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Update 2017 Shakemaps for "Maximum Considered Earthquake" Scenario in Groningen

A report prepared for the National Coordination of Groningen

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1. Introduction

The Royal Netherlands Meteorological Institute (KNMI) produced shakemaps calculated with the ground motion model (GMM), version v2, for the National Coordinator Groningen in July 2016. The shakemaps v2 were used in the committee 'Framework for earthquake resistance of chemical industry in Groningen' to assess the impact of a maximum credible earthquake on industry in the province of Groningen. The four main industry areas are in Delfzijl, Eemshaven, Hoogezand and Veendam (see Figure 1).

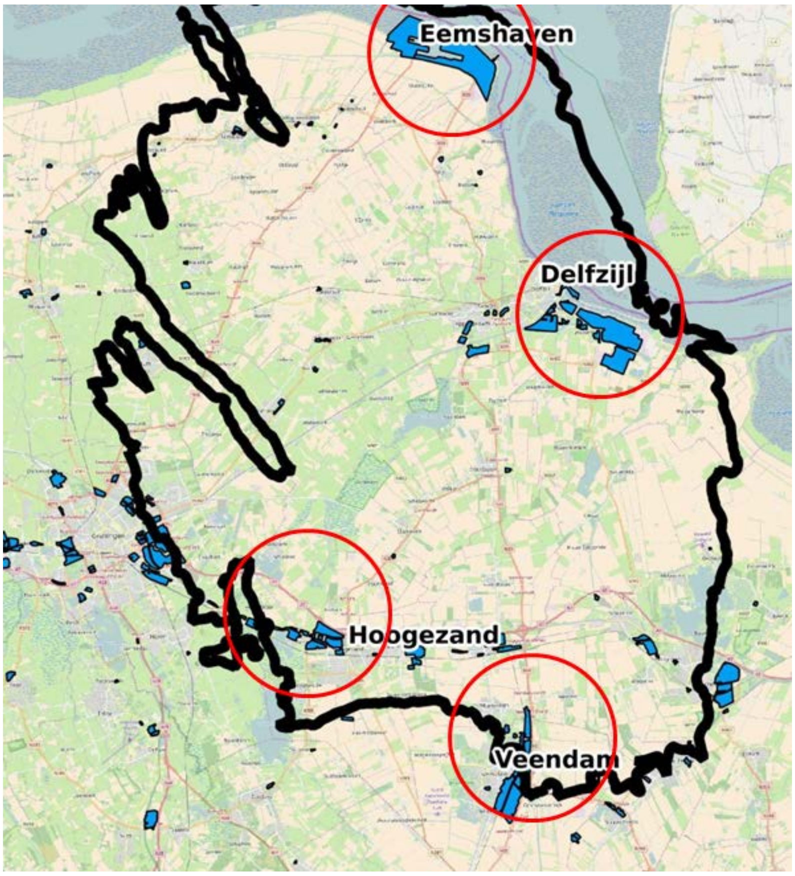


Figure 1: Map of Groningen with industrial sites under investigation (red circles). The extension of the Groningen field is marked with the black line.

This report is an update of the shakemaps for the industry. In the previous shakemaps report, only four spectral periods between 0.01 s and 3 s were calculated. This time 23 spectral periods between 0.01 s and 5 s are included. The representation of spectral periods below 3 s which is relevant for building structures is better represented. The GMM used in this work is the current v4 version. The latest GMM has not only more spectral periods, but is based on more recordings of induced earthquake and new insight in the near-surface geology. Another improvement is the addition of the Mmax distribution in the shakemaps calculations. Hence, two sets of shakemaps for industry locations are delivered. On set for the Mmax = 5 and another set for the Mmax distribution.

This report starts with an explanation of the improvements of the GMM v4 with respect to the GMM v2. The maximum magnitude of induced events in Groningen is shortly discussed. A short description of the developed shakemaps v4 software for scenario calculations is given. The location of the ‘maximum credible’ earthquake is estimated in a disaggregation analysis. The shakemaps for the Mmax = 5 and the Mmax distribution for all four industrial sites are presented. Finally, conclusions are drawn.

2. Ground motion model v4

The GMM v2 and v4 are similar in structure (Bommer et al., 2015, 2017). Both GMM’s are based on a two-layer model of Groningen. Whereas the bedrock was at -350 m in GMM v2, the strong layer discontinuity at -800 m (the bottom of the North Sea layer) is the new depth for the reference level. Figure 2 illustrates the two-layer approach with a half space layer below the near-surface layer. An induced earthquake is initiated in the gas reservoir (on average 3km) and propagates towards the surface through the half-space model and the near-surface layer with site-specific soil properties where the amplification of the seismic signal takes place. A novelty for the amplification factor in GMM v4 is the introduction of a magnitude-distance dependence. This means that not only the magnitude of the induced earthquake affects the amplification factor as it is the case in GMM v2, but the distance between the hypocenter and site plays a role. The rupture distance is used for the distance measure in GMM v4. In principle, the extension of the fault rupture should be incorporated in the hazard and shakemaps calculations. This type of geological information for Groningen has a lot of uncertainties. Effectively, the hypocenter distance definition is still used in GMM v4. For example , the shortest distance between a hypocenter directly below the site to the surface is 3 km.

The zonation model for the amplification factor has been improved from GMM v2 to v4. To sample an integrated shear-wave velocity model for the top column from the bed rock to the surface a combination of shallow seismic experiments conducted by Deltares (Kruivert et al., 2017), low-passed filtered surface data in 3D seismic reflection data and an improved time-to-depth model from seismic imaging were applied. The number of zones is reduced from 167 to 160. In general, the largest shear wave velocities are still found in the south where near-surface amplification effects are less severe and vice versa. The current geological zones for the GMM v4 is shown in Figure 3, (Kruiver et al., 2017).

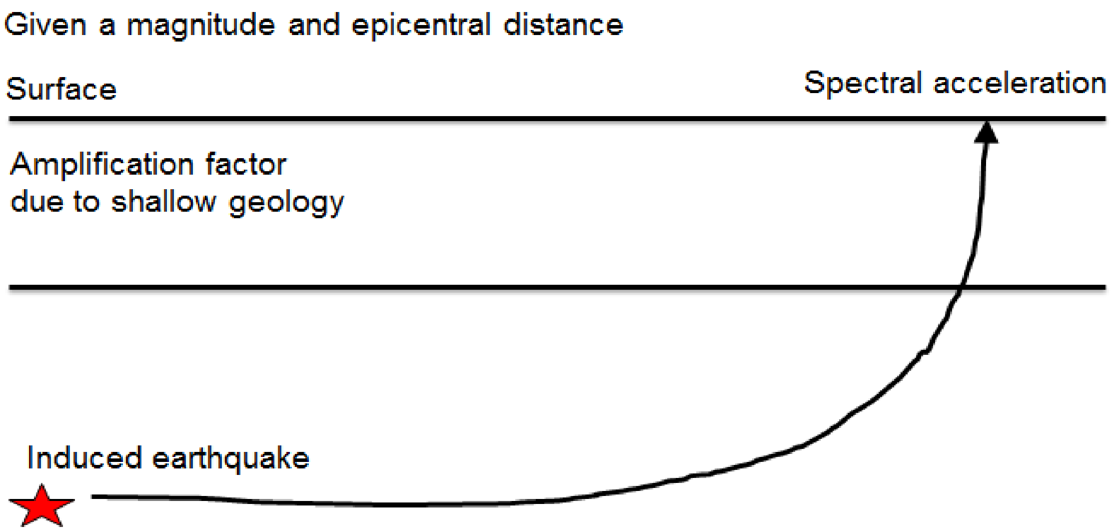


Figure 2: Schematics of the two-layer model used to define the GMPE v4.

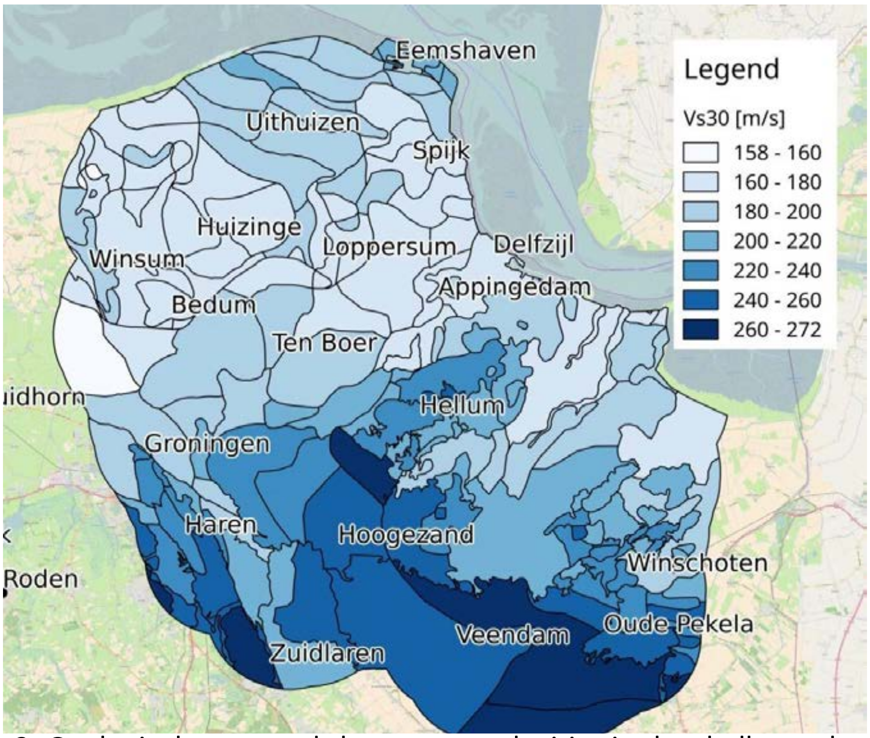


Figure 3: Geological zones and shear wave velocities in the shallow subsurface (Kruiver et al., 2017).

