

PREFACE

Non-point source (NPS) pollution in the vadose zone (simply defined as the layer of soil extending from the soil surface to the groundwater table) is a global environmental problem. Characteristically, NPS pollutants are widespread and occasionally ubiquitous in extent, thus making remediation efforts difficult and complex; have the potential for maintaining a relatively long active presence in the global ecosystem; and may result in long-term, chronic health effects in humans and other life forms. Similar to other global environmental issues, the knowledge and information required to address the problem of NPS pollutants in the vadose zone cross several technological and subdisciplinary lines: spatial statistics, geographic information systems (GIS), hydrology, soil science, and remote sensing. Cooperation between disciplines and scientific societies is essential to address the problem. Evidence of such cooperation was the jointly sponsored American Geophysical Union Chapman/Soil Science Society of America (SSSA) Outreach Conference that occurred in October 1997, entitled "Applications of GIS, Remote Sensing, Geostatistics, and Solute Transport Modeling to the Assessment of Non-Point Source Pollution in the Vadose Zone." The objective of the conference and this book, which was developed from the conference, was to explore current multidisciplinary research for assessing NPS pollution in soil and groundwater resources.

This volume focuses on advanced information technologies and methodologies (including global positioning, GIS, geostatistics, stochastic and deterministic solute transport modeling, fractals, neural networks, transfer functions, fuzzy logic, hierarchical and scaling theory, remote sensing, and uncertainty analysis) and how these technologies can be used to expedite NPS pollution assessment of the vadose zone. Beyond the real-time measurement and prognostication of NPS pollutants, societal considerations regarding public policy and assessing societal value are also addressed.

The 'Introductory' section brings the significance and magnitude of the NPS pollution problem specific to the vadose zone into perspective and discusses the multidisciplinary approach needed in the assessment of NPS pollutants. The 'Solute Transport Modeling' section provides examples of stochastic and deterministic modeling approaches and a protocol for their validation. The quantification of spatial variability is a crucial aspect of modeling NPS pollutants, and the section dedicated to this subject provides

a broad range of approaches: bootstrapping, geostatistics, fuzzy logic, and fractals. Remote sensing and noninvasive techniques offer great potential for contribution to NPS pollutant assessment by quantifying variability as well as measuring parameters and inputs needed by solute transport models. The 'Remote Sensing and Noninvasive Techniques' section overviews remote sensing in hydrology and showcases specific applications: geophysical measurement techniques to measure soil salinity, microwave remote sensing to estimate near-surface hydraulic properties, and remote sensing of evapotranspiration. The direct measurement of model parameters with remote sensing is generally preferred, but often not possible; consequently, estimation methods and model parameterization are useful tools for obtaining needed model parameters and input data. The section on 'Transfer Functions, Estimation Methods, and Parameterization' discusses the reliability and accuracy of pedotransfer functions for field-scale and larger modeling applications, the application of artificial neural networks for developing pedotransfer functions, and the parameterization of field-scale water flow and transport models.

The ramifications of scale and scaling are a paramount challenge to scientists attempting to model natural systems over politically specified time and space scales. Appropriately, the section on 'Scale and Scaling' presents a controversial and thought-provoking discussion concerning scaling spatial predictability, which questions the use of distributed parameter modeling and thereby the use of GIS as a viable approach for modeling NPS pollutants.

The next two sections, 'Case Study and Economics' and 'Issues and Perspectives,' present a case study and discuss social and political concerns. The value to society of NPS pollution information and the changing character of public policy regarding environmental pollution are addressed in separate chapters. Another chapter deals with the philosophical question, "Have models become ends in themselves resulting in modeling supplanting observation rather than complementing it?"

The 'Epilogue' discusses the future for the development of integrated methodologies and looks to the past for insight as to whether information technologies are the solution and the direction scientists should be taking to answer NPS pollution questions:

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