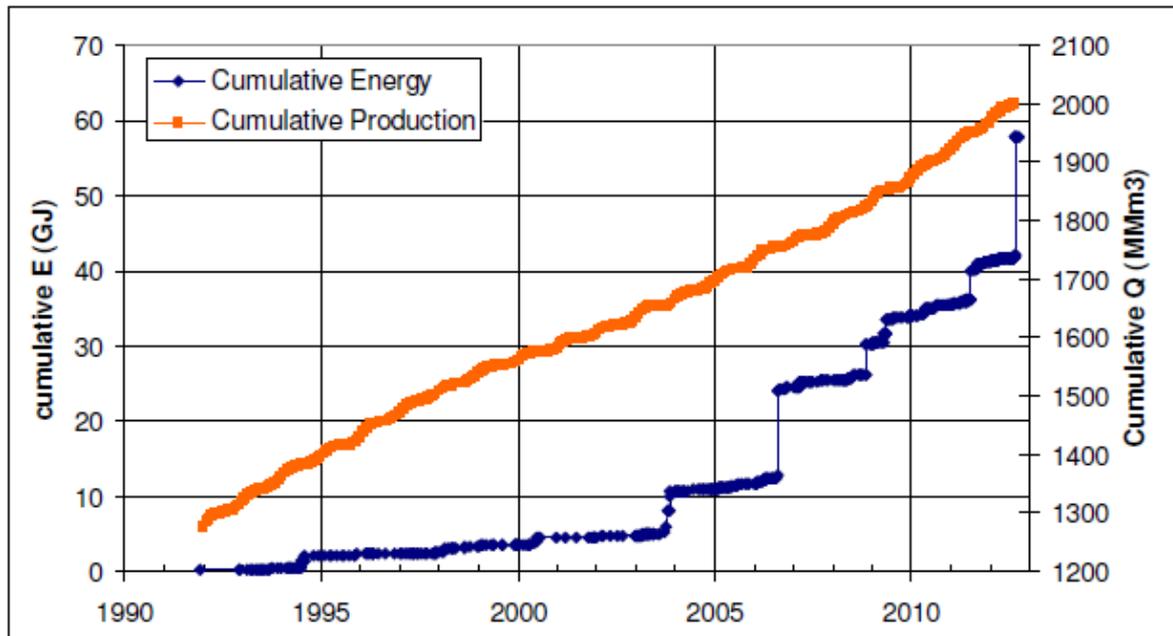


Figure 10. SodM, 2013. Cumulative seismic energy release and cumulative production through time. This figure shows the annual increase in production starting in 2003.

As can be seen in figure 9 and 10 is that the amount of earthquakes increased over time and that the more severe earthquakes ($M \geq 3.0$) occur more often. This is explained by the overall increase in production of natural gas extraction and the drop in pressure in the area which causes friction along the faults in the field. This is due to the fact that the Groningen gasfield is not as homogeneous as previously perceived.

The increase in earthquakes due to natural gas extraction has been statistically proven in the SodM 2013 report by using the Poisson distribution. “At the 99% confidence level the increase in the number of earthquakes is statistically significant” (Staatstoezicht op de Mijnen, 2013, p. 12). This indicates that a dependency between the production of natural gas extraction and the amount of induced earthquakes exists.

Decreasing the natural gas extraction production by the NAM unrealistic. As Prime Minister Rutte stated: stopping with the natural gas extraction is not an option. It goes beyond just the Treasury but is of vital importance to it (RTL Nieuws, 2013). The respondent from the GBB explained in the interview that the economy is currently rated more importantly than the safety of the community. It is likely to stay this way until a serious accident happens due to an induced earthquake.



The figure below depicts the output revenues of the gas exports in the year 2008.

Activity	Output (in billions of euros)
Gas exports	9.0
Gas production for local market	8.6
Oil refining	8.6
Network activities (gas and electricity)	5.1
Supply activities (gas and electricity for **retail consumers)	3.1
Heat networks	0.6

Figure 11. Ministry of Economic Affairs, Agriculture and Innovation, 2011. This table above shows an indicative output of gas, electricity, oil and heating sector in 2008. It shows how much money is involved in a particular sector like the gas exports, which accounts for an estimated €9.000.000.000,- in 2008.

The media often states that there will be an earthquake with a magnitude of 5.0 on the scale of Richter (RTVNoord, 2013) and claim they got the information from the SodM 2013 report. This is not what the report states. It states there is X per cent chance for a magnitude of 5.0 to happen when you set the maximum possible magnitude (M_{max}) variable to 6.0 (see figure 12) and when you have X amount of production/year. And all these variables and percentages are calculated through the bounded Gutenberg-Richter relationship (BGR) (appendix C). The KNMI takes the position that the BGR model used for calculations in the report is a reasonable model to predict the relative frequencies of higher, unobserved magnitudes. However, it should be clear that this model is an assumption. The results from the SodM report do not per se represent reality but should be seen as a model for unlikely situations (Staatstoelicht op de Mijnen, 2013).

scenario	Nm (2012-2016)	$M_{max}=5$			$M_{max}=6$		
		P(0,M>4, 2016)	P(0,M>4.5, 2016)	P(0,M>5, 2016)	P(0,M>4, 2016)	P(0,M>4.5, 2016)	P(0,M>5, 2016)
50 bcm	93 (75-113)	23 (19-28)	6.1 (5.0-7.4)	0.0	25 (21-30)	8.6 (7.0-10)	2.6 (2.1-3.1)
40 bcm	80 (63-100)	20 (16-24)	5.3 (4.2-6.6)	0.0	22 (18-24)	7.4 (5.9-8.2)	2.2 (1.7-2.5)
30 bcm	65 (50-83)	17 (13-21)	4.3 (3.3-5.5)	0.0	18 (14-23)	6.1 (4.7-7.7)	1.8 (1.4-2.3)
20 bcm	45 (32-60)	12 (8.7-14)	3.0 (2.1-3.6)	0.0	13 (9.5- 17)	4.3 (3.0-5.6)	1.3 (0.9-1.7)
10 bcm	20 (12-31)	5.5 (3.4-8.4)	1.4 (0.8-2.1)	0.0	6.0 (3.7-9.2)	1.9 (1.1-2.9)	0.6 (0.3-0.9)

Figure 12. SodM, 2013. When setting the maximum possible magnitude (M_{max}) for the Groningen gasfield at 6.0 the chance of having a magnitude 5.0 earthquake has a chance of 0.6% at a production rate of 10 billion cubic metres a year.



The NAM also states on their website that a magnitude of between 4.0 and 5.0 could occur (Nederlandse Aardolie Maatschappij, 2013). They say so based on a study conducted by the KNMI¹. The KNMI states that a comparison has been made between gas- and oilfields around the world and according to the literature the maximum possible magnitudes are between 4.2 and 4.8. From this they conclude that the maximum possible magnitude will not be bigger than 5.0 in the Groningen gasfield. According to the interviewed PhD Geo-Energy this statement is useless. Due to the fact that these results are based on foreign fields they say nothing about the Groningen gasfield. It is thus interesting to see what is the 'truth' and what is not. "A statement is true if and only if, what the statement says to be the case actually is the case" (Alston, 1996, p. 648). The KNMI is looking for coherences between the Groningen gasfield and other fields around the world but coherences are irrelevant to truth (Thagard, 2007).

Third point of critique to all concerned parties is the everlasting talk about the magnitude-scale of Richter even though the intensity-scale of Mercalli is the better variable to take into consideration. The scale of Mercalli measures the intensity of an earthquake. It measures the effects of an earthquake and these effects are not only determined by its magnitude but also by the depth of the epicentre, soil composition and porosity. The KNMI uses a survey on their website to measure the intensity of an earthquake perceived by the people (see appendix D).

The NAM is working hard on trying to send out appraisers to the people that suffered from damages. They admit that the process of assessing the damage and eventually paying out the sum takes too long. They hire a third party for their appraisers whom they cannot always control. They also admit that there are cases with appraisers being rude or not having the proper knowledge and they do take certain responsibility for it. The participant from the GBB said that the appraisers barely ever qualify to the needed knowledge for assessing damages. He accused the NAM for sending car appraisers to national monuments.

The spokesperson from the NAM said that they want to minimize the dangers for the affected people and they will accept the consequences the Ministry of Economic Affairs and SodM will give them. May it be decreasing natural gas extraction or may it be complete shutdown of all productions.