The GMM v4 introduces an uncertainty coming from fitting the observed data from the Groningen station network and the synthetically modelled data with the amplification factor for measured soil properties. The standard deviation (std) is used to express the uncertainty of the calculated spectral accelerations. The shakemaps approach to compute the standard deviation follows the traditional ergonic hazard approach (Rodriguez-Marek et al., 2014), and is considered to be rather conservative. In this report, the range of the median spectral acceleration (*SA*) is defined in-between one standard deviation. The lower and upper spectral acceleration (*Y*) is given by

$$Y = SA \pm std,$$

where *SA*, *Y* and *std* are in the unit [cm/s^2], [m/s^2] or [g]. To convert between cm/s^2 or m/s^2 to g, the conversion factor 1/(100*g) or 1/g, where g = 9.82 m/s^2. For example, an acceleration of 100 cm/s^2 converted to the unit of [g] is equal to 0.102 g.

3. Maximum credible magnitude for Groningen

The KNMI advises to use as maximum credible magnitude Mmax = 5 for the contribution of the induced seismic hazard in Groningen. The value for Mmax has been determined by comparing with other produced fields worldwide.

Another option is the Mmax distribution advised by an international workgroup of experts during the Mmax workshop on March 8-10, 2016 (Report on Mmax Expert Workshop, July 2016*)*. The Mmax distribution accounts for the possibility of induced and tectonic events in Groningen. The expert panel concluded that strong events in Groningen would have to be tectonic. It is still a point of discussion whether the conditions for tectonic events are present at the fault structures at or under the gas reservoir. There are no records of tectonic events before the gas production in Groningen was initiated in the late 1960’s indicating a non-existing-to-weak initial stress field. A triggered event with a magnitude 7 in Groningen is considered to be extremely unlikely by the KNMI since a tectonic earthquake with such a magnitude would have to partly take place outside the gas filled reservoir and would be associated with a deep fault in the carboniferous layer. The Mmax distribution is given in Table 1. The Mmax distribution is defined in the range from M4 to M7. Notice that the average magnitude of the Mmax distribution is M = 5.

Table 1: Mmax distribution for Groningen (Bommer and van Elk, 2017).

Mmax	4.0	4.5	5.0	5.5	6.0	6.5	7.0
Weight	0.0863	0.400	0.2438	0.1125	0.0788	0.0525	0.0263

Until present the strongest event recorded in Groningen is the 3.6 event in Huizinge on August 16, 2012. The station network in 2012 was much sparser than the current network configuration in Groningen with 80 station locations in and around the Groningen gas field. The available accelerometers during the 3.6 event in Huizinge recorded PGA values about 80 cm/s^2 and 10 cm/s^2 for the epicentral distances 2 km and 10 km, respectively. Figure 4 shows the recorded PGA values as function of epicentral distance for larger induced earthquakes in Groningen (Bommer et al., 2017).

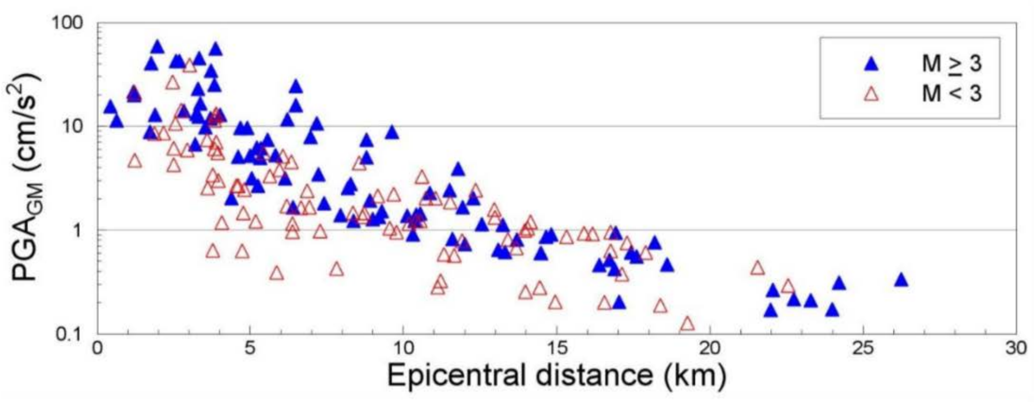


Figure 3.10. Geometric mean values of PGA against epicentral distance

Figure 4: Recorded PGA values as function of epicentral distance in the Groningen station network. (The GMM v4 report).

4. Shakemaps v4 for single event scenarios

The KNMI has developed a shakemaps program to accommodate for the possibility of calculating all spectral periods in the GMM. The software is written in C++ and a standard template library. For GMM v4, there are 23 spectral periods. In contrast, the shakemaps application by the USGS (United States Geological Survey Earth Hazard Program) only allows to calculate four spectral periods. The KNMI shakemaps v4 can be used for earthquake scenario calculations only and in its current state is not intended for the usage of generating shakemaps after a larger induced earthquake has occurred in Groningen.

The shakemaps developed by the KNMI will simply provide the expected spectral acceleration with an errorbar (that is the standard deviation of the probability distribution of all possible accelerations) at a specific location for a pre-defined earthquake scenario. Spectra with expected values of accelerations and errorbars at all spectral periods are intended to be used in a geo-technical hazard assessment of industrial constructions and structures in Groningen.

An illustration of the input parameters (i.e., epicentral distance and magnitude) is shown in Figure 3. The epicenter and magnitude of an event must be passed to the program. The program calculates the spectral acceleration at a location with a given distance to the epicenter for all periods.

The results of the new shakemaps program for a maximum considered earthquake has been tested by comparing with outputs of the USGS shakemaps program for the periods 0.01 s, 0.3 s, 1.0 s and 3.0 s. The results from both programs for a given earthquake epicenter and Mmax case are very similar. Consequently, the new shakemaps program has been properly tested and can be uses for earthquake simulations in this report.

5. Assessment of "maximum considered earthquake" for industry areas in Groningen

The update of the probabilistic seismic hazard analysis (PSHA) for Groningen was published in June 2017 (Spetzler and Dost, 2017). This update incorporated the GMM v4 and a new insight in the development of the seismicity in Groningen in the last three years. It was noted that the seismicity due to induced earthquakes is a non-stationary process over time because of the changes in gas production in the Groningen field. Generally, the contributing seismicity in the past years has moved towards the south. The KNMI earthquake catalogue includes several recent events with a lower magnitude between Hellum and Hoogezand and near Appingedam.

The disaggregation analysis in the PSHA in June 2017 is used to identify the most contributing induced events in Groningen in terms of magnitude and distance. The distance from the most contributing earthquake to the four cities with industry is estimated. To estimate the epicenter of the most likely event in Groningen, the standard method for earthquake location is used. That is to draw circles with a radius equal to the distances provided in the disaggregation method. The intersection of the circles indicates the area in which the most contributing earthquake would take place. An event with the magnitude M = 5 or a series of events described by the Mmax distribution at the estimated epicenter is defined as the "maximum considered earthquake" scenario in the shakemaps calculations for the industrial areas in Groningen.

Disaggregation distances

Location	Distance (km)
Delfzijl	~8
Eemshaven	~11

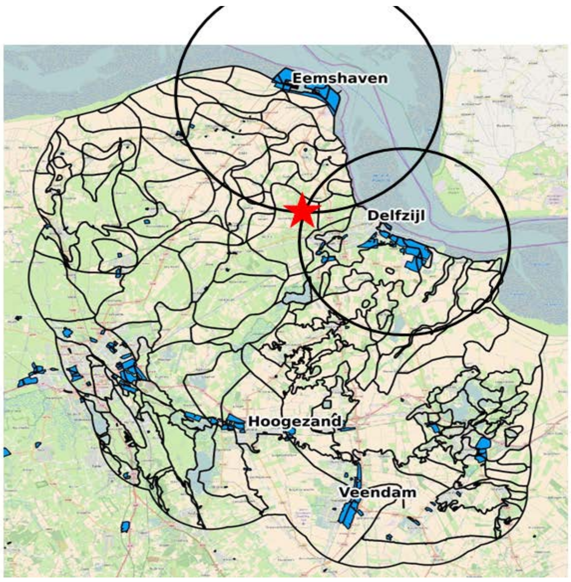


Figure 5: Earthquake scenario 1: “Maximum considered earthquake” scenario for industry in Delfzijl and Eemshaven.

Disaggregation distances

Location	Distance (km)
Hoogezand	~3
Veendam	~10

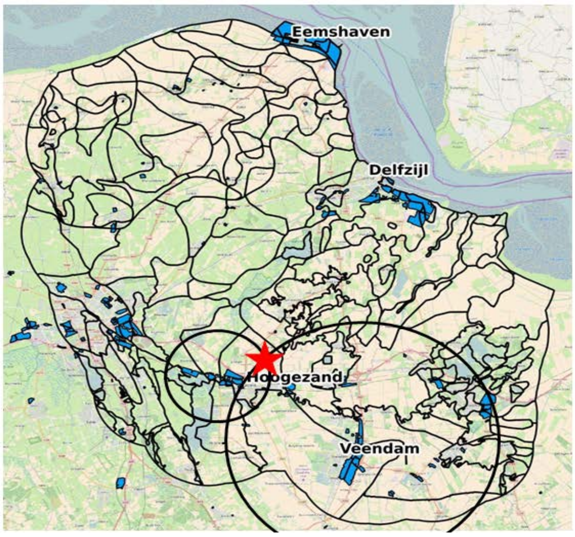


Figure 6: Earthquake scenario 2: “Maximum considered earthquake” scenario for industry in Hoogezand and Veendam.

It is found that the most contributing earthquake is respectively 8 km and 11 km from Delfzijl and Eemshaven according the disaggregation analysis. The case for these two cities is illustrated in Figure 5. This is earthquake scenario 1. The estimated epicenter (red star) is still in the Loppersum area like in the shakemaps report 2016, but it is shifted 2.5 km towards the east. The boundaries of the different geological zones are shown with the black line.

The earthquake scenario 2 for Hoogezand and Veendam is presented in Figure 6. The disaggregation analysis returns the distances 3 km and 10 km for Hoogezand and Veendam, respectively. The epicenter for the maximum considered event is therefore close to Hoogezand. The lateral displacement of the epicenter for earthquake scenario 1 and 2 is illustrated in Figure 7. For both scenarios, the epicenters are on average shifted above 2 km.

Figure 7: Displacement of the epicenter for the earthquake scenario for Delfzijl/Eemshaven and Hoogezand/Veendam.

We do not find support for a third epicenter which was presented in the shakemaps report 2016. There is simply not a clear overlap of intersecting circles with radii from the disaggregation analysis for Hoogezand, Veendam and Delfzijl.

6. Shakemaps for Chemiepark in Delfzijl

Shakemaps for all periods for the earthquake scenario 1 have been calculated. The shakemap for the province of Groningen for the period T = 0.3 s (i.e., the period with a high spectral acceleration) is presented in Figure 8 for the case Mmax = 5 and the Mmax distribution, while for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s plots are available in appendix A. There are minor discrepancies between the two shakemaps in Figure 8, but these differences are difficult to see in a visual inspection. Maps for all 23 spectral periods are available in a ncf-file format. The ncf-files are a supplement to the report.

Generally, the geological zones near the epicenter have the greatest spectral accelerations and will be reduced for increasing distance to the earthquake. Some geological zones have greater spectral accelerations than their neighbouring zones. This is because of the site-specific amplification factor which depends on local soil properties.

A) B)

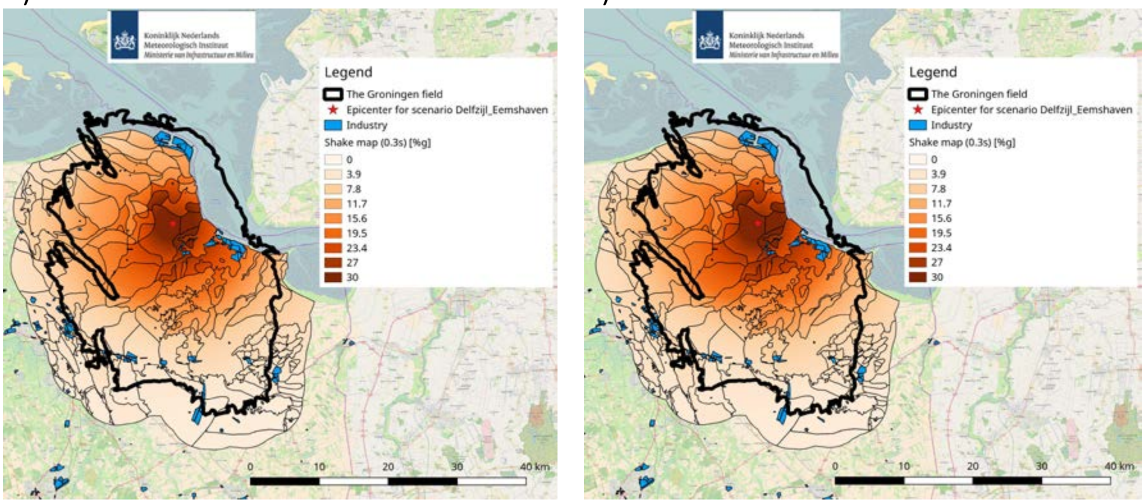


Figure 8: Shakemap with spectral acceleration for the period T = 0.3 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A zoom into the industrial area at the Chemiepark in Delfzijl is presented in Figure 9. Examples of industry in the area are Contitank, Akzo Nobel, Noord Gas Transport, Lubrizol Advanced Materials and NAM (see green circles). To provide spectral accelerations at other locations in Delfzijl, arbitrary locations in all geological zones have been selected (see yellow circles). For locations where the spectrum is not explicitly calculated, an estimate can be made by using the site location closest to one of the specified sites with spectra or by interpolation of values at more nearby sites. The spectral accelerations and standard deviations for each location either for a specific industry or location of geological zone are provided by dat files enclosed to this report. One file exists for one spectrum at each location in the four industrial areas. The coordinate of the location in the "Rijksdriehoekscoordinaat" (RD) system is indicated in the filename. Each dat-file has five columns: The first column is the spectral period in seconds [unit: s]. The next two columns are for the spectral acceleration per period in the units [m/s^2] and [g], respectively. The last two columns are for the standard deviation also in the units [m/s^2] and [g]. To find out which spectrum file corresponds to which company or site for the near-surface zonation, tables with industry names and sites and their geographical and RD coordinates are added in appendix C.

The local shakemaps for the four periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s are presented in Figure 10. The colour scale is the same in the four shakemaps. The shakemap for the period T = 0.3 s shows the greatest spectral accelerations in the four presented maps. The amplification effect has a clear lateral variation over the geological zones in the Delfzijl area.

An example of the spectrum with spectral accelerations for all 23 spectral periods for Akzo Nobel is presented in Figure 11 for the Mmax = 5 and the Mmax distribution scenario. The spectral acceleration values are given in the unit of [g]. The two spectra have a similar shape due to the site-specific amplification factor. The peak value is found around the period T = 0.4 s in both spectra. The spectrum for the Mmax distribution has greater spectral accelerations for periods above 0.4 s.

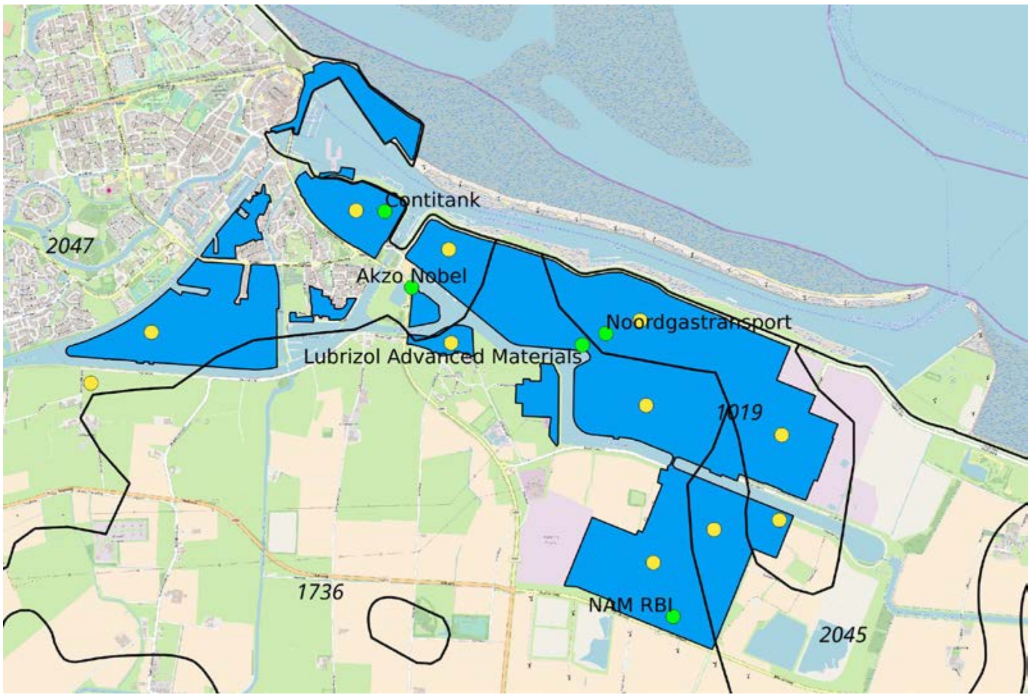


Figure 9: View of industrial area in Delfzijl with the location of industry and sites in different geological zones.

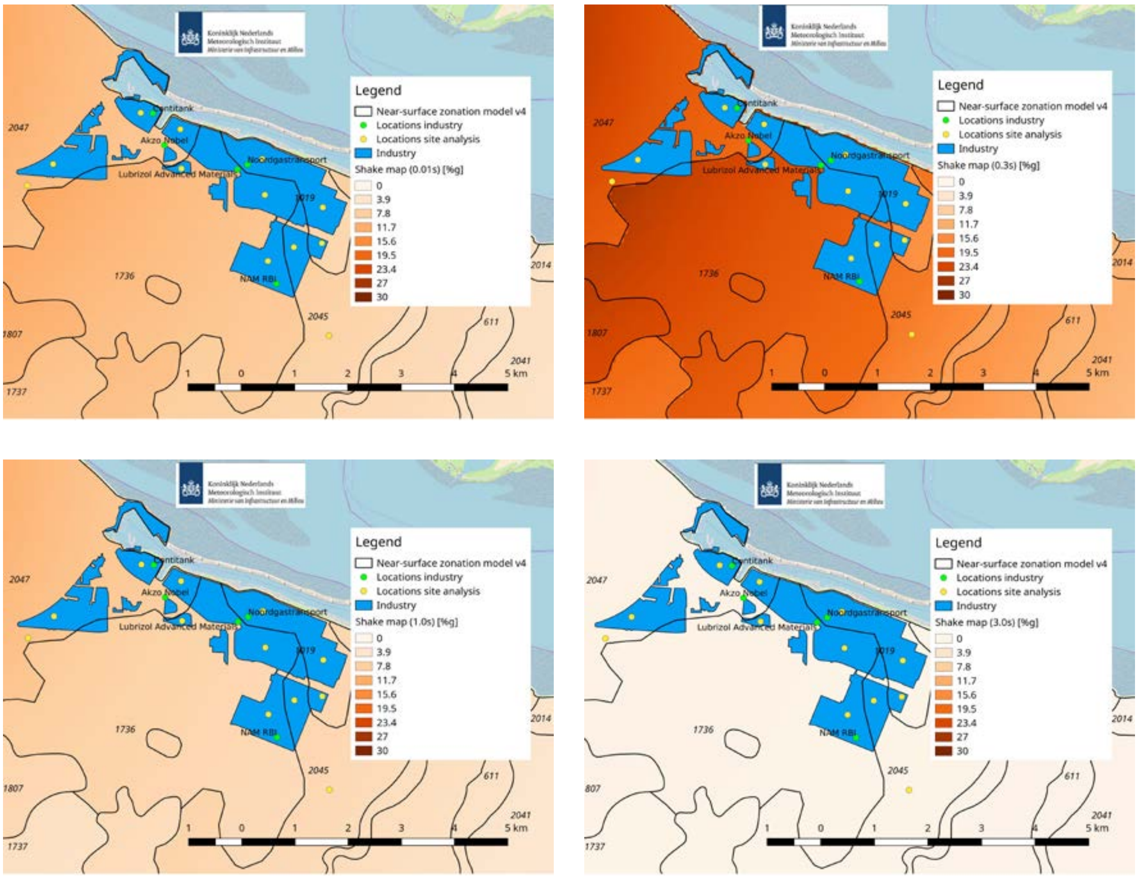


Figure 10: Local shakemaps of industrial area in Delfzijl with the location of industry and sites in different geological zones for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s. The Mmax = 5 case is illustrated.

