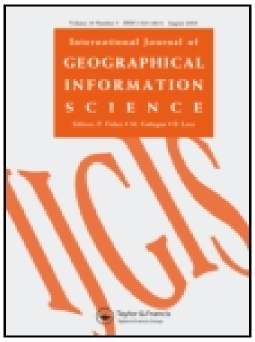


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# Guest editorial

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This issue includes eight articles that demonstrate how environmental models can be integrated with geographic information systems to improve our knowledge of environmental science and management. They were chosen from the 90 plus papers presented at the Second International Conference on Integrating Geographic Information Systems and Environmental Modelling held in Breckenbridge, Colorado, 27–30 September, 1993. The conference proceedings will be published as a book by GIS World, Inc. in early 1995 and the eight papers in this issue were chosen to illustrate some of the more innovative methods for integrating GIS (Geographical Information Systems) and environmental modelling that were demonstrated or proposed at the conference.

The first theoretical article, written by Jonathan Raper and David Livingstone, notes how most researchers continue to adopt a series of representational compromises when formulating environmental models within a GIS (because the representational basis of the GIS is allowed to drive the form and nature of the environmental model) and argues that new integrated object-oriented modelling environments are required for spatial modelling within the environmental sciences. They discuss the philosophical background to environmental representation and spatio-temporal referencing to develop a framework for the design of QOgeomorph, an object-oriented spatial modelling system for geomorphology. The paper concludes by describing the future use of QOgeomorph to represent and test some of the hypotheses about spatio-temporal development of coastal cells proposed by coastal geomorphologists.

The four papers which follow all use GIS as a means of environmental description. Michael Hutchinson compares two statistically precise models and a series of progressively less precise models that use thin plate splines to interpolate annual mean rainfall for a standard period from point data in southeastern Australia. Several of these models, which vary in terms of data inputs and model complexity (i.e., the ways in which they handle the departures of observed rainfall means from standard period means due to missing records), provide accurate spatially-distributed estimates of rainfall as a smooth function of position and elevation. The use of actual station elevations allows the fitted rainfall surface to be stored as a series of surface coefficients describing the fitted function of longitude, latitude and elevation. Files of these coefficients are combined with a DEM to construct climate surfaces as needed. Overall, the results from southeastern Australia illustrate why partial thin plate splines are a flexible and computationally efficient tool for interpolating mean rainfall for a standard period.

Ralph Dubayah and Paul Rich describe their work with solar radiation models and the implementation of these models within both GIS and image processing systems. They summarize the topographic effects which should be considered and the types of the data that are required to drive two specific models: ATM, a collection of separate programs that are part of an image processing workbench, and SOLARFLUX, a GIS-based model. Their experience with these models is used to explore several design issues related to the GIS implementation and interface as well as several outstanding computational problems and error propagation concerns.

Paul Gessler and his co-authors developed a series of statistical soil-landscape models using data from measurements of soil attributes (response variables) made in the field at locations where measurements of environmental attributes (explanatory variable(s)) are available. The soil layer serves as the basic unit of study and the catchment as the boundary of the system because of its significance for spatially-distributed hydrological and erosional processes. Models predicting A horizon depth, solum depth and the probability of encountering an E horizon in a $100\,km^2$ study area with uniform geology and geomorphic history (southeastern Australia) are used to illustrate the methodology. The spatial predictions are compared with those produced in conventional soil surveys.

The final paper to use GIS as a means of environmental description, written by Helena Mitasova and her colleagues, uses smoothing splines with tension (similar to Hutchinson) in a GIS to: (1) compute grid representations of continuous fields from scattered point data; (2) predict spatial processes, and (3) perform three-dimensional dynamic visualizations. Several new programs developed by the authors and fully integrated with the data structure of GRASS are presented and used to demonstrate two potential applications: (1) the prediction of spatial and temporal variations in soil erosion and deposition; and (2) multivariate interpolation and visualization of nitrogen concentrations in Chesapeake Bay.

The sixth paper by Philip Emmi and Carl Horton uses a Monte Carlo simulation to evaluate the sensitivity of seismic risk assessment results for Salt Lake County, Utah to random perturbations in earthquake ground shaking intensity zone boundaries. A series of GIS overlays is also used to evaluate the sensitivity of the risk results to error in intensity estimation. The two sources of error are then used by the authors to demonstrate how GIS can be used to simulate error propagation and identify strategic error reductions in risk assessments.

The next paper illustrates how GIS and environmental models can be combined to simulate the functioning of environmental systems. Chi Ho Sham, John Brawley and Max Mortiz linked the MODFLOW finite-difference, three-dimensional groundwater flow model, ARC/INFO GIS, and a customized spatio-temporal nitrogen loading program to evaluate septic nitrogen inputs to Waquoit Bay, Massachusetts. The GIS was used to integrate the spatial and temporal characteristics of the groundwater flow and land use data to assess cumulative impacts. The results show that: (1) large increases in nitrogen loadings occurred in the 1950s when Waquoit Bay experienced accelerated eutrophication; (2) the bulk of septic nitrogen entering the bay lags behind development by 10 years due to the slow-speed of groundwater movement; (3) septic nitrogen inputs will increase by 36 per cent over current levels during the next decade even if residential development is held at 1989 levels; and (4) full development will increase septic nitrogen loadings to more than twice the current levels. This application shows how GIS can be used to evaluate cumulative impacts and alternative management strategies.

The final paper by Steve Carver and his colleagues explores the possibilities for using field-based GIS for environmental characterization, modelling and decision support. The authors use the GeoAltai research project, a joint Anglo-Russian program to evaluate proposals for a new national park in the Altai Mountains of south central Siberia near the Russian/Kazakhstan/Mongolian borders, to demonstrate how the interactive use of GIS and GPS (Global Positioning Systems) in the field can improve primary data collection, groundtruthing and updating of existing databases, visualization, design of sampling strategies, and the integration of different data sources (field data, existing digital databases, remotely-sensed imagery, etc.). Continuing advances in computer hardware and GIS/GPS software linkages will promote increased numbers of projects combining field-based database development and environmental modelling with GIS efforts in future years.

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