A probabilistic framework for representing and simulating uncertain environmental variables

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Abstract: Understanding the limitations of environmental data is important for managing environmental systems effectively and for encouraging the responsible use of uncertain data. Explicit assessment of the uncertainties associated with environmental data, and their storage in a database, are therefore important. This paper presents a statistical framework for representing and simulating uncertain environmental variables. In general terms, an uncertain variable is completely specified by its probability distribution function (pdf). Pdfs are developed for objects with uncertain locations ('positional uncertainty') and uncertain attribute values ('attribute uncertainty'). Objects comprising multiple space-time locations are separated into 'rigid objects', where positional uncertainty cannot alter the internal geometry of the object, and 'deformable' objects, where positional uncertainty can vary between locations in one object. Statistical dependence is allowed between uncertainties in multiple locations in one object. The uncertainties associated with attribute values are also modelled with pdfs. The type and complexity of these pdfs depends upon the measurement scale and the space-time variability of the uncertain attribute. The framework is illustrated with examples. A prototype software tool for assessing uncertainties in environmental data, storing them within a database, and for generating realisations for use in Monte Carlo studies is also presented.