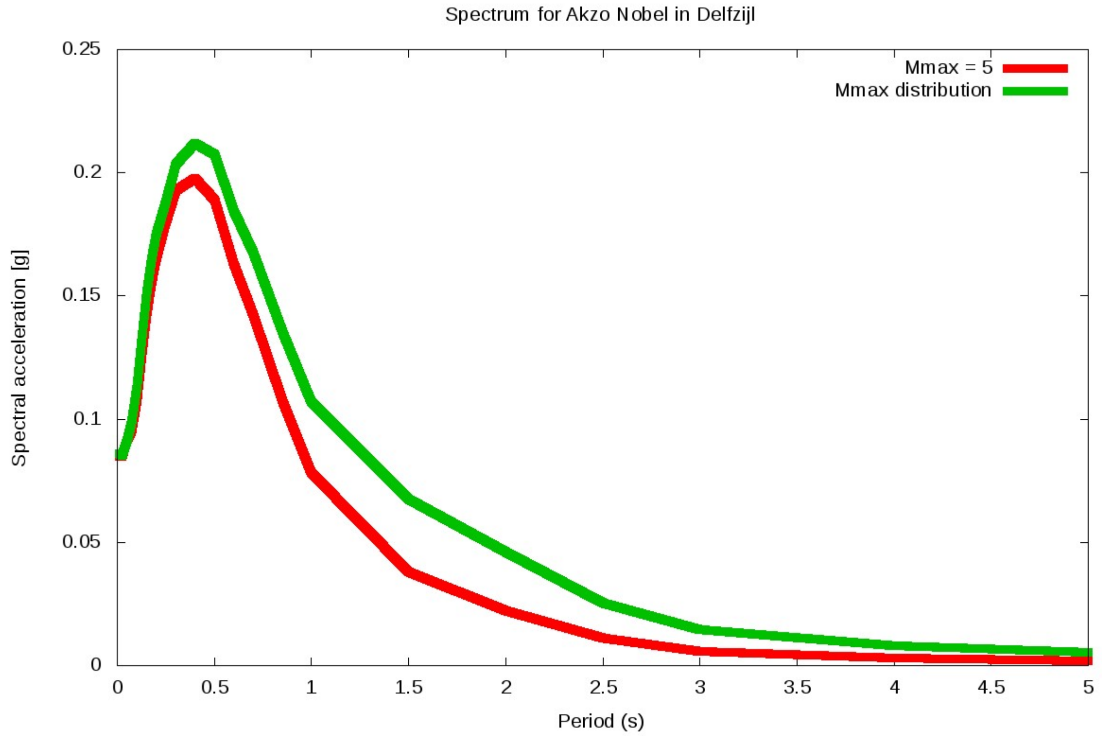


Figure 11: Spectra with spectral accelerations for Akzo Nobel in Delfzijl for the Mmax = 5 and Mmax distribution case.

7. Shakemaps for Eemshaven

The presentation of shakemaps and spectra for the other industrial areas in Eemshaven, Hoogezand and Veendam is in the order of plots as in the previous section for Delfzijl. A local map for Eemshaven with the industry and sites in different geological zones is shown in Figure 12. Vopak and GDF Suez are located in Eemshaven. The shakemaps for periods T = 0.01s, 0.3 s, 1.0 s and 3.0 s are presented in Figure 13. The Vopak location is chosen for the site-specific spectrum which is in Figure 14. Once more, it is seen that the spectrum for the Mmax distribution scenario has greater values than the spectrum for the Mmax = 5 case for periods above 0.2 s. The two spectra have the same shape. However, the Mmax distribution spectrum peaks above 0.5 s while the spectrum for the Mmax = 5 scenario has the maximum spectral acceleration below 0.5 s.

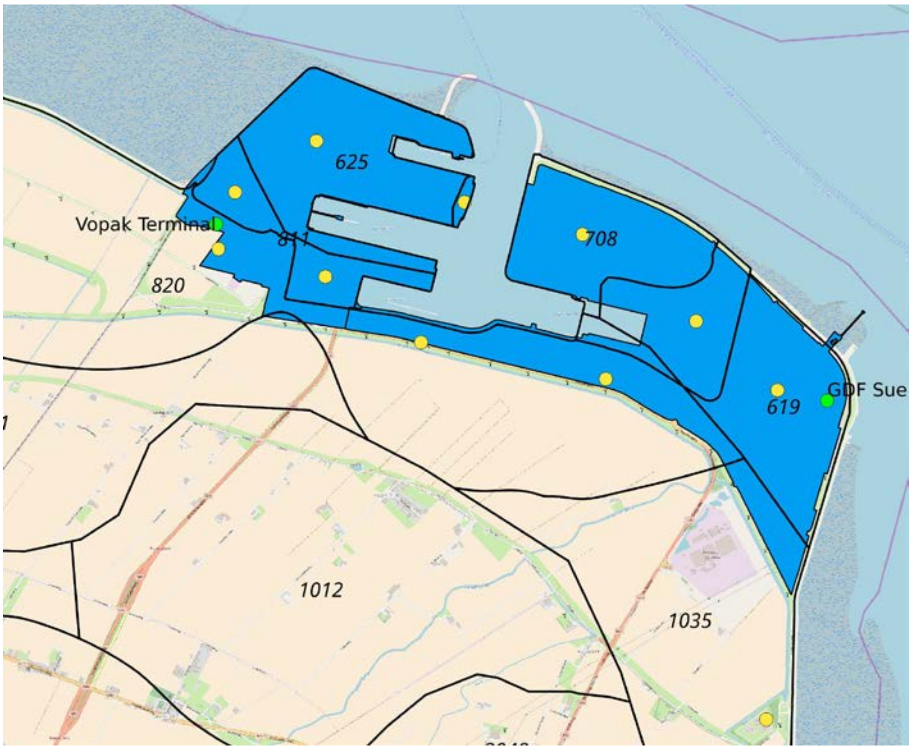
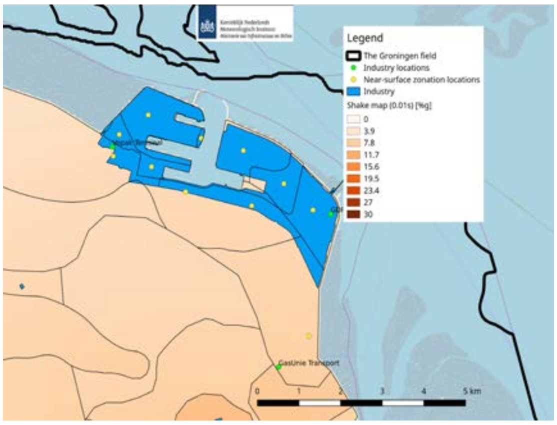


Figure 12: View of industrial area in Eemshaven with the location of industry and sites in different geological zones.



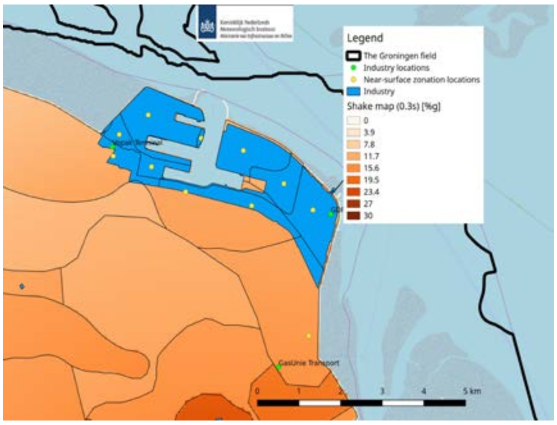


Figure 13: Local shakemaps of industrial area in Eemshaven with the location of industry and sites in different geological zones for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s. The Mmax = 5 case is illustrated.

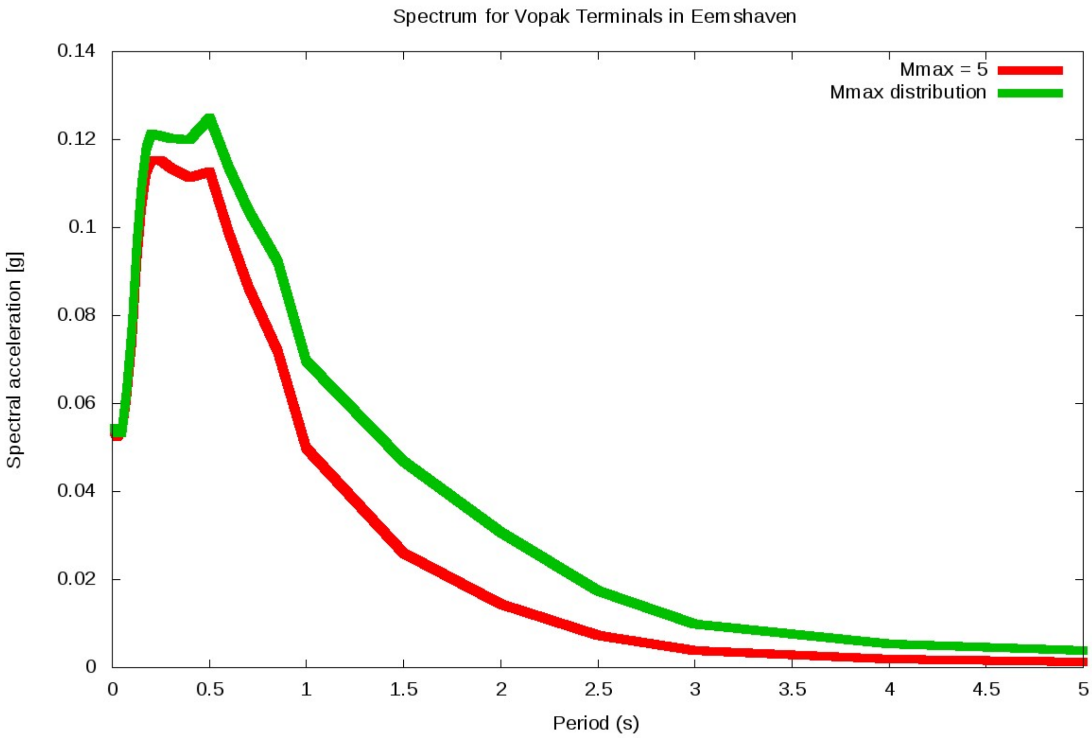


Figure 14: Spectra with spectral accelerations for Vopak in Eemshaven for the Mmax = 5 and Mmax distribution case.

