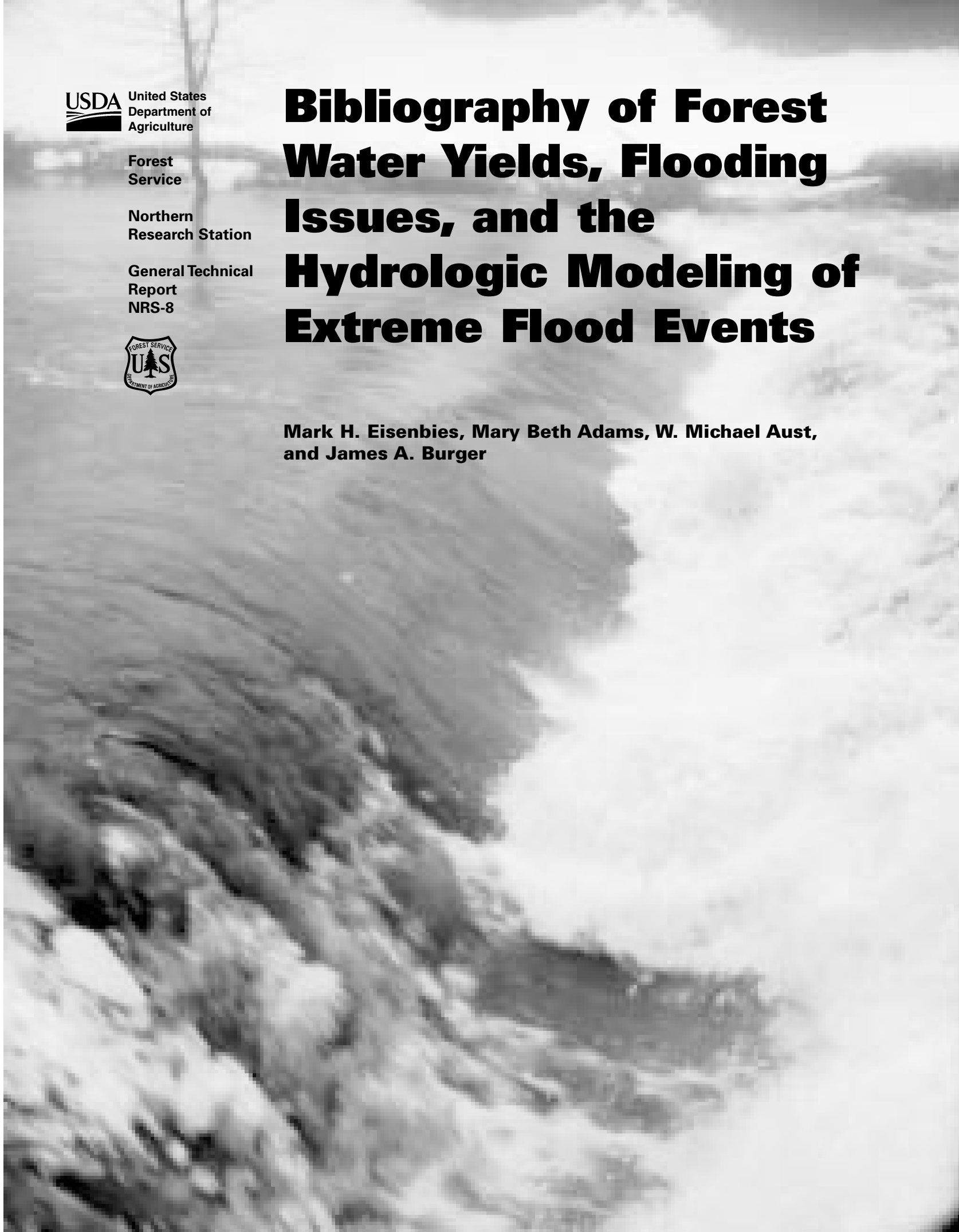

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General Technical
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NRS-8

Bibliography of Forest Water Yields, Flooding Issues, and the Hydrologic Modeling of Extreme Flood Events

