A Bayesian belief network approach for assessing uncertainty in conceptual site models at contaminated sites - DTU Orbit (08/11/2017)

A Bayesian belief network approach for assessing uncertainty in conceptual site models at contaminated sites
A key component in risk assessment of contaminated sites is in the formulation of a conceptual site model (CSM). A CSM is a simplified representation of reality and forms the basis for the mathematical modeling of contaminant fate and transport at the site. The CSM should therefore identify the most important site-specific features and processes that may affect the contaminant transport behavior at the site. However, the development of a CSM will always be associated with uncertainties due to limited data and lack of understanding of the site conditions. CSM uncertainty is often found to be a major source of model error and it should therefore be accounted for when evaluating uncertainties in risk assessments. We present a Bayesian belief network (BBN) approach for constructing CSMs and assessing their uncertainty at contaminated sites. BBNs are graphical probabilistic models that are effective for integrating quantitative and qualitative information, and thus can strengthen decisions when empirical data are lacking. The proposed BBN approach facilitates a systematic construction of multiple CSMs, and then determines the belief in each CSM using a variety of data types and/or expert opinion at different knowledge levels. The developed BBNs combine data from desktop studies and initial site investigations with expert opinion to assess which of the CSMs are more likely to reflect the actual site conditions. The method is demonstrated on a Danish field site, contaminated with chlorinated ethenes. Four different CSMs are developed by combining two contaminant source zone interpretations (presence or absence of a separate phase contamination) and two geological interpretations (fractured or unfractured clay till). The beliefs in each of the CSMs are assessed sequentially based on data from three investigation stages (a screening investigation, a more detailed investigation, and an expert consultation) to demonstrate that the belief can be updated as more information becomes available.

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Authors: Thomsen, N. I. (Intern), Binning, P. J. (Intern), McKnight, U. S. (Intern), Tuxen, N. (Ekstern), Bjerg, P. L. (Intern), Troldborg, M. (Ekstern)
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