

Preface

I wanted to write this book on distributed hydrologic modeling, from a spatial perspective. When the modeling approach seeks to preserve “distributed” characteristics, then geospatial information management becomes important, particularly in the setup and assignment of parameters, and in related actions involving query, manipulation, and analysis using a geographic information system (GIS). All models are an abstraction from actual hydrologic processes. Longstanding representation by lumping of parameters at the watershed or river basin scale was originally necessitated by a lack of information, and limited computer and data resources. With available geospatial data sets for soils, topography, land use, and precipitation, there is a need to advance the science and practice of hydrology, by capitalizing on these rich sources of information.

To advance from lumped to distributed representations requires re-examination of how we model for both engineering purposes and scientific understanding. We could reasonably ask what laws govern the complexities of all the paths that water travels, from precipitation falling over a river basin to the flow in the river. We have no reason to believe that each unit of water mass is not guided by Newtonian mechanics, making conservation laws of momentum, mass, and energy applicable. Once we embark on fully distributed representations of hydrologic processes, we have no other choice than to use conservation laws (termed “physics-based”) as governing equations. It is my conviction that hydrologists will opt for distributed physics-based representation of hydrology, because it has a firmer scientific foundation than traditional lumped conceptual techniques, and takes advantage of a wealth of geospatial data available within a GIS framework.

What was inconceivable a decade ago is now commonplace in terms of computational power; availability of high-resolution geospatial data; and management systems supporting detailed mathematical modeling of complex hydrologic processes. Technology has enabled the transformation of hydrologic modeling from lumped to distributed representations with the advent of new sensor systems such as radar and satellite, high-performance computing, and orders-of-magnitude increases in storage. Global remote sensing data sets now are available at 30 cm resolution,

and soil moisture estimates from satellite at 500 m. Such tantalizing geospatial detail could be of use in making better hydrologic predictions or estimates of the extremes of weather, drought, and flooding, but only if we adapt new modeling techniques that can leverage such detail.

When confronted with the daunting task of modeling a natural process, individuals may be ill-equipped to address even a few of the most important aspects affecting hydrologic processes. In actuality, water does not care whether it is flowing through a meteorologist's domain or that of a soil scientist's. Early in my training, I realized that the flow direction grid derived from digital terrain, could be used to create a system of equations solving channel and overland flow. Or that a soil map could be reclassified to produce runoff curve numbers for calculating rainfall-runoff from a watershed useful in the design of flood control dams or reducing erosion and sedimentation. Applying these "new" distributed hydrologic methods and techniques derived from diverse scientific domains seemed natural, if only because the common fabric linking them together was the physics of natural processes that govern the distribution of water (or lack thereof) on or near the earth's surface.

The writing of this book attempts to balance between principles of distributed hydrologic process modeling on the one hand, and how modeling can be implemented using GIS. As the subject emerged during the writing of this book, it became clear that there were issues with geospatial data formats, spatial interpolation, and resolution effects on information content or drainage network detail that could not be omitted. Examples and case studies are included that illustrate how to most effectively represent the process, while avoiding the many pitfalls inherent in such an undertaking. It is my hope that this monograph provides useful guidance and insights to those hydrologists interested in physics-based distributed hydrologic modeling.

This third edition has updated reference citations; additional figures and tables; and needed corrections. Case studies are provided that demonstrate principles of distributed physics-based hydrology. Many of the examples and case studies provided rely on distributed hydrologic model software, *Vflo*[®], for which I guided development.

Norman, OK, USA

Baxter E. Vieux

Distributed Hydrologic Modeling Using GIS

Vieux, B.E.

2016, XVI, 262 p. 124 illus., 60 illus. in color., Hardcover

ISBN: 978-94-024-0928-4