Mark H. Eisenbies, Mary Beth Adams, W. Michael Aust, and James A. Burger

Abstract

Floods continue to cause significant damage in the United States and elsewhere, and questions about the causes of flooding continue to be debated. A significant amount of research has been conducted on the relationship between forest management activities and water yield, peak flows, and flooding; somewhat less research has been conducted on the modeling of these activities as related to flooding. This bibliography and online bibliographic database provide a searchable listing of more than 600 publications related to the interrelationships of forest and forest management on watershed and flood hydrology. Also included are publications related to the capability and limitations of currently available hydrologic models and modeling approaches, with particular emphasis on their utility for evaluating forest management effects.

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INTRODUCTION

The connection between forests and water resources is well established, but the relationships among the components are only partially understood. There is some evidence that the frequency of severe flooding may be on the rise due to climate change and permanent large-scale changes in land use (Macklin and Lewin 2003). Floods caused an estimated $90 billion in damage in the United States during the 1990s (Pielke et al. 2002), and recent severe flooding in the U.S. has renewed interest in the relationships among land use, forest management operations, and proportionate surface runoff. Recurrent flooding in the Appalachians has been especially troublesome and has resulted in extensive property damage and the loss of human lives.

Extreme rainstorms have the potential to cause considerable economic damage to persons and property, usually due to either flooding or landslides. The severity of these events can be influenced by numerous climatic and site factors such as rainfall amounts and intensity, existing soil moisture content, soil depth, slope, geographic aspect, and geology (glaciated versus unglaciated). Land use and management practices have also been identified as influential factors and are the only variables over which humans have any reasonable degree of control.

Because forested watersheds have been relied upon for centuries to protect water resources, land uses such as forestry, agriculture, urbanization, and mining have come under increasing scrutiny for their potential and perceived effects on water quality and quantity. Public and political pressure to prevent future floods usually follows large, damaging events, and forest protection is often a centerpiece of prevention plans. Such plans should be based upon the best available information, which of necessity comes from long-term research.

The U.S. has traditionally been very active in the area of forested watershed research. Between 1900 and 1950 about 150 watershed studies were conducted, primarily to assess the effects of land management on water yield (Stednick 1996). Several long-term research facilities in the Appalachian region are dedicated to basic research in forest hydrology (Adams et al. 2003). These facilities include the Coweeta Hydrologic Laboratory in North Carolina (est. 1934), the Fernow Experimental Forest in West Virginia (est. 1934), the Hubbard Brook Ecosystem Study in New Hampshire (est. 1962), and the Walker Branch Research Project in Tennessee (est. 1967). These facilities have each accumulated between 35 and 70 years of nearly continuous stream discharge and other data, which represent the best long-term datasets available in the Appalachian region. Research at these sites addresses a variety of large-scale and small-scale ecological questions; however, none of the sites were established expressly to research extreme flooding.

Nonetheless, a significant amount of knowledge about the links between forests and watershed hydrology has been gained in the Appalachian region. Cutting trees reduces water demand and can affect water yield from forested watersheds primarily during the growing season. Forest road systems may affect hillslope hydrology and flow routing to rivers and streams. Rapid subsequent runoff and increased water yield may in turn affect the frequency and magnitude of local and regional floods, but this remains to be demonstrated in the field. The influence of forestry practices and the specific mechanisms by which they affect flooding remain the focus of much research and debate throughout the world.

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Despite centuries of scientific observations and research inspired by major flooding events, many aspects about the relationship between land use and flooding remain unresolved (Andreassian 2004). Extreme events are rare, and because of the complexity of the system and the cost of installing large-scale hydrologic studies, data are usually limited for answering specific research questions. Models are therefore frequently used to simulate reality in comparing and evaluating land use scenarios or to reconstruct floods after they occur.

