KEM Research Question
KEM-16b Towards a *relation between subsidence and damage*

Objective

This research is a follow up of KEM-16 regarding a toolbox for subsidence. In KEM-16 work was performed in two pilots regarding the relation between multiple causes of deep subsidence and the relation between deep and shallow causes of subsidence in the period 2020-2022. The relation between subsidence and building damage was postponed to a follow up. Since 2022 other research is ongoing to describe the relation between subsidence and building damage (GEMMA projects by the Commission Mining damage (CM). In order to prevent double work this follow up project is redefined along two lines:

1. To elaborate the pathways linking surface water level change to groundwater level change to damage to buildings (link chain).
2. To improve/advance the knowledge base of pertinent links of the chain with (model-based) research. And to address the question how validation can be achieved.

State of the art, background of the research question

Figure 1 reproduces a graphical representation of the link chain for surface water level (SWL) lowering (relative to the land surface), taken from the Deltares report submitted for part 1, pilot 3 of KEM-16 [1]. In this report a start was made to elaborate the link between items 1 and 2 of the chain: "groundwater level lowering due to surface water level lowering". Preliminary results were presented, and a listing was provided of required and desired further steps. The general aim of this work is to develop (authoritative) tables which provide practical information on GWT lowering due to SWL lowering, for application in the context of damage risk of buildings due to differential sagging. The modelling should establish a meaningful classification of conditions that can be linked to distinct GWT lowering impacts of SWL lowering. The information in the desired tables is expected to be in the form of impact factors (ratio of GWT lowering to SWL lowering).

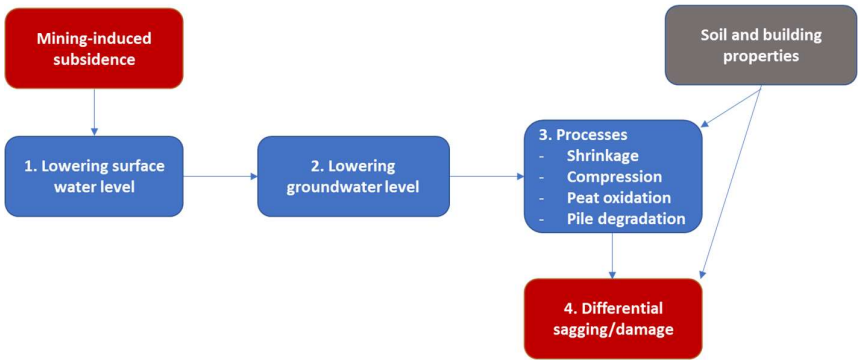

Figure 1: Flow chart illustrating the damage-risk chain of deep mining subsidence through surface water level lowering (freeboard increase). The numbered components require quantification in risk assessment.

Research activities

These research activities are considered:

1. Elaboration of the link chain between damage-risk and surface water level change

The aim of this task is to create an accessible overview of the damage-risk chain following surface water level change. The overview should allow experts and non-experts to better understand the processes that are involved. The overview will consist of a concise document containing:

- A generalized flow chart like Figure 1, extended surface water level rise
- Graphics clarifying the various components-processes and connections, with concise texts.
- Table(s) listing existing guidelines for quantification of processes (where available)
- A concise listing and discussion of key knowledge gaps in the chain.
- Flow charts/graphics elucidating the position of building damage due to surface water level change within the broader spectrum of causes of building damage.
- A concise description how the above relates to 'shallow subsidence' which is often mentioned as a cause of building damage.

2. Extend the knowledge base for key elements in the link between groundwater level lowering due to surface water level lowering, including climate forcing, phreatic storage, the role of ditches. This work contains the following stages: preparatory, model improvement, validation and synthesis.

   Model improvement

   1. Climate forcing.
   2. Phreatic storage; depth-dependency of this property will be included. This is expected to improve the GWT response during drought.
   3. The modelling will be extended to study the role of:
      A. Deepening of the ditch together with SWL lowering. This is usually done to maintain sufficient water depth and functionality of the surface water system.
      B. The width of the ditches (parcel-bounding water courses).
      C. Parcel width and pipe drainage (especially for soil profile type A).
      D. Topsoil thickness
      E. The climate forcing. In the present analysis a three-year drought (2018 on repeat) was used. What are impacts for a single year drought? (2016-2018)

   Validation.

   1. An inventory will be made of plans for SWL lowering (or raising) by consulting waterboards. Relevant information will be gathered and documented for each plan. This documentation may then be used at a later stage to explore promising cases for dedicated groundwater monitoring.
   2. The model framework and base parameter values will be evaluated by modelling existing groundwater monitoring data. Although this will not directly test the impact of SWL lowering, it does provide a basal check on the appropriateness of the model setup and parameterization.

   Synthesis

   This is the final activity where all results of modelling are evaluated and summarized in the desired practicable tables listing impact factors for relevant settings and conditions.

Deliverables expected

These deliverables are expected:

1. An accessible overview of the damage-risk chain following surface water level change. The overview should allow experts and non-experts to better understand the processes that are involved.
2. A report describing the improvements to the modelling, the validation and synthesis in tables listing impact factors for relevant settings and conditions to be used in future work.

Timeline

The project should take not more than 10 months to complete.

Expected use

This project will provide information about the link between groundwater changes to surface level changes and possible damages to buildings.

Expertise and tools preferred for the team

Knowledge on KEM-16, knowledge on groundwater changes and surface water level changes.

Quality assurance, Organisational and communication requirements

Internal quality assurance. The KEM panel and the client will react with the project team at least once every 2 months.

References

1. KEM-16 reports and references (see KEMprogramma.nl)