8. Shakemaps for Hoogezand

The shakemaps based on earthquake scenario 2 (i. e., the epicenter is close to Hoogezand) for the spectral period T = 0.3 s for the Mmax = 5 and the Mmax distribution scenario are illustrated in Figure 15. The two shakemaps do differ from one another, but the differences are difficult to see in the plots. The shakemaps for the province of Groningen for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s are shown in section B. Bayer materialscience, DFE Pharma, Reining Warehouse, Koopman Warehouses and C. G. Holthauser are situated in Hoogezand. A map of the industry and sites with geological zones, the local shakemaps for the spectral periods T = 0.01 s, 0.3 s, 1.0s and 3.0 s and the spectrum for DFE Pharma are found in Figures 16, 17, and 18, respectively. The Mmax distribution scenario again results in greater values of the spectral accelerations for periods above T = 0.2 s.

A) B)

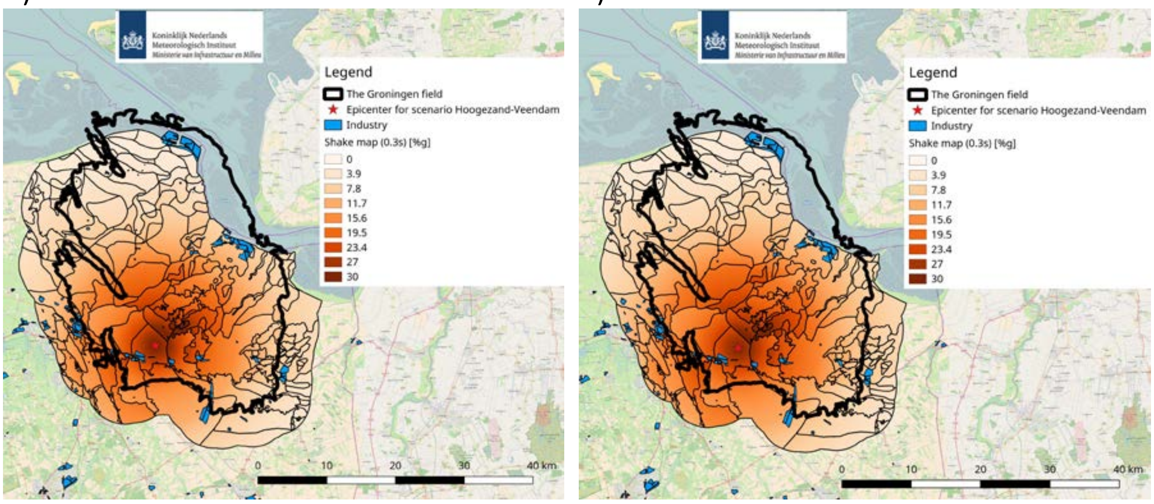


Figure 15: Shakemap with spectral acceleration for the period T = 0.3 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

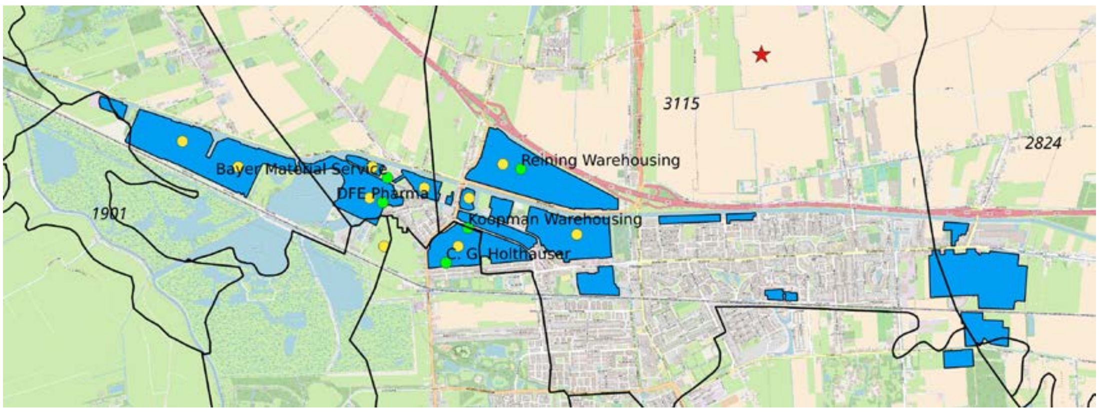


Figure 16: View of industrial area in Hoogezand with the location of industry and sites in different geological zones.

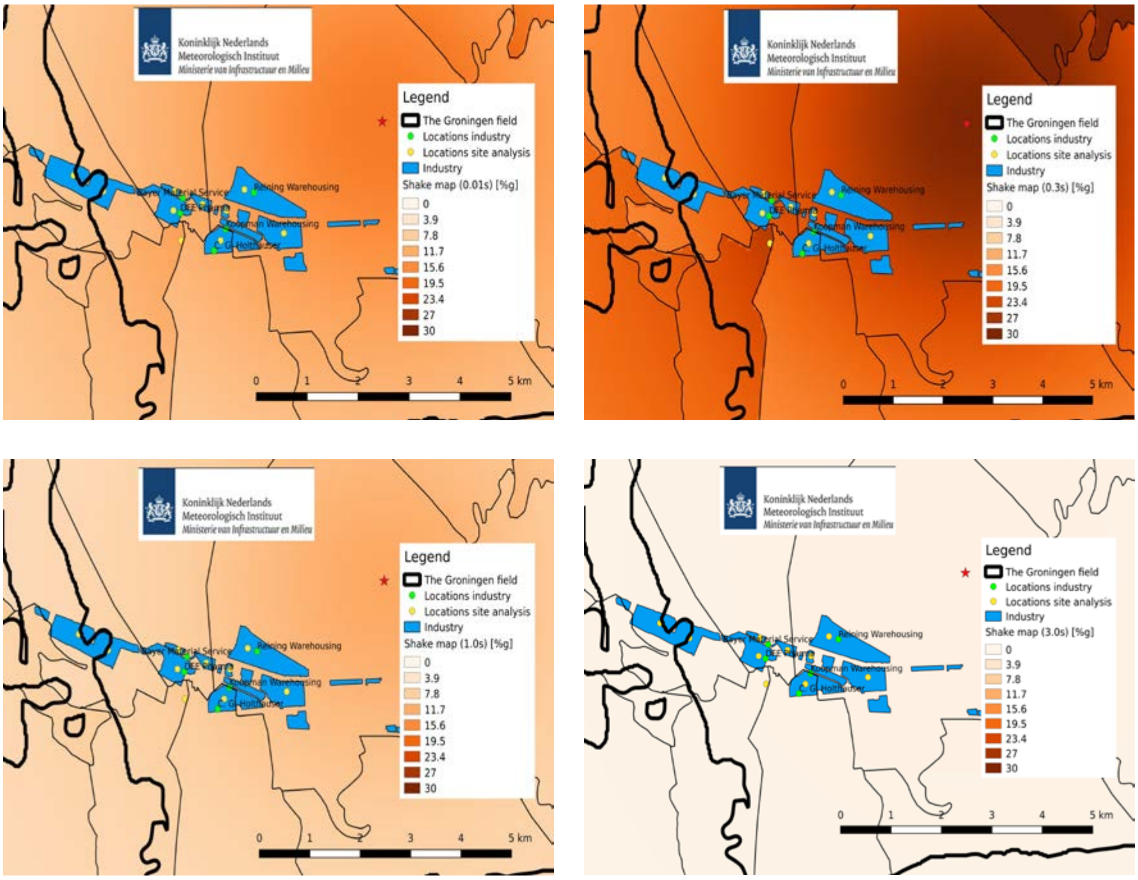


Figure 17: Local shakemaps of industrial area in Hoogezand with the location of industries and sites in different geological zones for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s. The Mmax = 5 case is illustrated.

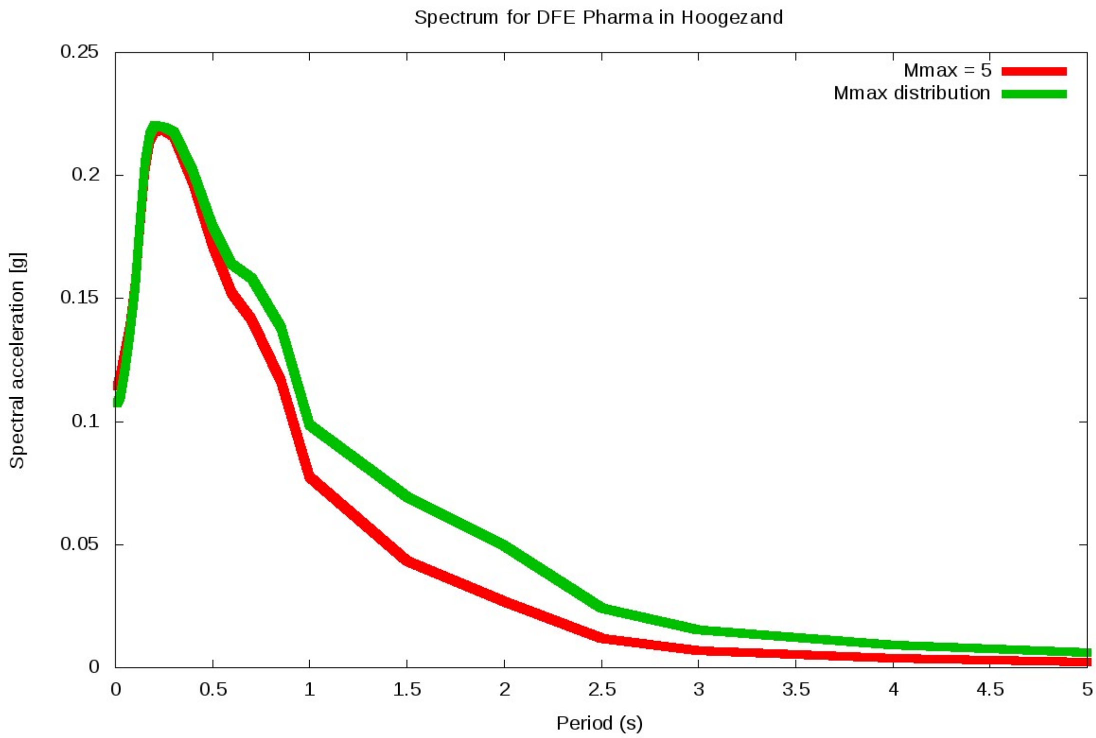


Figure 18: Spectra with spectral accelerations for DFE Pharma in Hoogezand for the Mmax = 5 and Mmax distribution case.