The Bibliography

We created this bibliography to provide an extensive listing of available literature on the interrelationships of forests and forest management on watershed and flood hydrology. Also provided is a listing of literature on the capability and limitations of currently available hydrologic models and modeling approaches for evaluating the effects of land use on flooding. At the time of publication, this bibliography includes a total of 617 citations that are cross-listed within 12 general categories as they relate to land use, hydrology, flooding, and modeling; individual citations may appear in multiple categories. Some emphasis has been placed on articles concerning extreme flooding and the Appalachian region. Citations after 1980 are emphasized and are primarily drawn from journal articles, books, and book chapters (fig. 1). Proceedings papers, reports, and other items are included based on their relative availability.

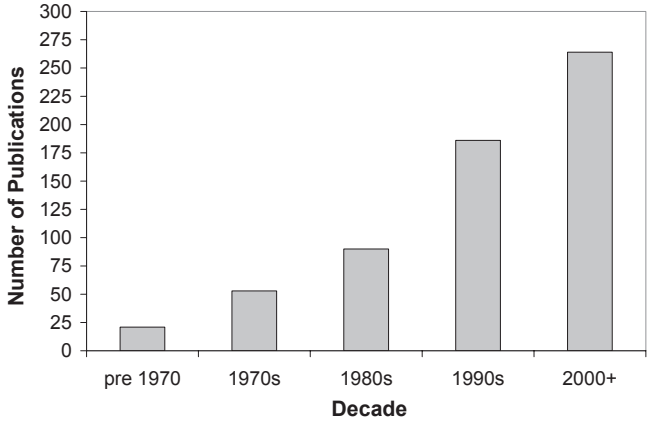

Figure 1.—*Number of publications cited in this document corresponding to decade.*

Category Descriptions

(1) *Forest hydrology, policy, history, case studies, and watershed function:* a broad overview of forest hydrology as well as case studies of specific floods.

(2) *Watersheds, forest, and hillslope hydrology*: general hydrologic concepts concerning the water cycle.

(3) *Geomorphology*: stream and flood topography, geomorphology, and fluvial processes.

(4) *Forest operations and management effects*: silvicultural and harvesting effects on hydrology and soils.

(5) *Nonforest land use effects*: impacts of other land uses (agriculture, mining, and urban) on hydrology and soils.

(6) *Soil disturbance, roads, and best management practices:* soil disturbance effects on hydrology and management implications and prescriptions for reducing erosion and protecting water quality.

(7) *Modeling approaches, concepts, and reviews:* general techniques and a variety of models for simulating hydrology on watersheds.

(8) *Hydrologic model descriptions and applications:* specific application of models.

(9) *Land use hydrologic modeling*: models specifically designed to evaluate land use change.

(10) *Hillslope hydrologic modeling:* models designed for hillslope hydrology.

(11) *Modeling issues*: a wide variety of modeling issues including uncertainty, scale, heterogeneity, thresholds, and inference.

(12) *Flood frequency analysis*: techniques for determining the return periods of floods and rain events.

Using This Bibliography

This bibliography is available at http://www.nrs.fs.fed.us/flooding as a printed document, searchable online database, or as a downloadable EndNote™ database[1]. The information will be updated periodically, and we encourage readers to send additional citations and reprints for inclusion in the updates (see the Web site above for more information). Most of these references may be obtained from public or university libraries directly or via interlibrary loan. Reports are usually available from the publishing agency.

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Floods continue to cause significant damage in the United States and elsewhere, and questions about the causes of flooding continue to be debated. A significant amount of research has been conducted on the relationship between forest management activities and water yield, peak flows, and flooding; somewhat less research has been conducted on the modeling of these activities as related to flooding. This bibliography and online bibliographic database provide a searchable listing of more than 600 publications related to the interrelationships of forest and forest management on watershed and flood hydrology. Also included are publications related to the capability and limitations of currently available hydrologic models and modeling approaches, with particular emphasis on their utility for evaluating forest management effects.

KEY WORDS: forest hydrology, peak flows, flow modeling, watershed research, forest management.

Capitalizing on the strengths of existing science capacity in the Northeast and Midwest to attain a more integrated cohesive landscape scale research program