

KEM Research review, evaluation and interpretation (max. 4 pages + annex)

TITLE Groningen SHRA model (component) sensitivity analysis

KEM Quality review

Description of the scientific quality of the results (team, research method, research results, quality of the products, ...), if needed external review result (project evaluation text website)

Team: the team is considered qualified for the scope of the research question and particularly committed to the quality of the results. The focus of the team is predominantly on the seismological source model (SSM); however, also the other two risk model components, that is the ground motion model (GMM) and the fragility and consequence model (FCM), are addressed by the TNO team in a satisfactory manner.

Research results and quality: the work by TNO in addressing this research question can be considered to have delivered high-quality results. This kind of work is not an accessory to risk analysis, as it should be part of the model development and assessment in the first place. The process set in place by this project seem to be a possible way to assess the effects and relevance of the eventual further developments in the risk assessment model.

Research method: the report has performed a thorough sensitivity analysis with respect to uncertainty treatment related to several model settings in the seismic risk analysis for Groningen. This was done by setting a base-case designed and implemented by TNO. The research question could have been addressed in several different ways. The one chosen by the TNO team is somewhat related to the issues emerged in the transition of the risk analysis from the Groningen field operator (NAM) to the public (governmental) domain. However, this is considered an acceptable interpretation of the research question as it is ultimately fit for purpose.

KEM Evaluation of the results

Evaluation whether the research questions are addressed adequately (questions answered, precision and uncertainties on outcomes, potential consequences on current practice addressed, ..) (project evaluation text website)

Question answered: The study has adequately addressed two main questions: (i) how some aggregate risk metrics for Groningen are sensitive to some models in the risk analysis pertaining to all the three main components (SSM, GMM, FCM); (ii) how the modelling of the epistemic uncertainty propagates through the logic tree and, therefore, which elements of it most affect the results. These are valuable results and provide insights that were not available so far. One of the main conclusions is that all model components (SSM, GMM, FCM) have a significant impact on the results, at least according to the criteria chosen by the team. The team also alerted about possible inconsistencies in the risk analysis; for example, between GMM and FCM models.

Precision and uncertainties on outcome: the analysis performed seems methodologically robust; therefore, there are not precisions and uncertainty concerns. However, it would be beneficial to render the means for the analysis publicly available, for reproducibility and/or pose the analysis to the scrutiny of the scientific community, for example, via dedicated peer-reviewed publications (which is still possible).

Potential consequences on current practice: KEM-09 can set the base for a standardisation for the assessment of the need and relevance of risk model updates/development for Groningen and possibly for other mining activities in the Netherlands and beyond. In more general terms it could be an important part of the risk assessment itself and of its quality assurance.

KEM interpretation of the outcome

The interpretation of the results (consequences on methods/data to be used in practice, con risk instrument modules, on inspection procedures and operator procedures, ..) (project evaluation text website)

The main outcomes of KEM-09 can be summarised as follows:

1. The final risk values are sensitive to all model components, at least considering the risk metrics and the sensitivity impact thresholds chosen in the study. Therefore, it remains important to attempt to reduce uncertainties in all model components.
2. The way the logic tree is shaped, and the weights given to the branches have a substantial effect on the risk (see #1 above) such that it could be helpful to establish a codified procedure to determine these weight in future developments of the risk assessment.
3. The study has shown how some parts of the logic tree produce extremely right-skewed risk results, which have a significant relatively large effect on the risk assessment, this may call for further analysis and deepening as well as for considering other risk metrics on which to evaluate the impact.

4. The study has highlighted potential inconsistencies in some model components, which may call for adjustment and corrections. This warrants further analysis.
5. The study has highlighted the difficulty in reproducing the risk assessment from the Groningen field operator, which should be solved in further developments of the seismic risk assessment for Groningen when it fully goes public.
6. The study has shown the importance of the assessment of the impact of model components based on the effect on risk metric and has paved the way to include this kind of work in future developments, also for other mining activities.

Closure text for the website

A summary in simple terms of the goal, the outcome and impact on mining policies or toolboxes of the research project (project evaluation text website)

KEM-09 aimed at evaluating how much the modelling assumptions and the uncertainty characterization, necessarily taken in the seismic risk assessment for Groningen, reflect on the risk results. This is useful to understand the robustness of the risk results and evaluate further proposals/needs of future model developments.

The conclusions of the study appear sound in the framework of the approach taken by the TNO to develop it, and relevant to the Groningen region.

The methodological approach of this study, if further developed, can be eventually useful for the risk assessment related to other mining activities and different regions in the Netherlands and beyond.