9. Shakemaps for Veendam

The results presented for Veendam are similar to the previous plots from Hoogezand. The plots are in Figure 19, 20 and 21. The spectrum is calculated at the location of Stinoil. Other industry in Veendam are Groningen Railport, Kisuma Chemicals and Sita Ecoservice. Spectra accelerations at Veendam are lower compared to the ones in Hoogezand because of the greater distance.

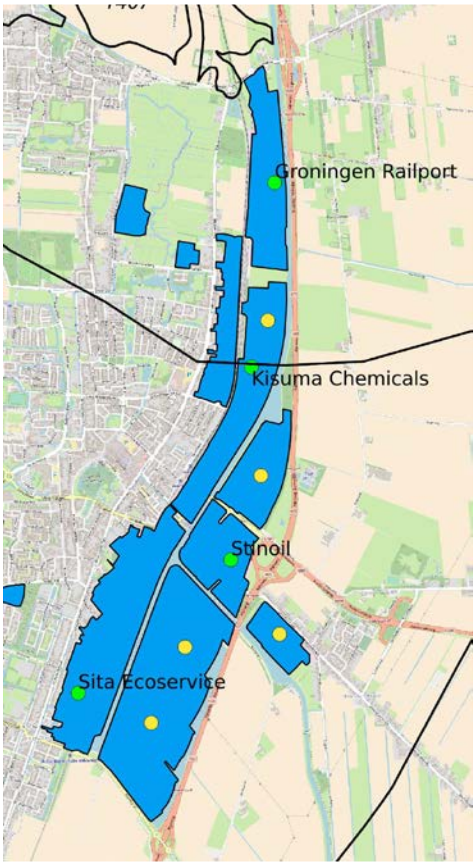
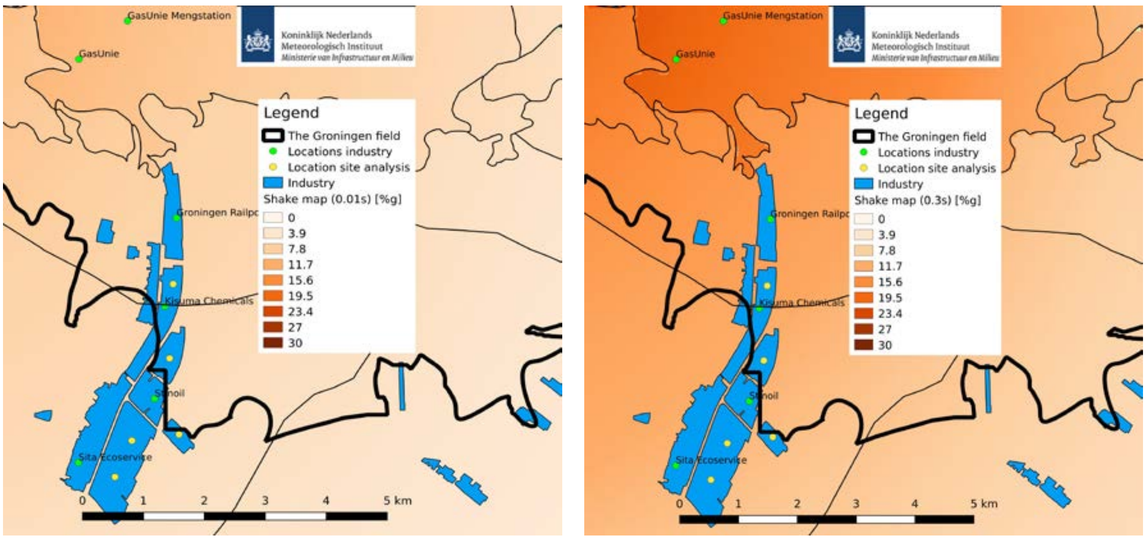


Figure 19: View of industrial area in Veendam with the location of industry and sites in different geological zones.



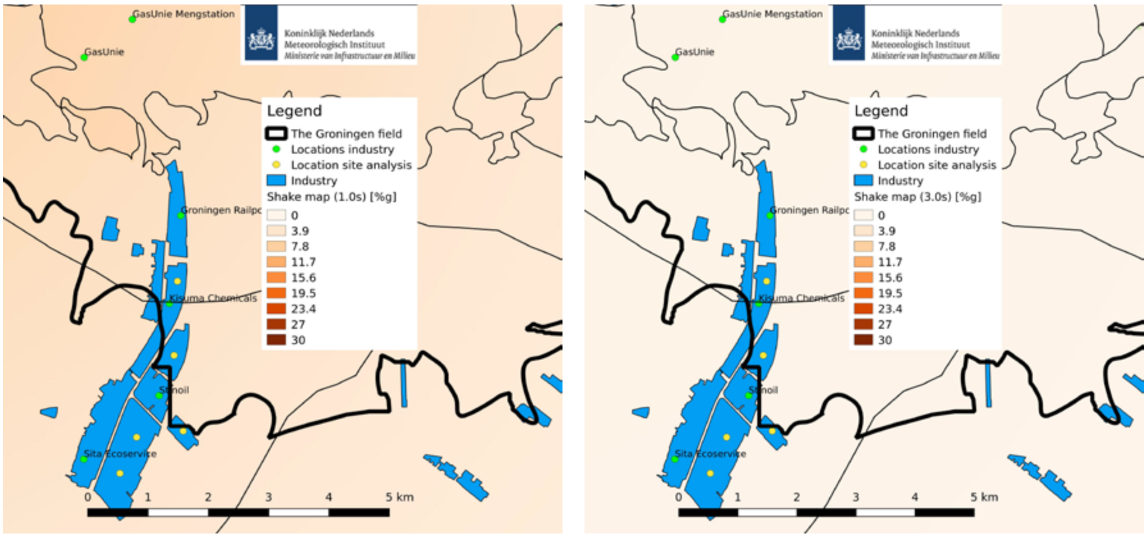


Figure 20: Local shakemaps of industrial area in Veendam with the location of industry and sites in different geological zones for the periods T = 0.01 s, 0.3 s, 1.0 s and 3.0 s. The Mmax = 5 case is illustrated.

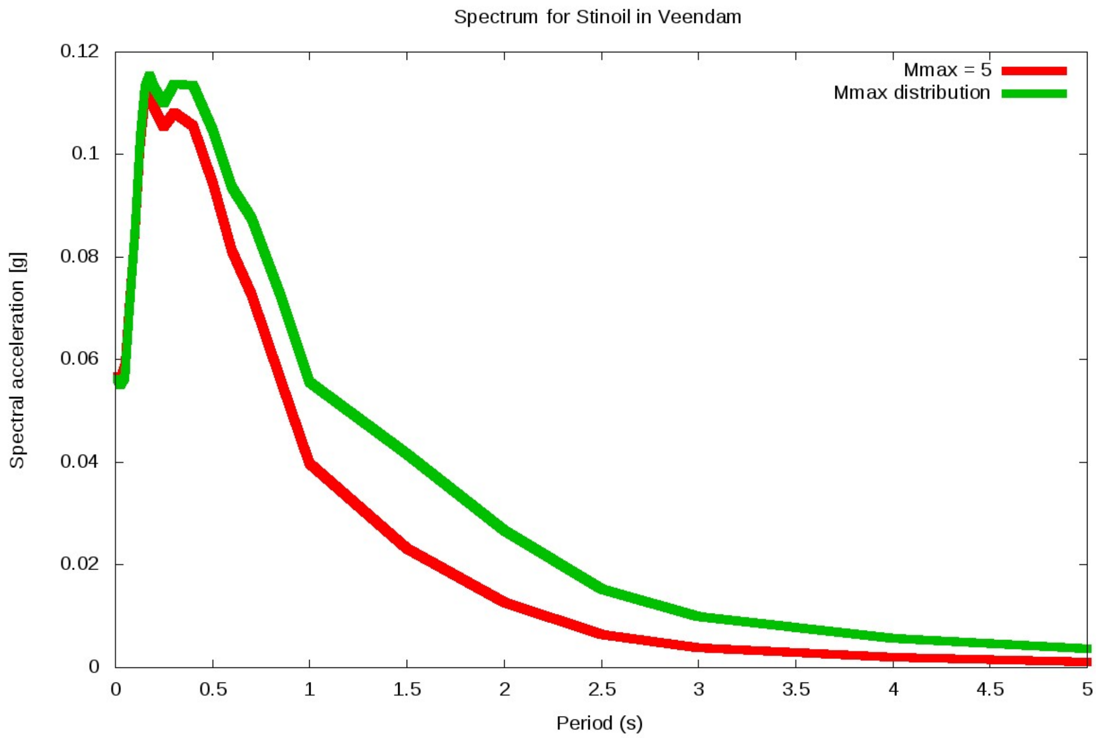


Figure 21: Spectra with spectral accelerations for Stinoil in Veendam for the Mmax = 5 and Mmax distribution case.

10. Conclusions

The shakemaps for the industry in Delfzijl, Eemshaven, Hoogezand and Veendam in the 2016 report calculated with the GMM v2 is updated with respect to four points.

1) The GMM v4 developed from the largest data base of Groningen data until date is used in the shapemaps calculations.

2) The update of the development of seismicity in Groningen due to a new production regime is included in the estimation of the epicenter of the maximum considered induced earthquake. The seismic disaggregation analysis points towards two earthquake scenarios. One with an epicenter closest to Delfzijl and Eemshaven and another with an epicenter near Hoogezand and Veendam.

3) The number of spectral periods which was previously 4 in the 2016 report has been increased to the full spectrum with 23 spectral periods between 0.01 s and 5 s in the GMM v4.

4) The Mmax = 5 and the Mmax distribution scenario are both used for the shakemaps calculations.

