Uncertainty of mass discharge estimation from contaminated sites at screening level

Thomsen, Nanna Isbak; Troldborg, M.; McKnight, Ursula S.; Binning, Philip John; Bjerg, Poul Løgstrup

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

CONTROL ID: 1481061

TITLE: Uncertainty of mass discharge estimation from contaminated sites at screening level

AUTHORS (FIRST NAME, LAST NAME): Nanna Isbak Thomsen[1], Mads Troldborg[2], Ursula S Mcknight[1], Philip J Binning[1], Poul L. Bjerg[1]

INSTITUTIONS (ALL): 1. Technical Universtity of Denmark, Lyngby, Denmark.
2. The James Hutton Institute, Aberdeen, AB15 8QH, United Kingdom.

ABSTRACT BODY: Contaminated sites threaten groundwater resources worldwide. The number of contaminated sites is large and there are too few economic resources available to ensure a thorough investigation and remediation of them all. Risk assessment must already be done at a screening level in order to ensure that only the sites that present an actual risk are further investigated and perhaps later remediated.

We propose a method for quantifying the uncertainty of dynamic mass discharge estimates from poorly characterised contaminant point sources on the local scale. Techniques for estimating dynamic uncertainty are not currently available for such sites. Mass discharge estimates (mass/time) have been proposed as a useful metric in risk assessment, because they provide an estimate of the impact of a contaminated site on a given water resource and allow for the comparison of impact between different sites. But mass discharge estimates are uncertain and these uncertainties should be quantified as part of a risk assessment. Our aim is to improve the foundation for risk assessment of contaminated sites by assessing parameter and conceptual uncertainty using a multi model approach. Such uncertainty estimates are particularly important to have during the initial screening process because of the poor understanding of the conditions at the sites.

Conceptual and parameter uncertainty is evaluated with a multi model approach which considers multiple conceptual models of the same site. The different conceptual models consider possible source and hydrogeological descriptions, where each model is believed to be a realistic representation of the given site, based on the current level of information. Parameter uncertainty is quantified using Monte Carlo simulations. For each conceptual model we calculate a transient mass discharge estimate with uncertainty bounds resulting from the parametric uncertainty. To quantify the conceptual uncertainty from a given site, we combine the outputs from the different conceptual models using Bayesian model averaging. The weight for each model is obtained by integrating available data and expert knowledge using Bayesian belief networks.

We applied the methodology to an actual contaminated site, located west of Copenhagen, Denmark. The site has been used as a storage facility for various chemicals. We focus on a DNAPL (dense non aqueous phase liquid) spill consisting of PCE (perchloroethylene) that has contaminated a clay till aquitard overlaying a limestone aquifer. The nature of the geology and the exact shape of the source are unknown. The decision factors in the Bayesian belief network for the site are presented. Model output is shown in the form of time varying mass discharge probability density functions for each model, and an assessment of the combined model uncertainty obtained from the Bayesian model average. The results show that the conceptual uncertainty contributes significantly to the total uncertainty in the transient mass discharge estimates from the site. The methodology is expected to provide decision support for managers and regulators of contaminated sites, because it improves the foundation of the risk assessment.

KEYWORDS: [1873] HYDROLOGY / Uncertainty assessment, [1832] HYDROLOGY /

Groundwater transport, [1831] HYDROLOGY / Groundwater quality.

(No Image Selected)

(No Table Selected)

Additional Details

Previously Presented Material:

Contact Details

CONTACT (NAME ONLY): Nanna Thomsen

CONTACT (E-MAIL ONLY): nait@env.dtu.dk

TITLE OF TEAM:
