Geophysical Research Abstracts
Vol. 19, EGU2017-15924, 2017
EGU General Assembly 2017
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# Differential subsidence and its effect on subsurface infrastructure: predicting probability of pipeline failure (STOOP project)

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Due to heterogeneity of the subsurface in the delta environment of the Netherlands, differential subsidence over short distances results in tension and subsequent wear of subsurface infrastructure, such as water and gas pipelines. Due to uncertainties in the build-up of the subsurface, however, it is unknown where this problem is the most prominent. This is a problem for asset managers deciding when a pipeline needs replacement: damaged pipelines endanger security of supply and pose a significant threat to safety, yet premature replacement raises needless expenses. In both cases, costs – financial or other – are high. Therefore, an interdisciplinary research team of geotechnicians, geologists and Big Data engineers from research institutes TNO, Deltares and SkyGeo developed a stochastic model to predict differential subsidence and the probability of consequent pipeline failure on a (sub-)street level.

In this project pipeline data from company databases is combined with a stochastic geological model and information on (historical) groundwater levels and overburden material. Probability of pipeline failure is modelled by a coupling with a subsidence model and two separate models on pipeline behaviour under stress, using a probabilistic approach. The total length of pipelines (approx. 200.000 km operational in the Netherlands) and the complexity of the model chain that is needed to calculate a chance of failure, results in large computational challenges, as it requires massive evaluation of possible scenarios to reach the required level of confidence. To cope with this, a scalable computational infrastructure has been developed, composing a model workflow in which components have a heterogeneous technological basis.

Three pilot areas covering an urban, a rural and a mixed environment, characterised by different groundwater-management strategies and different overburden histories, are used to evaluate the differences in subsidence and uncertainties that come with different types of land use. Furthermore, the model provides results with a measure of reliability, and determines what is the limiting input factor causing most uncertainty. The model results can be validated and further improved using inSAR data for these pilot areas, by iteratively revising model parameters. The design of the model is such, that it can be applied to the whole of the Netherlands.

By assessing differential subsidence and its effect on pipelines over time, the model helps to establish when and where maintenance is due, by indicating what areas are particularly vulnerable, thereby increasing safety and lowering maintenance costs.