The Mmax = 5 scenario takes only induced earthquakes into account, while the Mmax distribution includes a combination of induced earthquakes for the lower magnitudes and the possibility of tectonic events for the larger magnitudes. The shakemaps and site-specific spectra for the Mmax = 5 and Mmax distribution case show the same pattern inherent to the Groningen specific amplification factor. It is observed that spectral accelerations are greater in the spectra calculated for the Mmax distribution scenario than for the Mmax = 5 scenario for spectral periods greater than 0.3 s. For both magnitude cases, the greatest spectral accelerations are found in the period range 0.3-0.5 s.

The KNMI delivers shakemaps and spectra for industry locations in Delfzijl, Eemshaven, Hoogezand and Veendam for both magnitude cases. However, the KNMI do not decide which of the two scenarios for the magnitude that should be used in the seismic LOC assessment of industry in Groningen. That is for the constructors to decide.

It should be kept in mind that the spectral accelerations are median values and they have an associated errorbar defined by the standard deviation. The calculation of the standard deviation is ergonic, implying that the estimates are conservative. Shakemaps for all locations and spectra are provided in ncf-files and dat-files, respectively, for the two earthquake scenarios.

11. References

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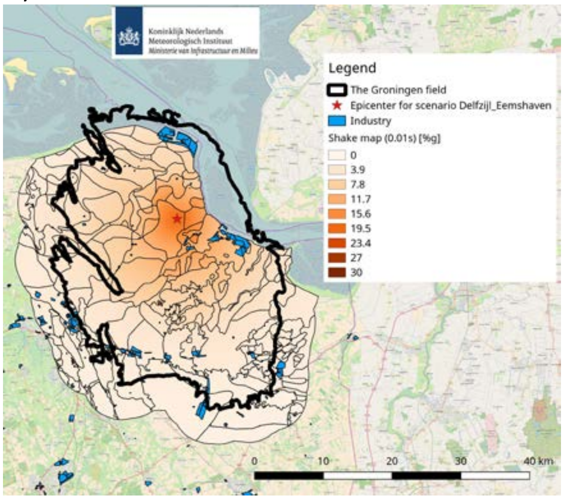
Appendix

A: General Shakemaps for Delfzijl and Eemshaven, earthquake scenario 1

A)



B)

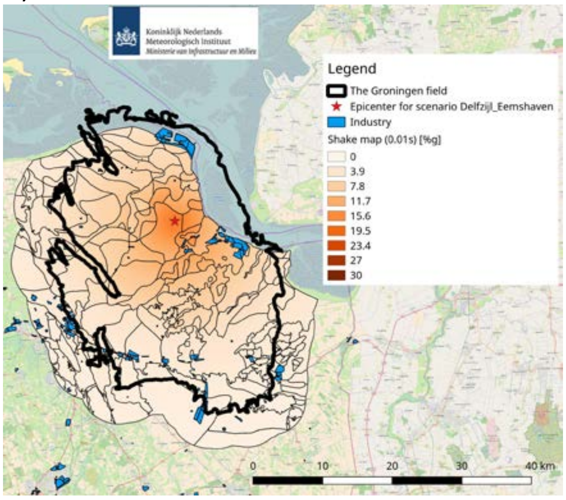
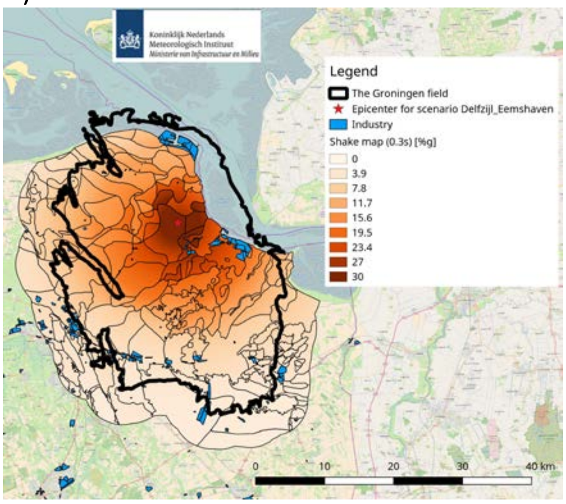


Figure A1: Shakemap with spectral acceleration for the period T = 0.01 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A)



B)

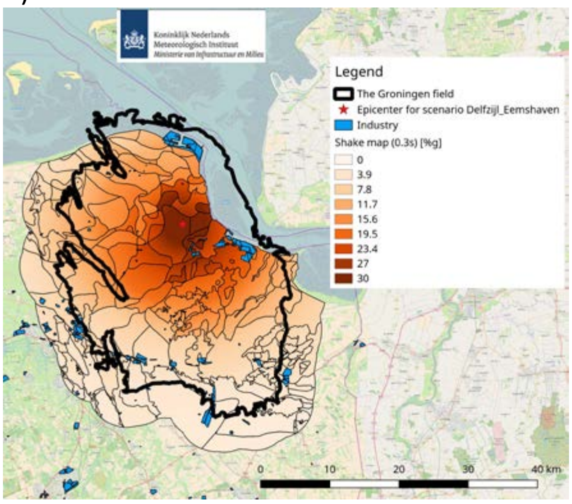


Figure A2: Shakemap with spectral acceleration for the period T = 0.3 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A)

B)

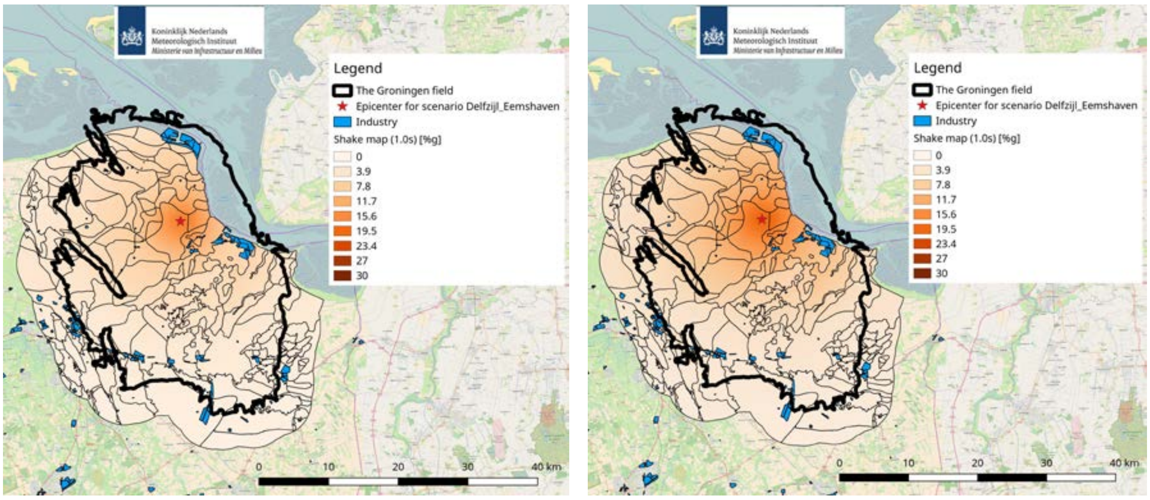


Figure A3: Shakemap with spectral acceleration for the period T = 1.0 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A) B)

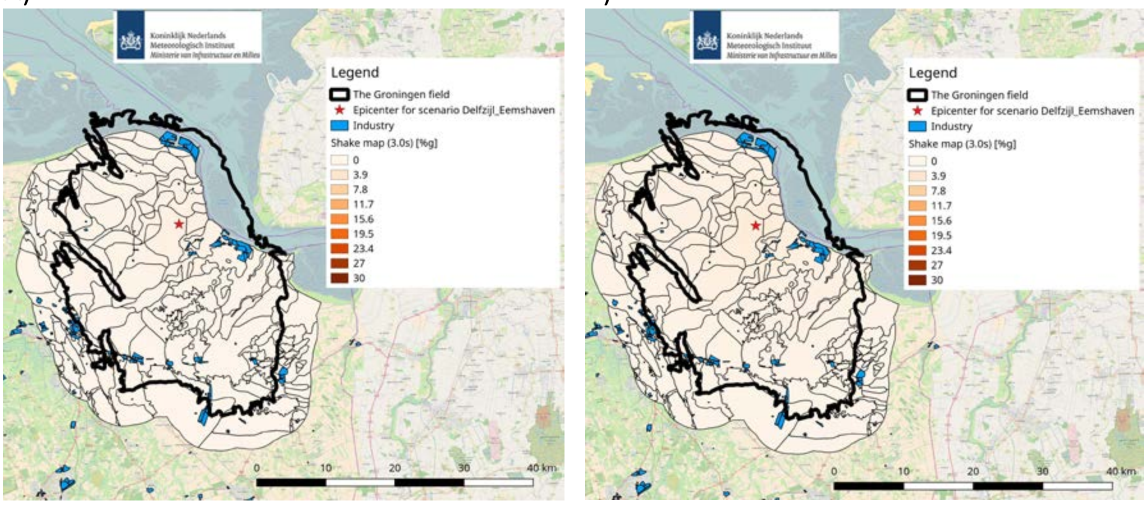


Figure A4: Shakemap with spectral acceleration for the period T = 3.0 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

B: General Shakemaps for Hoogezand and Veendam, earthquake scenario 2

A) B)

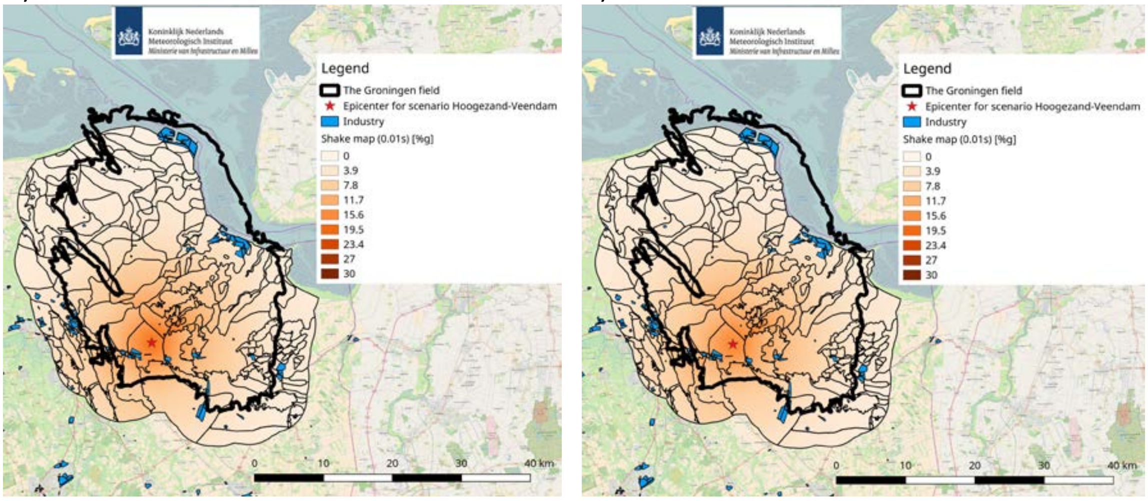


Figure B1: Shakemap with spectral acceleration for the period T = 0.01 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A) B)