A solution and recommendation for the NAM to help reduce the earthquakes could be: mapping out the different compartments of the Groningen gasfield and adjust the production of natural gas

¹ "Tenslotte is een vergelijking gemaakt met gas- en olievelden buiten Nederland en de daarin opgetreden geïnduceerde events. Maximale sterktes van bevingen, zoals in de literatuur vermeld, variëren van M=4.2 tot 4.8. Hieruit wordt de conclusie getrokken dat niet verwacht wordt dat de maximale mogelijke magnitude groter dan 5 zal worden" (Koninklijk Nederlands Meteorologisch Instituut, 2013, p. 2).



extraction to the compartments pressure level. Solutions like putting CO² back into the ground are perceived useless and not economically viable by the interviewed PhD Geo-Energy. When CO² is pumped into the ground, whilst still extracting natural gas, one would eventually extract CO²+natural gas. The economic returns of the extraction would decline in an amassment when continuing this process of putting CO² in the ground while extracting. This is thus a non-viable solution that a lot of people perceive possible. Professor Wim Turkenburg is an example of these people, in 'BNR Duurzaam' he brings up the theorem that CO² together with olivine could prohibit Groningen from future earthquakes (BNR.nl, 2013).

A plan from the NAM themselves is to strengthen weak houses to make them able to resist future earthquakes, they have put aside 100 million euro for this project. Currently they are assessing which houses are in the most desperate need for help and which might be due in the near future.

However, the GBB states that the 100 million euro that the NAM sets aside for the preventive measurements is just 'a drop in the ocean'² (NOS, 2013). The Royal Commissioner Max van den Berg agrees that it is not enough (RTL Nieuws, 2013).

Part V: Conclusions

SIAs are conducted because it can help individuals and communities, as well as government and private-sector organizations, understand and better anticipate the possible social consequences for communities of planned and unplanned social change resulting from proposed projects (Burdge, 2003). SIAs monitor and manage the intended and unintended social consequences of planned interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment (Vanclay, 2003). Concepts and theories like SLO, PI and FPIC are important to consider in the process of conducting SIAs. FPIC can be a process to protect consumers by providing relevant information for them to make informed choices (Goodland, 2004) while SLO is considered to be the acquisition and on-going maintenance of the consent of local stakeholders to specific projects (Pike, 2012). The concept of PI helps the affected community to voice their opinion (Burdge & Robertson, 1990).

Obtaining a SLO from the affected people is of importance to the NAM and its projects. Conducting a SIA can help minimize the impacts and maximize the profits. FPIC is there to help the affected people make informed choices and thereby deciding whether or not they give the NAM a SLO in the Groningen gasfield. When deciding not to give the NAM a SLO they can voice their opinion through

² De 100 miljoen euro die de NAM beschikbaar stelt voor preventieve maatregelen en schadevergoeding is 'een druppel op een gloeiende plaat' (NOS, 2013).



PI. Currently the NAM does not have a SLO in the Groningen gasfield area due to the influences of the natural gas extraction on the affected people.

Figures 9 and 10 show that the NAM should decrease their annual gas production to decrease the annual number of earthquakes. The SodM 2013 report provided evidence that the number of induced earthquakes is dependent on the amount of natural gas extraction.

Therefore research about the maximum possible production of natural gas extraction to minimize the earthquakes should be conducted independently by an autonomous institution because the NAM cannot be unbiased in the matter. The decrease of annual gas production leads to a decrease in the gas revenues of the NAM. Perhaps even the government and citizens are unfit parties in this case. The decrease in gas revenues leads to a decrease in the government revenues which causes the amends the people in the earthquake hit areas receive to diminish. The most suitable autonomous institution for conducting this research is most likely a foreign institution.

The NAM is aware of the situation and awaits orders from the Ministry of Economic Affairs to tell them what to do. The production of natural gas extraction can be either, unchanged, increased, decreased or stopped entirely. The Ministry of Economic Affairs on its turn is waiting for eleven independent studies to be completed, to draw their conclusions on about what to do next and on which the advice to the NAM will be based. There are a lot of parties involved and a lot of variables to take into consideration when drawing conclusions on this matter.

A transparent relationship between the NAM and the affected community is desirable for both parties. The NAM would spend less time explaining their actions because the affected community knows why they are doing it, and the affected community does not have to ask what, why or how the NAM is doing it because they already provided this information. This is something the NAM could work on together with the SodM and the Ministry of Economic Affairs. They could try and create a forum on which they make a clear overview of the available information about the natural gas extraction in the Groningen gasfield. The NAM would also be able to utilize the forum as a grievance mechanism to hear the community and make use of this information. Through listening and reacting to the community they could improve their relationship with the affected community and avoid the conflicts which are currently happening and perhaps obtain a SLO which they currently do not have.



