



Market orientation: 'Cumulative effects due to mining, general and in the Grijpskerk area'

Organization: Ministry of Economic Affairs and Climate Policy (EZK)

Reference: KEM-48 | 202305009

Purpose of the notification

The purpose of this market orientation is to determine whether there are parties interested to perform the research project as described below. If you are interested in participating in the request for proposal for this future assignment, we ask you to register via the instruction that follows in this document.

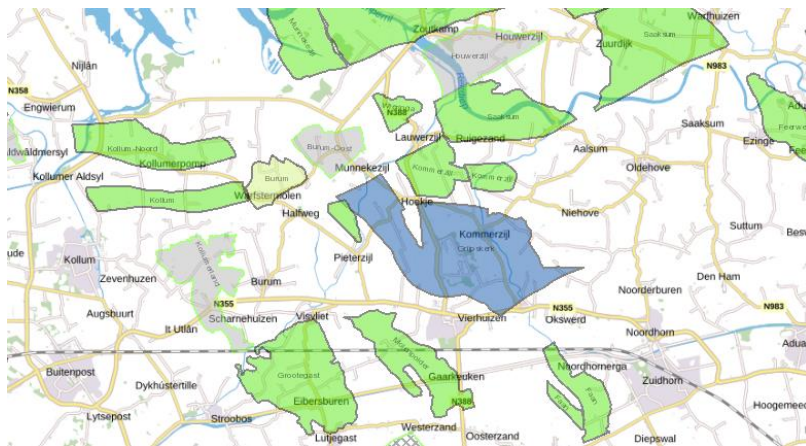
Description of the assignment

The assignment focuses on defining and clarifying the possible interactions between different subsurface activities in the Northern part of the Netherlands.

This research project is defined with the assistance of some citizens in the Northern part of the Netherlands worried about the number of activities in their neighbourhood as well as the possible interaction between these activities. As such the research question will strive to give an independent answer to address these worries. The main concern of the people in the living environment is stated in the last research question: "What are the cumulative effects and interactions of the different mining activities around the Lauwers Sea trough and the interaction of the UGS Grijpskerk, the surrounding small gas fields and the Groningen gas field?"

This research project aims to answer this question scientifically by defining the possible interactions between various activities in the subsurface. The research is divided in part I and part II. In part I a general answer to the possible interactions between different subsurface interactions is obtained. In part II the region close to the gas storage Grijpskerk (general "Lauwers Sea trough" area) will be studied in more detail concerning these possible interactions, including specific geology of the Lauwers Sea region (both shallow and deep, with old river beds, sand from the Wadden Sea), geological history, production locations of small gas fields and gas storage operations in the region.

In the North of the Netherlands



It is known that

The gas fields cause subsidence in the Grienskerk area which according to the latest report on



Subsidence due to these deeper subsurface activities may lead to a shallower ground water table which, if corrected by measures of the Water boards, may lead to subsidence due to shallow causes such as peat or clay oxidation. Additionally, natural causes of subsidence take place including very deep effects from the last ice age as well as climate dependent shallow summer-winter differences in the phreatic groundwater levels.

InSAR data gives insight into both deep and shallow causes of subsidence due to the fact that reflections can originate from both founded buildings as well as road, lantern posts, etc. It is therefore vital in this study to analyse and use the InSAR data to form conclusions on the subsidence effects at the surface, specifically for the Grijpskerk area. The InSAR data can also be compared to the levelling and GPS data in the same area.

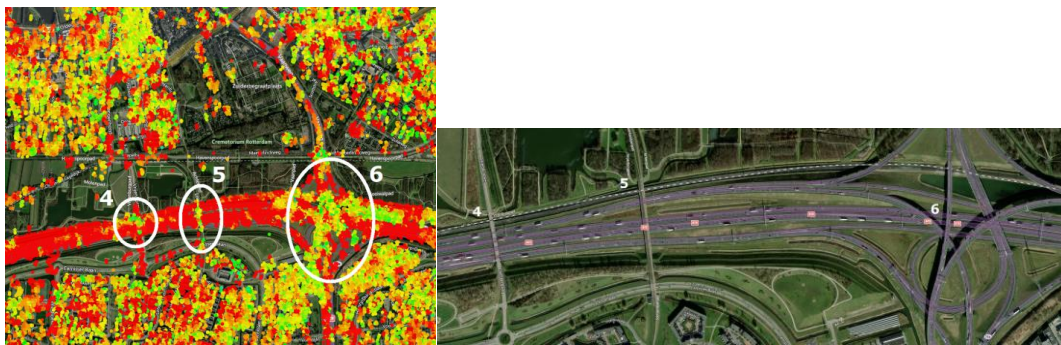


Figure. Illustration of difference in subsidence due to a different foundation. Detail 4, 5, 6 (in both figures) are overpasses which are deeply founded. The roads are not founded and have the largest subsidence signal (red) in the figure to the left.

Induced seismicity

Gas depletion causes lower pressures inside gas reservoir, induces compaction, and leads to subsidence. It may also lead to induced seismicity on faults that are already present in the subsurface. Whether induced seismicity will occur depends on the initial amount of stress on the existing faults and the change in stress due to the subsurface activity. For gas depletion, numerical modelling has shown that changes in stress are focused mainly in the reservoir itself but may also occur in the overburden and outside the reservoir.

Grijpskerk area

In the Grijpskerk area multiple seismic events have occurred in the past:

Near	date	Magnitude (ML)
Pieterzijl	02-03-1997	1,3
Leens	25-12-2006	1,3
Kollum	16-10-2012	1,1
Houwerszijl	09-01-2013	1,0
Houwerszijl	01-03-2015	1,4
Kommerzijl	01-03-2015	1,5
Kollum	30-10-2016	1,5
Kommerzijl	07-04-2018	1,0
Lauwerzijl	07-04-2018	1,7
Kommerzijl	23-01-2020	0,4
Munnekezijl	28-02-2021	1,3

Lauwerzijl	17-11-2022	1,7
Kommerzijl	17-11-2022	1,1

Source: KNMI database

Additionally, a couple of stronger magnitude events from the Groningen gas field have caused larger ground motions in the Grijpskerk area:

Near	date	Magnitude (ML)
Westeremden	08-08-2006	3,5
Huizinge	16-08-2012	3,6
Zeerijp	08-01-2018	3,4
Westerwijtwerd	22-05-2019	3,4

Source: KNMI database

Leakage

Gas fields that have a spill-over point may transfer gas from one field to a second causing additional depletion in the first gas field. Are there however more mechanisms that may cause leakage to occur from one activity to the other in the neighbourhood? What are the safe distances between subsurface activities, based upon the geology of the Northern part of the Netherlands? Additionally, shallow leakages may occur due to damages to gas pipes.

The State Supervision of Mines (SodM) also recently published a report ([Methaanlekkages afgesloten olie- en gasputten miniem | Nieuwsbericht | Staatstoezicht op de Mijnen \(sodm.nl\)](#)) on their website on methane leakages. In this report, 1430 abandoned wells are examined. SodM concluded that 24 of the 1430 abandoned wells, all located in the western part of the Netherlands, could be leaking small amounts of methane due to shallow gas reservoirs, presence of methane in the subsurface and faulting. No abandoned wells in the North of the Netherlands were likely to form potential sources of leakage. In the research the technical review reports of the drilling and completion of the Grijpskerk wells have to be taken into account (for example Grijpskerk-43).

In KEM-19 ([KEM-19 Long term fluid migration, leakage risks and monitoring strategies \(finished\) · KEM programma](#)) long term fluid migration, leakage risks and monitoring strategies were studied, specifically focussed on the abandonment phase of the gas fields. Part of this research was possible fluid migration along wells to the biosphere. It was concluded that a highly depleted reservoir is not a likely source of gas leakage, as long as the gas flow potential at the top of the reservoir is below the gas potential of the closest aquifer overlying the caprock. Small reservoirs with an active water-drive are more likely to lead to leakage due to the pre-pressurization of the gas after abandonment. Presence of gas at hydrostatic pressure in formations shallower than the target reservoir can however lead to methane leakage along a damaged cement sheath. The proposed risk analysis of KEM-19 can be used to assess the local wells in the Grijpskerk area (see below) for possible (future) leakages.

Other effects

Are there other possible effects or interactions related to mining activities? Such as interaction effects between subsurface and surface activities (gas transport and gas compression, vibrations).

Research questions

In the future assignment, attention will be paid to the following research questions.

Please note: you do not have to answer this in this phase (market orientation). This is for informational purposes only.

Part I: General cumulative effects

1. What is known about the interactions between different adjacent underground activities and the cumulative effect of those interactions? Please divide it into the following topics:
 - a. Subsidence
 - b. Induced seismicity
 - c. Leakage
 - d. Other
2. What is the distance (both in depth as well as lateral) which would exclude cumulative effects between mining activities for subsidence, induced seismicity, leakage, other?
3. What should be studied in more detail in phase II for the Grijpskerk area?
After part I deliverables 1-3 will be due including a project plan for phase II. The project plan should describe which research questions related to the Grijpskerk area will be studied in more detail as well as which questions can be answered using the results of phase I as well as the methods, intended results and planning of the second phase. These documents will form the basis of a go/no-go decision for part II.

Part II: Specific cumulative effects for the Grijpskerk area

4. What are the cumulative effects and interactions of the different specific mining activities (subsurface and surface) around the Lauwers Sea trough and the interaction of the UGS Grijpskerk, the surrounding small gas fields and the Groningen gas field?
 - a. Subsidence aspects to be considered:
 - i. Gas production from gas fields causing compaction of the reservoir, resulting in subsidence at the surface, possible liquid loading and salt creep due to changing stresses in the salt. Gas storage and groundwater extraction.
 - ii. Possible physical processes which take place during the lifecycle of the mining activities, e.g. drilling, operation and abandonment.
 - iii. Possible effects on surface waters: salinization and future sea-level rise.
 - iv. Shallow and deeper characteristics of soils (specific for the Grijpskerk region: river beds, sand from the Wadden Sea)
 - v. Possible permanent changes in the (shallow) soil due to ultrasonic and low frequency noise vibrations caused by, for example, gas transport through transport pipes, operation of compressors, furnaces, etc.
 - vi. Effects of subsidence and seismic activity on water-holding capacity of water supply aquifers.
 - vii. Effect of subsidence on local infrastructure (gas/water pipes, bridges, etc.)
 - b. Induced Seismicity aspects to be considered:
 - i. In what way can subsurface activities (drilling, hydraulic stimulations, workovers and abandonment) interact and cause additional stress in the subsurface, which may lead to induced seismicity?
 - ii. Is there pressure communication between the UGS Grijpskerk and surrounding small fields such as Kommerzijl and Pieterzijl that may lead to induced seismic events?
 - iii. Should seismicity occur, the rock around the seismic event would be subjected to a movement due to the seismic waves. Can this lead to interactions between different subsurface activities and fields?

- iv. Can there be permanent changes in permeability of faults due to seismicity or fracking?
- v. What are potential effects of pressure drawdown close to the well on nearby faults. Due to gas production, the depletion close to the well will be higher than further away in the gas reservoir. The relatively small area of lower pressure is dependent on the recovery velocity of the gas. Could this be an additional source of seismicity in the reservoir? Under which conditions? Can this be seen in the subsidence signature?
- vi. Specifically, for Grijpskerk: could the transition from production to injection and vice versa lead to pressure changes close to the well and induce seismicity?
- vii. Are events in the Grijpskerk area possibly induced by fracking?
- viii. What are potential effects of specific soils in the Grijpskerk area leading to possible amplification of the seismicity signal.
- c. Leakage
 - i. Which wells in the Grijpskerk area could be potential sources of leakages? What is the risk of leakage?
 - ii. What is the expected reservoir-aquifer pressure and formation water redistribution after the abandonment of gas fields in the Grijpskerk area?

Deliverables expected

These deliverables are expected at the end of phase 1:

1. A literature study on the possible mechanisms of interactions among various subsurface activities, including worldwide experiences.
2. A general report on part I (research questions 1, 2 and 3), with clear conclusions and recommendations.
3. A Dutch summary of the main findings of part 1 which answers the research question in a clear and non-technical way.

These deliverables are expected at the end of phase 2:

4. A report on part II focussing on the Grijpskerk area and the specific questions for this area with clear conclusions and recommendations.
5. A Dutch summary of part II on the findings specific for the Grijpskerk area which answers the questions from the Dutch citizens in a clear and non-technical way.

Other deliverables are:

6. Presentations on the progress of the research project for the KEM panel (twice) and a final presentation for the KEM-panel (scientific) as well as other interested parties.
7. Presentation in clear language to the interested member of the environmental trajectory Grijpskerk (in Dutch *omgevingstraject Grijpskerk*), consisting of different stakeholders (citizens, spokespeople for action groups, local government) at the finish of the project.
8. Open sharing of data which contributed to this project.

The research should lead to a final report in which answers are given to the hypotheses for testing and the research questions. The final report must be an independently readable report that is suitable for external publication and should contain a description of all activities performed during the research project. The report should contain sufficient details so that the results can be reproduced by a third party. Any underlying data must also be made available to the Contracting Authority. The final report must be submitted digitally in English (PDF file).

Expertise and tools preferred for the team

- Knowledge of mining
- Knowledge of the Dutch subsurface

- Knowledge of gas production technology
- Knowledge of subsidence
- Knowledge on InSAR measurements
- Knowledge on seismicity
- Knowledge of shallow processes
- Knowledge of ground mechanics
- Knowledge on surface gas operation and the relation to subsurface activities

Extent and duration

The research project will last a maximum of 18 months, 8 months for phase I and 10 months for phase II.

Budget indication

The currently estimated maximum total value of the future assignment is € 450.000,- excluding VAT.

Application

Interested companies are invited to send an expression of interest, including a motivation by 8 June 2023 at the latest, to the Procurement Office of the Ministry of Economic Affairs and Climate Policy, to the attention of Merel van Dorp by e-mail IUC.accountEZK@rvo.nl.

Please state the name of the contact person of your company and his or her e-mail address.

You do not have to send any documents; please only send message that you are interested and the motivation why you are interested.

Interested parties can be invited in this process to submit a request for proposal. In case of a follow-up process, no distinction will be made between parties that have or have not participated in the market orientation. The market orientation is non-binding for all parties (the organization and the interested parties) and does not in any way imply an obligation to enter into a specific legal relationship with participants. No rights can be derived from participation in the market orientation or information provided during the market orientation.

Deadline

The deadline for responding to this market orientation is set at **June 8th 2023, 12.00 CET**.