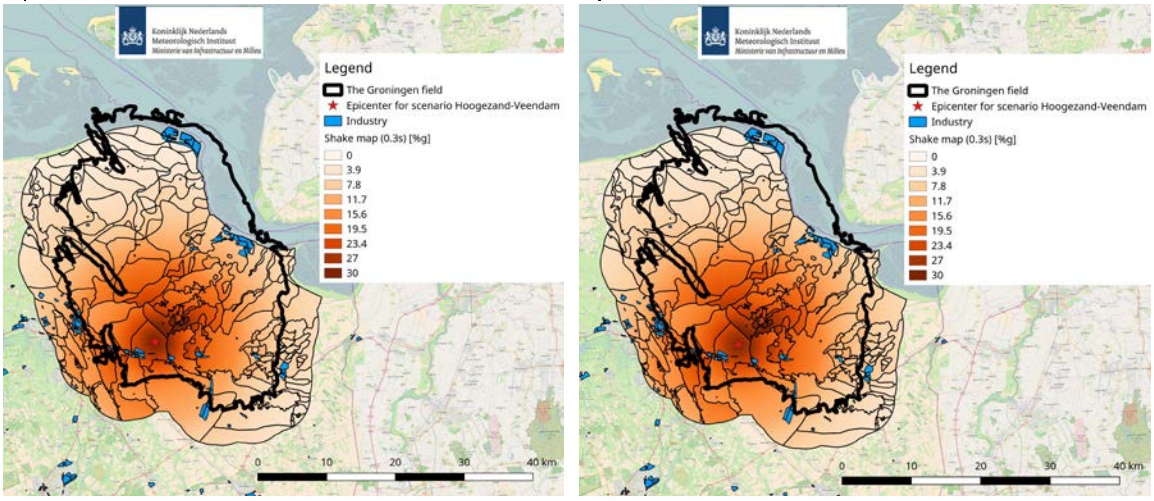


Figure B2: Shakemap with spectral acceleration for the period T = 0.3 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A) B)

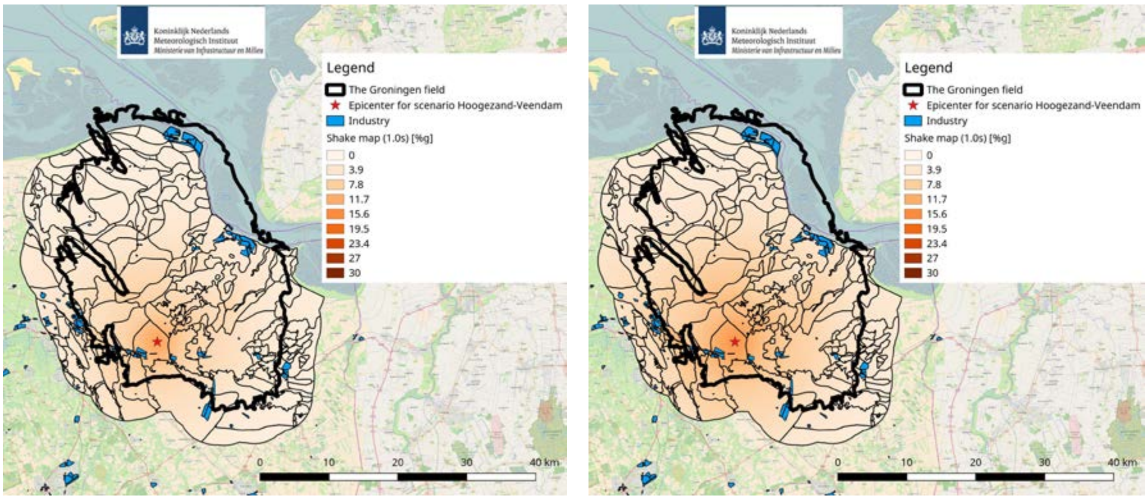


Figure B3: Shakemap with spectral acceleration for the period T = 1.0 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

A) B)

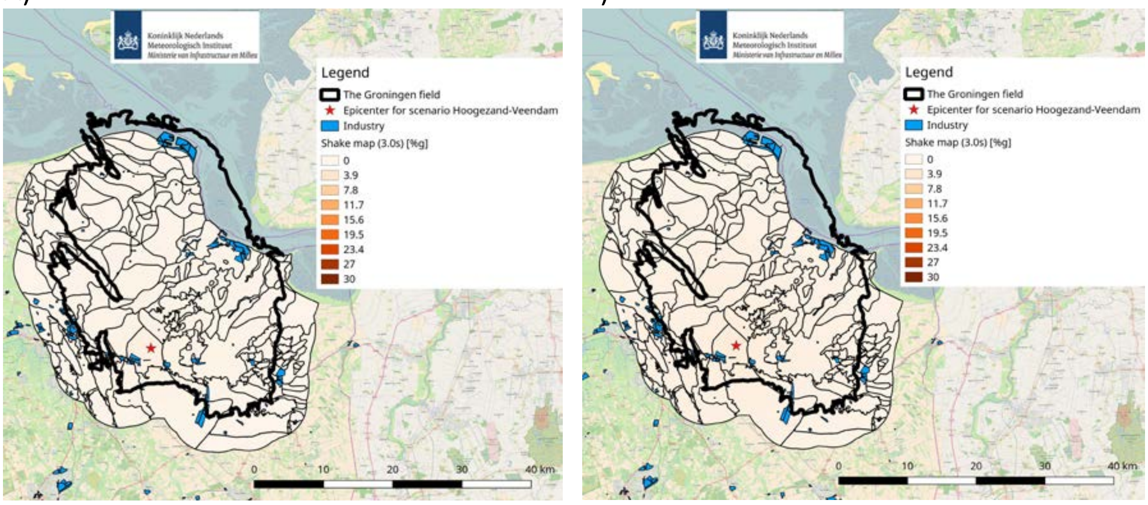


Figure B4: Shakemap with spectral acceleration for the period T = 3.0 s. A) Mmax = 5 scenario. B) Mmax distribution scenario.

C: Tables for industry, sites and location coordinates

Table C1: Coordinates for industry locations.

Company	Lon	Lat	RD_X	RD_Y
Noordgastransport	6.965814	53.31408	260207	593111
Vopak Terminal	6.800963	53.451345	248921	608157
GDF Suez	6.879396	53.436785	254165	606642
GasUnie Transport	6.859493	53.406097	252913	603200
Contitank	6.939494	53.323294	258432	594098
Lubrizol Advanced Materials	6.96294	53.313288	260018	593018
Akzo Nobel	6.942524	53.317738	258647	593484
Aardolie Opslag Groningen	6.562888	53.239586	233491	584307
Bayer Material Service	6.716619	53.17206	243893	576972
C. G. Holthauser	6.725536	53.163967	244506	576083
DFE Pharma	6.71581	53.169758	243843	576715
GasUnie Mengstation	6.886298	53.156098	255274	575419
GasUnie	6.874151	53.150399	254475	574768
Groningen Railport	6.897239	53.125705	256077	572052
Kisuma Chemicals	6.893934	53.112165	255887	570541
Koopman Warehousing	6.729106	53.16719	244738	576446
NAM RBI	6.973165	53.293422	260748	590823
Reining Warehousing	6.73753	53.172644	245290	577063
Sita Ecoservice	6.871923	53.088437	254468	567870
Stinoil	6.890917	53.098018	255718	568962

Table C2: Coordinates for sites in near-surface zonation model.

Industry zone	Lon	Lat	RD_X	RD_Y
Eemshaven	6.814132	53.457615	249782	608872
Eemshaven	6.8035117	53.453786	249085	608432
Eemshaven	6.8012156	53.449437	248942	607945
Eemshaven	6.8149424	53.447127	249859	607706
Eemshaven	6.8331012	53.452662	251053	608346
Eemshaven	6.8271254	53.441914	250680	607142
Eemshaven	6.8482603	53.44999	252066	608069
Eemshaven	6.8626861	53.443119	253040	607324
Eemshaven	6.8508892	53.438797	252266	606827
Eemshaven	6.8730029	53.437664	253738	606731
Eemshaven	6.8706812	53.412279	253642	603904
Delfzijl	6.9036216	53.311284	256069	592711
Delfzijl	6.9110563	53.314883	256556	593122
Delfzijl	6.9360331	53.323407	258200	594106
Delfzijl	6.9471074	53.320433	258945	593791
Delfzijl	6.9471466	53.313639	258964	593035
Delfzijl	6.9699902	53.314984	260483	593217
Delfzijl	6.9704832	53.308795	260531	592529
Delfzijl	6.9867353	53.306432	261620	592290
Delfzijl	6.9862212	53.300256	261601	591602
Delfzijl	6.9783241	53.299678	261076	591526
Delfzijl	6.9709186	53.297367	260588	591258
Delfzijl	6.987638	53.284267	261735	589825
Hoogezand	6.6846476	53.175833	241748	577352

Hoogezand	6.6932923	53.173331	242331	577084
Hoogezand	6.7137764	53.170185	243707	576759
Hoogezand	6.7159243	53.165614	243860	576253
Hoogezand	6.7142845	53.1731	243735	577084
Hoogezand	6.7223721	53.171033	244280	576864
Hoogezand	6.7347313	53.173133	245101	577113
Hoogezand	6.7293399	53.170012	244748	576759
Hoogezand	6.7274947	53.165485	244634	576253
Hoogezand	6.7460961	53.16639	245875	576377
Veendam	6.8948074	53.104165	255964	569651
Veendam	6.8966852	53.092467	256117	568352
Veendam	6.885102	53.09166	255343	568246
Veendam	6.8807764	53.086133	255066	567625
Veendam	6.8960554	53.115572	256022	570922