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Appendices

Appendix A: Main interview questions set out *before* conducting them. During the interviews a lot more questions were asked and perhaps also more relevant ones. They are ordered chronologically.

1) To the PhD Geo-Energy from the Rijksuniversiteit Groningen (RuG)

1. Bent u het eens met de stelling; De aardgaswinning gedaan door de NAM veroorzaakt aardbevingen in dorpen in Noord-Nederland.

Ja, dan;

→ Zou u kunnen uitleggen hoe deze processen te werk gaan en zijn er nog mogelijke oplossingen tegen deze aardbevingen?

Zijn de aardbevingen in februari een logisch gevolg van de aardgaswinning of was dit niet te voorzien?

→ Naar ons weten worden de aardbevingen veroorzaakt doordat er holtes in de grond zitten, door deze holtes krijg je aardverzakkingen die weer druk veroorzaken en op zijn beurt weer aardbevingen veroorzaken, zouden deze holtes niet opgevuld kunnen worden met bijvoorbeeld CO² of heeft u hier nog andere ideeën over?

→ In hoeverre neemt de NAM verantwoordelijkheid voor de veroorzaakte schade en gevolgen? En is het iets nieuws/sinds wanneer? Zijn er geen andere partijen die verantwoordelijkheid hebben in deze kwesties (i.e. Shell, Gasunie) welke partij is eigenaar van het gas?

→ De sterkste aardbeving tot nu toe wordt verondersteld op 3.5 op de schaal van Richter, denkt u dat dit nog erger gaat worden of juist niet? Is de KNMI in uw academische wereld een geaccepteerde organisatie voor het uitvoeren van deze metingen?

→ Hoe lang doet de KNMI dit al?

2. Heeft u enig idee hoe de NAM omgaat met de schade afhandeling van de getroffen individuen?

→ Menig over?

→ Hoe wordt de schade uitgedrukt in waarde (cultuurhistorie, landschap, structurele schade)? Wat zijn de criteria?

→ Is het bouwtechnisch mogelijk om aardbevingsbestendige huizen neer te zetten en is dit een oplossing? Zou dit een betere oplossing zijn in uw mening dan het constant repareren van huizen? En financieel gezien?



3. Heeft u ook onderzoek gedaan naar de meetbare gevolgen van de aardbevingen in de getroffen gemeenschap als geheel?
 - Ontvolking dorpen o.i.d.? Achterblijven kansarmen?
 - Is het ongenoegen tegen deze aardbevingen vanuit de gemeenschappen nu op een historisch hoogtepunt of is er altijd al wel veel protest geweest tegen de aardgaswinning en de daarmee veroorzaakte aardbevingen?
4. Heeft u enig idee wat de gevolgen van de aardbevingen zijn op de individu?
 - Zou u zich voor kunnen stellen dat u getroffen wordt door een aardbevingen en hoe denkt u dat dit u zou beïnvloeden in uw dagelijkse leven?
5. Wie ontvangt wat van de gas en olieopbrengsten? Shell/gemeente/NAM/Staat?
6. Welke autoriteit heeft vorige maand beslist om de productie van de groninger gasvelden niet te verlagen?
 - Heeft dit te maken met de 'gasrotunde-strategie' van de Gasunie?
7. Zijn er ook andere positieve economische effecten voor de regio? Banen/sociaal programma van NAM of shell, etc.

2) *To the woman living in Stedum. A village in the Groningen gasfield area and hit by induced earthquakes.*

1. Bent u ooit benaderd door de NAM of een ander lokaal bestuur over de aardbevingen en de gevolgen ervan? Zo ja, wanneer was dit en wat werd er zoal gevraagd door ze?
(Compensatie voor schade, stil houden ervan of hoe ze het in de toekomst willen gaan doen?)
2. De NAM organiseert ook get-togethers voor de bevolking om te praten over problemen, bent u hier ooit bij geweest? Heeft u ook enig idee of ze ooit iets anders hebben geprobeerd om te communiceren met de bevolking dan op deze manier?
3. Welke gevoelens roept het bedrijf NAM op bij u?
 - Steekwoorden o.i.d.?
4. Wat heeft u persoonlijk ondervonden van de aardbevingen? Enige gevoelens die bij u naar boven komen zoals angst o.i.d.? Schade aan uw huis?



