IAHS2017-177
IAHS Scientific Assembly 2017

A probabilistic health risk driven approach for the steady plume delineation and risk management

Antonio Zarlenga (1), Aldo Fiori (1), and Felipe de Barros (2)

(1) Dept. of Engineering, University of Roma TRE, Rome, Italy (antonio.zarlenga@uniroma3.it), (2) Sonny Astani Dept. of Civil and Environmental Engineering, University of Southern California, Los Angeles, California, USA

We propose a probabilistic methodology for the contaminant plume delineation based on the effects on the human health. We start from the tolerable risk value prescribed by the risk management procedure and define the plume as the zone where the risk is higher than the given threshold.
We implement a standard scenario consisting of a contaminant plume, the hazard source, through an aquifer supplying water to an exposed population. The health risk assessment is carried forward by standard procedures proposed by regulatory agencies like e.g. USEPA, ARPA (Italy). In practice, health risk involves two main steps: i- the exposure assessment and ii- the dose response assessment. The first one is the estimate of the contaminant dose intake; the key parameter is the environmental concentration at the sensitive location (e.g. a pumping well). Environmental concentrations result from complex physical and biochemical processes which take place in the aquifer. Due to the random hydrogeological properties of natural formations, contaminant moves erratically from the release zone through the aquifer; advection dilution, mixing and biodegradation are phenomena which contribute to the local concentration. A three-dimensional stochastic Lagrangian model for reactive contaminant provides the statistic characterization of the concentration in each point of the domain. Different exposure pathways models allow the estimate of the of the total contaminant dose intake by humans.
The dose-response assessment quantifies the likelihood and severity of the adverse health effects related to the contaminant dose assimilated. Different dose-response models are provided in literature pertaining to different hazardous compounds. In this work we focus on carcinogenic substances and assume a simple linear model. By this simple relation the contaminant concentration field and its statistical properties can be mapped in terms of human health risk. The plume length definition follows from the acceptable health risk values suggested by regulatory agencies in a straightforward manner. The parsimonious procedure allows the screening of different scenarios with a limited computational effort and financial resources; uncertainty on input parameters can be easily propagated to the final results.