

KEM Research Question

KEM-19b Groningen SW aquifer depletion and seismicity

Objective

The Groningen gas field has been produced since the 60's and has caused many induced seismic events. Next to the Groningen gas field, some of the surrounding aquifers are also depleting in pressure. These aquifers may extend quite a bit beyond the gas reservoir. One of such aquifers is the southwestern aquifer, a region where small-scale seismicity has been observed in recent times, likely caused by the depletion of the Groningen gas field and the resulting pressure depletion in the aquifer.

The specific objective of this research is to focus on this southwestern aquifer and look into the pressure depletion as well as the future seismic activity originated in the aquifer. This project is a follow-up of the KEM-19 study that was completed recently.

State of the art, background

The geological formations and tectonic structures of gas reservoirs are generally well known in the Netherlands due to the large-scale coal, salt, gas and oil exploration and production. Also, the hydrogeological properties and pressures in and around the reservoirs of relevant geological formations are relatively well known (A lot of data and information is available at www.nlog.nl).

However, the information on the post-abandonment state of mechanical stresses and pore pressures is available but only for individual fields and not in an integrated way or within regional models combining multiple fields. Also, it is known that fluid migration processes will continue well beyond the operational time spans and beyond field boundaries of gas production or storage. Specifically, the southwest aquifer is expected to be affected by the depletion of the large Groningen gas field as well as the depletion of the smaller gas fields to the west of this aquifer in the Lauwerssea trough. Also, small-scale seismicity has been registered in the aquifer.

There is a need to better understand the occurrence of seismicity related to the southwestern aquifer and the possibility of inducing seismic events in case other mining activities, such as a geothermal project, are carried out in and around this same aquifer.

In KEM-19, a regional model was constructed that included the southwestern aquifer of the Groningen gas field. However, this model proved to be too coarse and the results for induced seismicity too general. The project will be focusing on improving the existing regional model into a local model of the southwestern aquifer. Special focus is on the characterization of smaller and larger scale faults including fault orientation and throw to be able to include them in a geological model. For the pressure modelling, the improved geological model should be used as well as additional information on the small gas fields in the Lauwerssea trough and, if needed, the Annerveen gas field. This will significantly improve the quantification of the current pressure depletion and its evolution in the future, including uncertainties. Additionally, further work needs to be performed on the geomechanical analysis of this aquifer, taking into account a possible geothermal project in the southwestern aquifer and the long-term expectations of induced seismicity. The overall goal is the long-term safety of the region after cessation of gas production.

Research Question

This project focuses on the following research questions:

1. What will be the pressure depletion of the southwestern aquifer taking into account the depletion of Groningen gas field as well as the smaller gas fields in the Lauwerssea trough?
2. What are the locations of smaller faults, and their orientation and throw in the southwestern aquifer?
3. What is the expected induced seismicity in the coming decades?
 - a. What is the seismic hazard?

- b. How does this compare to the seismic hazard of the Groningen gas field?
4. Would a possible geothermal project impact the estimates for induced seismicity? If yes, to what extent?
5. To what extent is the area of influence of a geothermal project changed by pressure depletion in the southwestern aquifer?
 - a. What areas are more or less prone to induced seismicity due to a geothermal project?
 - b. At what distance from a geothermal doublet are the effects due to the activity negligible?

Deliverables expected

These deliverables are expected:

1. Report on the improved geological model
2. Report on the pressure development, including the regional model
3. Report on the geomechanical analysis, including
 - a. Full seismicity workflow in which rates and magnitude of seismic events are addressed
 - b. Seismic hazard estimates now and in the future
 - c. Seismicity estimates for a potential geothermal project in the southwest aquifer

Timeline

It is expected that this project will last 12 months.

Expected use

The study will be used to increase our understanding of induced seismicity occurring in aquifers, especially close to the Groningen reservoir, the long-term induced seismicity and the potential induced seismicity due to a geothermal project. As such, this research will help the regional government of Groningen to decide upon the use of geothermal projects for the energy transition in this aquifer.

Expertise and tools preferred for the team

- Knowledge on results of KEM-19
- Availability of regional dynamic reservoir model of this region.
- 3D seismic data interpretation knowledge
- Possibility to use public seismic hazard and risk assessment model chain

Quality assurance, Organisational and communication requirements

A supervisory committee will be formed, with members including representatives of the client, the KEM scientific panel, State supervision of Mines, and the regional government, in order to ensure the usability of project results for the Groningen area.

There will be at least one meeting every three months to inform the supervisory committee about the scientific progress and to steer the work towards the regional and nationwide needs.

The project will be presented at the bi-annual KEM meetings (December 2022, June 2023, November 2023) and to the regional/local government at the end of the project.

The results of the project should be reviewed by independent researchers, organized by the project team. This is independent from the evaluation of the KEM scientific panel.

References

1. *TNO report KEM-19 and SHRA model*
2. *NAM reports*