→ Zou u de aardbevingen ook nog steeds zo erg vinden als uw huis versterkt wordt en aardbevingsbestendig gemaakt zou worden // of uw huis in zijn totaliteit zelfs vervangen zou worden? Zou u dat überhaupt wenselijk vinden of zou u, denkt u, daardoor uw gevoel van “thuis” kwijt raken?

5. Wat voor gevolgen hebben deze aardbevingen verder op Stedum? Heeft u enig idee of bijvoorbeeld de waarde van de huizen zijn afgenomen of dat er mensen wegtrekken uit het dorp? /leeglopen

-Bent u nog ergens specifiek bang voor dat in de toekomst kan gebeuren?

(Instorten huis o.i.d.)

-Overweegt u te verhuizen naar een ander dorp door de aardbevingen?

6. *Een quote van de NAM site is dat “de NAM staat voor maatschappelijk verantwoord ondernemen. Dit uit zich in de duurzame ontwikkeling van bedrijfsactiviteiten. Naast economische haalbaarheid spelen het milieu en sociale verantwoordelijkheid een rol in de bedrijfsvoering van de NAM. Middels een dialoog met de samenleving wordt gezocht naar een gezonde balans.”*

→ Heeft u het idee dat de NAM hier ook daadwerkelijk mee bezig is? Heeft u enig idee of die “dialoog met de samenleving” ooit plaats heeft gevonden? Of heeft u het idee dat de NAM gewoon weer wat uit z’n duim loopt te zuigen, net zoals de quote dat er geen schade aan huizen en gebouwen zal optreden.

→ Vindt u dat de NAM zich hierin kan verbeteren?

3) To the participant from the Groninger Bodem Beweging (GBB)

1. Is de brief van directeur , begin van dit jaar gepubliceerd op uw website, de eerste officiële toegeving van schuld?

Al in 1984 is de commissie bodemdaling Groningen opgericht. Deze commissie heeft in die tijd een bedrag van 650 miljoen gulden namens de Nam en 50 miljoen namens de overheid te besteden gekregen om de effecten van de Bodemdaling tegen te gaan.

2. Is dit niet al een toekenning van schuld aan de NAM en waarom moest het volgens u dan zo lang duren voordat de directeur deze brief schreef? En de bewoners toegang tot schadevergoeding.
3. Denkt u dat de aansprakelijkheidstelling van de NAM voor waardedaling van panden(zoals vermeld op uw website) succes zal hebben? Waarom wel/niet?



4. Op uw website geeft u aan dat een belangrijk doel van de GBB is om schaderegelingen en taxaties te verbeteren, vindt u dat de NAM hierbij te kort schiet?
5. Hoe vindt u dat de NAM omgaat met immateriële schade?
6. Bent u ooit benaderd door de NAM of een ander lokaal bestuur over de aardbevingen en de gevolgen ervan? Zo ja, wanneer was dit en wat werd er zoal gevraagd door ze?
(Compensatie voor schade, stil houden ervan of hoe ze het in de toekomst willen gaan doen?)
7. Wat heeft u persoonlijk ondervonden van de aardbevingen? Enige gevoelens die bij u naar boven komen zoals angst o.i.d.? Schade aan uw huis?
→ Zou u de aardbevingen ook nog steeds zo erg vinden als uw huis versterkt wordt en aardbevingsbestendig gemaakt zou worden // of uw huis in zijn totaliteit zelfs vervangen zou worden? Zou u dat überhaupt wenselijk vinden of zou u, denkt u, daardoor uw gevoel van “thuis” kwijt raken?
8. Wat voor gevolgen hebben deze aardbevingen verder op dorpen? Heeft u enig idee of bijvoorbeeld de waarde van de huizen zijn afgenomen of dat er mensen wegtrekken uit het dorp? /leeglopen
-Bent u nog ergens specifiek bang voor dat in de toekomst kan gebeuren?
(Instorten huis o.i.d.)
-Overweegt u te verhuizen naar een ander dorp door de aardbevingen? / Denkt u dat andere mensen dit overwegen i.v.m. de aardbevingen.

Op 25 Januari van dit jaar heeft de Staatstoezicht op de mijnen een rapport gepubliceerd waarin zwaardere aardbevingen dan 3,9 niet uit te sluiten zijn.

