KEM Innovation/Research Question (max. 4 pages + annex)

Subsidence hazard and risk models

Objective

As a follow-up to recommendations from the Knowledge Program on Effects of Mining (KEM 3a project: Mining effect hazard and risk assessment models Toolbox), the objective is to develop a generic method for evaluating subsidence due to mining activities and other subsidence mechanisms relevant onshore in the Netherlands.

Currently (2019), practical subsidence questions posed by various authorities on the accumulation of causes of subsidence cannot all be answered with one integrated instrument but require a complex toolbox with working methods for specific issues. The available methods can vary from integration of models and formal inversion with subsidence data to decoupled, step-by-step deployment of a selection of models, from deep to shallow. A suitable approach depends, among other things, on whether it concerns reconstruction or forecasts for the future.

The objective is to research in several pilots how current subsidence hazard models available in The Netherlands can be integrated and improved to include to become a high-quality generic tool for onshore subsidence hazard analysis, which can later be extended to full subsidence hazard and risk instrument.

State of the art, background

Currently the Dutch Mining law prescribes that in submitted production plans a subsidence analysis and risk management is required. Depending on the surface condition (land, coastal and offshore) hazards may lead to different risk. Offshore the risks are limited, for the Waddenzee area a full subsidence hazard and risk instrument exists. Due to the complexity of subsidence causes on land, the tools to quantify the subsidence hazards on land are multiple and can be better integrated and improved.

In the Netherlands various model instruments are available for on land subsidence due to various deep and shallow causes (use of gas fields, salt extraction, groundwater extraction, water level management and settlement due to loads). TNO's models focus mainly on mining and geological characterization of the subsurface. Those of Deltares on groundwater, water level management and land use. Therefore, various components of a subsidence toolbox are already present.

In order to at the same time respond to the wishes of the various stakeholders, it is proposed to focus for this research question on several case studies in the project in addition to the methodology development. These case studies are aimed at obtaining a shared understanding of the possibilities and limitations of the methodology developed (for example (model) uncertainty, data availability and quality, potential intervention or control measures and monitoring). In conclusion much knowledge in the public domain is already available in The Netherlands, which can be mobilized for this research.

Research Question

How can the current subsidence predictive models be improved to include multiple causes and heterogeneous circumstances?

- ***which numerical or analytical tools provide for acceptable results, benchmarked on 2-3 cases?***
- ***how can model integration and calibrating methods improve the predictive model using the subsidence data?***

Which available models are recommended to be applied to quantify the hazards of multiple subsidence causes on land and which can be integrated in a public subsidence hazard assessment toolbox?

- ***How can subsidence models help to differentiate damage due to natural compaction-isostacy, (ground)water management, mining activities?***
- ***Can subsidence models help to differentiate subsidence damage causes (vertical, horizontal motions) from damage caused by structural aging?***

Deliverables expected

Sound approach and planning including theory and practical evidence on two or three cases, addressing situations of multiple subsidence causes.
For each case the arguments for model choices, the modelling and calibration itself and the added value to of the chosen methods and instruments for a generic subsidence hazard analysis instrument should be reported.
A final report on how to transform the various subsidence impact models for various risks (mining, water management, building and infrastructure) into a generic toolbox for on land subsidence hazard assessment.

Timeline

Half a year for each pilot addressing several research questions and half a year for the conclusions and recommendations.
Two years in total.

Expected use

EZK and SodM will use results to assess and check subsidence management of operators (licences, inspection)
In case of damage attribution of causes will be improved leading to less discussion (schadeprotocol)

Expertise and tools preferred for the team

Rock mechanics and Geomechanical subsidence physics and modelling expertise's
Geotechnical and water management subsidence e physics and modelling expertise's

Quality assurance, Organisational and communication requirements

The objective is to make subsidence analysis methods and the subsidence hazard and risk instruments (data and models) publicly available.

Remarks and Suggestions

Maximum 200 characters (extra information concerning the Innovation/Research question)

References

NAM report Ameland subsidence
NAM reports on Groningen subsidence
TNO reports on subsidence modelling
Deltares reports on subsidence modelling
Subsidence datasets (www.nlog.nl and www.bodemdalingskaart.nl)