- Wat vindt u van de dit rapport?
- Wat is voor de GBB het maximum risico wat acceptabel is voor de lokale bevolking?
Bijvoorbeeld max kracht aardbevingen of intensiteit?
- Wij hebben met inwoners van de getroffen gebieden gesproken en deze waren vaak positief over uw organisatie. Maar was er voor 2009, de oprichting van de GBB, geen organisatie die voor uw belangen op kwam?
- Vanuit de media en eerdere interviews kreeg ik het idee dat de NAM te weinig vertrouwen heeft van de bevolking om nog onderzoek te laten doen naar gevolgen van aardbevingen ook al zou dit op recht zijn. Bent u het met deze stelling eens? (Uitleg)
- Zo ja, sinds wanneer is de NAM volgens u ongeloofwaardig?



9. Welke gevoelens roept het bedrijf NAM op bij u (zelfzuchtig, geldwolven, etc.)
→ Steekwoorden o.i.d.?

4) To the spokesperson of the Nederlandse Aardolie Maatschappij (NAM)

- Heeft de NAM een bepaald gevaarteniveau waarbij ze ook vinden dat het niet erger mag worden? Zo ja, zodra deze bereikt wordt wat is dan het plan van aanpak van de NAM?
- Heeft de NAM worst-case scenario's voorbereidt? Of is dat meer iets voor de overheid?
- Wat is de rol van de Groningen Bodemdaling Commissie bij de schade afhandeling? Deze organisatie bestaat al sinds '83 maar, de mensen die wij gesproken hebben kregen pas vanaf 2006 een schadevergoeding.
- Gezien de kans op grote aardbevingen, vindt u het budget van 100 miljoen voor de afhandeling van schade niet een beetje weinig? Gezien de NAM vorig jaar iets van 12 miljard winst heeft gemaakt.
- Snapt u de ophef onder de bevolking over de folder die, samen met de brief van de directeur van de NAM, is verspreidt afgelopen Maart? (zie link)
http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/Downloads/Folder_bewonersinformatie.pdf
- Mits de overheid een ander beleid wil hanteren dan de NAM jegens de gaswinning, in hoeverre kan de NAM dan zijn eigen beleid doorvoeren?
- Is het alleen de minister van Economische Zaken (Dhr. Kamp) die bepaald hoeveel gas er uit de grond gewonnen mag worden en wat de maximale risico's zijn? Of komen er nog andere ministers bij kijken? i.e. minister van Sociale Zaken.



Appendix B: Village garden in Stedum.



Sales stall of village garden “De Heemen” where they sell locally produced products. Including the by kids from Stedum painted wall in the background.



Rented out plots.



Appendix C: Bounded Gutenberg-Richter (BGR) relationship

Bounded Gutenberg-Richter relationship (BGR), this measurement takes account for minimum (M_{min}) and maximum (M_{max}) magnitude.

The modified GR is often called the *Bounded Gutenberg-Richter relationship (BGR)* [16]:

$$N(M) = e^{\alpha - \beta M_{min}} \frac{e^{-\beta(M - M_{min})} - e^{-\beta(M_{max} - M_{min})}}{1 - e^{-\beta(M_{max} - M_{min})}} \quad (2)$$

where $\alpha = a \ln(10)$ and $\beta = b \ln(10)$. As for the GR, the BGR is valid for both the number of earthquakes with magnitudes equal to or higher than M , as for the frequency of earthquakes which occur in a given area and time period, with a magnitude $\geq M$.

$N(M)$ is the number of earthquakes which occur in a given area and time period, with a magnitude $\geq M$.

Constant a is subsequently a measure of the level of seismicity.

Constant b , describes how the number of earthquakes in the zone varies for different magnitudes (it is the negative of the slope of the GR relationship)

(Staatstoezicht op de Mijnen, 2013).



Appendix D: Survey form from the KNMI to measure the intensity of an earthquake.

Enquêteformulier aardbevingen in Nederland

Als u van mening bent dat u een aardbeving heeft gevoeld, wordt u verzocht dit enquêteformulier in te vullen. De gegevens in de drie gekleurde blokken hieronder moeten ten minste worden ingevuld.

Uw gegevens

Het gaat hier om de gegevens van het adres waar u was op het moment van de aardbeving. De onderstaande vragen gaan over uw ervaringen in dat betreffende huis. Dit hoeft dus niet uw eigen huis te zijn. U kunt eventueel voor uw eigen huis nog een enquête invullen met de bijbehorende postcode.

Zonder postcode en huisnummer kan uw melding niet verwerkt worden.

Woonplaats:
 Straat:
 Postcode: Huisnummer:
 E-mailadres:

Datum en tijdstip van de aardbeving

Datum: 1 januari 2012 Tijdstip: 00:00

Heeft u iets gemerkt van de aardbeving?

Wilt u dit formulier ook invullen als u niets gemerkt heeft? U hoeft dan alleen maar de vraag hieronder met 'Niets gemerkt' te beantwoorden. Het is voor ons ook van belang om te weten waar er niets gevoeld is.

- Niets gemerkt. U kunt het formulier gelijk verzenden.
 Wel gemerkt. Ga dan verder met de volgende vragen.

Heeft u een beweging gevoeld?
 Nee Zwak
 Golven Duidelijk
 Schudden/Trillen Sterk
 Schok(ken) Zeer sterk

Aantal schokken:
 Duur in seconden:

Anders:

Heeft u geluid gehoord?
 Nee Zwak
 Gerommel Duidelijk
 Dreun Sterk
 Knal(len) Zeer sterk

Aantal knallen:
 Duur in seconden:

Anders:

Wat was er eerder, de beweging of het geluid?
 Niet van toepassing
 De beweging was er tegelijk met het geluid
 De beweging was er eerder dan het geluid
 Het geluid was er eerder dan de beweging

Bewogen er in huis voorwerpen of maakten ze geluid?
 Nee
 Serviesgoed, planten, staande voorwerpen
 Hangende voorwerpen zoals lamp, kloggewicht, lamellen, enz.
 Stoel, bank, kast, bed
 Anders:

Bewogen er delen van het huis of maakten ze geluid?
 Nee
 Huis, dak, muur, vloer
 Radiatoren, deuren, ramen
 Deuren of ramen openden of sloten zich
 Anders:

Vielen er voorwerpen om of werden ze verplaatst en zo ja, hoeveel?
 Nee
 Serviesgoed, planten, staande kleine voorwerpen
 Vloeistof uit kopje/glas
 Stoel, bank, kast, bed
 Anders:

Hoeveel personen op dit adres hadden de hiernaast genoemde reacties?
 Niets gemerkt:
 Kalm gebleven:
 Geschrokken:
 Beangstigd:
 In paniek:

Andere reacties:
 Geen
 Uzelf of de burens zijn naar buiten gelopen
 U heeft uit het raam gekeken
 Anders:

Vertoonden dieren opvallend gedrag?
 Nee
 Ja, namelijk:

Waar bevond u zich?
 Binnen
 Welke etage:
 Welke ruimte:
 Buiten
 Waar:

Stond, zat of lag u op dat moment?
 Staand
 Zittend
 Liggend

Was u wakker, of sloep u en werd u er wakker van?
 Wakker
 Wakker geworden door de gebeurtenis

Was het lastig om te blijven staan of te lopen?
 Nee
 Lastig om te blijven staan
 Lastig om te lopen

Hoe heeft u de aardbeving ervaren?
 Niet van toepassing
 Donder van onweer
 Explosie
 Vliegtuig dat door de geluidsbarrière vliegt
 Vallend voorwerp
 Een voorbereidende vrachtauto
 Een voorbereidende zware vrachtauto
 Een vrachtauto die tegen het huis aan rijdt
 Een zware vrachtauto die tegen het huis aan rijdt
 Anders:

Weet u uit welke richting de beweging of het geluid kwam?
 Niet bekend
 Richting:

Waar leidt u de richting uit af?

Zijn er schilderijen of klokken scheef gaan hangen?
 Nee
 Ja
 Weet u de richting van die muur?

Wat voor type huis is het?
 Bouwjaar:
 Eengezinswoning
 Bungalow
 Vrijstaand of twee onder een kap
 Boerderij
 Flat
 Anders:

Heeft het huis schade opgelopen?
 Nee
 Ja. Opgelopen schade:

Heeft u op dit adres al eerder een dergelijke ervaring meegemaakt?
 Nee
 Ja
 Hoeveel jaar geleden:

Huidige beving is:
 Zwakker
 Gelijk
 Sterker

Heeft u andere verschijnselen opgemerkt of wilt u aanvullende opmerkingen maken?
 Nee
 Ja

Formulier verzenden

Formulier wissen

(Koninklijk Nederlands Meteorologisch Instituut, 2013).

