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WILDLAND HYDROLOGY

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ISSUE DEFINITION

We define the wildland hydrology issue as the indequate understanding of the movement of water through undisturbed and disturbed forest ecosystems. Inadequacy is determined by the extent we cannot correctly interpret observed changes in soil solution chemistry, accuractely predict the hydrologic consequences of timber harvest, or devise methods for analyzing the cumulative effects of land management on aquatic resources.

We view "wildland hydrology" in the context of experimental forests and watersheds, hydrologic laboratories, and current LTER sites. At these sites, basic studies of water quality and hydrologic processes are used to obtain insight into the internal workings of ecosystems and to provide data bases for the development of conceptual models and hypotheses involving other forest environmental issues.

Wildland hydrology research is the so-called traditional hydrology research that has focused on how hydrologic systems function and how they are altered by land management activities. Much of wildland hydrology research has been basic research. Wildland hydrology includes both streamflow quantity and quality as well as hydrologic processes at the stand or even smaller scale and snow hydrology, erosion processes, and fluvial processes. Long-term records are an important aspect of wildland hydrology for they yield information on probabilities of occurrence of certain hydrologic events and are as essential bases for future research on global climate change.

FUTURE PROSPECTS FOR THE ISSUE

Basic research under the banner of "wildland hydrology" is a critical precursor to improve chances of effectively meeting the challenge of PRPs. The issue as defined above will remain a major issue although it will likely be folded into several other, sexier, high-profile issues. For example, as we attempt to focus on landscape-scale issues such as cumulative watershed effects or environmental issues such as acidification and global climate change, we will likely find that new, trendy research will be delayed by limited information on how water moves through wildland ecosystems, how this movement is affected by land management activites, and how disturbed areas recover over time. A substantial portion of the total effort directed at issues such as landscape-scale analyses will have to be directed at improving our basic understanding of how water moves through wildland ecosystems.

The wildland hydrology issue is involved in a number of other issues or concerns including but not limited to water rights, evaluation of cumulative watershed effects,

channel-maintenance flows, water quality, acid neutralization, generation of mass and surface erosion, forestry-fisheries interactions, landscape-scale analyses, global climate change, and basic ecosystem function.

SCIENCE QUESTIONS

There are a variety of science questions of different scales associated with the wildland hydrology issue. There is considerable overlap with questions that can be generated under the other issues that have been identified for this workshop. The following is a partial list of questions, and they are not listed in any order of importance or priority. Some of these questions have been around for decades.

1. ***What are the pathways and rates of water movement through forest soils?***

Complex interactions of biogeochemical processes are closely tied to the physics of water movement. Although there has been progress in describing subsurface flow processes, a much better understanding of the rates and pathways of wate movement through soils is essential for modeling soil chemical reactions and quantifying leaching rates in ecosystems. Basically, we know water goes in the top and comes out the bottom, but details of the middle are sketchy. The residence time of soil water before reaching a stream or aquifer is dependent on the pathways followed, and this contact time affects water chemistry. Process-level field studies will be necessary to reveal more aboutthe pathways and rates of subsurface water movement.

2. ***How can the hydraulic properties of soils be adequately characterized for various scales of hydrology models?***

Field methods for quantifying unsaturated, saturated, and macropore flows for complex forest soils are needed to interpret solute responses and water quality changes due to environmental problems such as atmospheric deposition and to develop and validate hydrologic models of water flow. A critical point for study is the highly dynamic contact zone between unsaturated and saturated flows near streams.

3. ***From a hydrologic point of view, how do we scale up from plot and small watershed studies to large watersheds with a variety of land uses of differing age and intensity of disturbance?***

Test existing, large-scale, distributed parameter hydrology models with flow routing capabilities to determine if they can adequately represent watershed hydrology of progressively larger watersheds. Incorporate GIS technology and results from plot and small watershed studies dealing with hydrologic change following logging to determine if a GIS-based model would be sensitive to effects of land-use changes on hydrologic processes.

4. ***What are the probabilities of flows (annual water yields, peak flows, low flows) from undisturbed forest lands and how do these probabilities change with forest management?***

Existing hydrometeorolgical data sets need to be more completely analyzed.

5. ***What are the effects of altered flow regimes on channel stability, scouring, channel widening, sediment transport, etc.?***

Answering this question would require field studies not only to determine the nature of altered flow regimes but also of fluvial processes in steep channels.

6. ***How do forest cutting patterns affect snow accumulation and melt rates in various climatic zones of the West? How are these effects routed downstream (flow synchronization or desychronization)?***

Answering these questions requires process and plot studies and the development and/or testing of flow routing models in a nested series of gaged watersheds.

7. ***What effects do forest roads have on evapotranspiration and moisture redistribution and surface runoff below the road?***

Answering this question would require plot studies using natural precipitation events.

PROGRAM TRENDS

For a variety of reasons, wildland hyrology research has decreased rapidly over the past decade. With shrinking budgets and the financial burden for maintaining long-term data sets resting on individual research work units, decisions were made to terminate a number of long-term studies. Thus, there are few truly long-term data sets dealing with wildland hydrology and effects of management activities on hydrologic processes. In addition, other process-level studies were terminated or seriously cut back.

Funding of wildland hydrology research needs to be increased substantially immediately if the basic understanding of hydrology is to be improved. If PRP's are going to be the mechanism for publicizing research needs and soliciting research funds, then PRP's dealing with water movement must also include provisions for basic, wildland hydrology research. Wildland hydrology as defined here is an absolute necessity if we are to provide the linkage between upland, headwater areas and downstream effects.

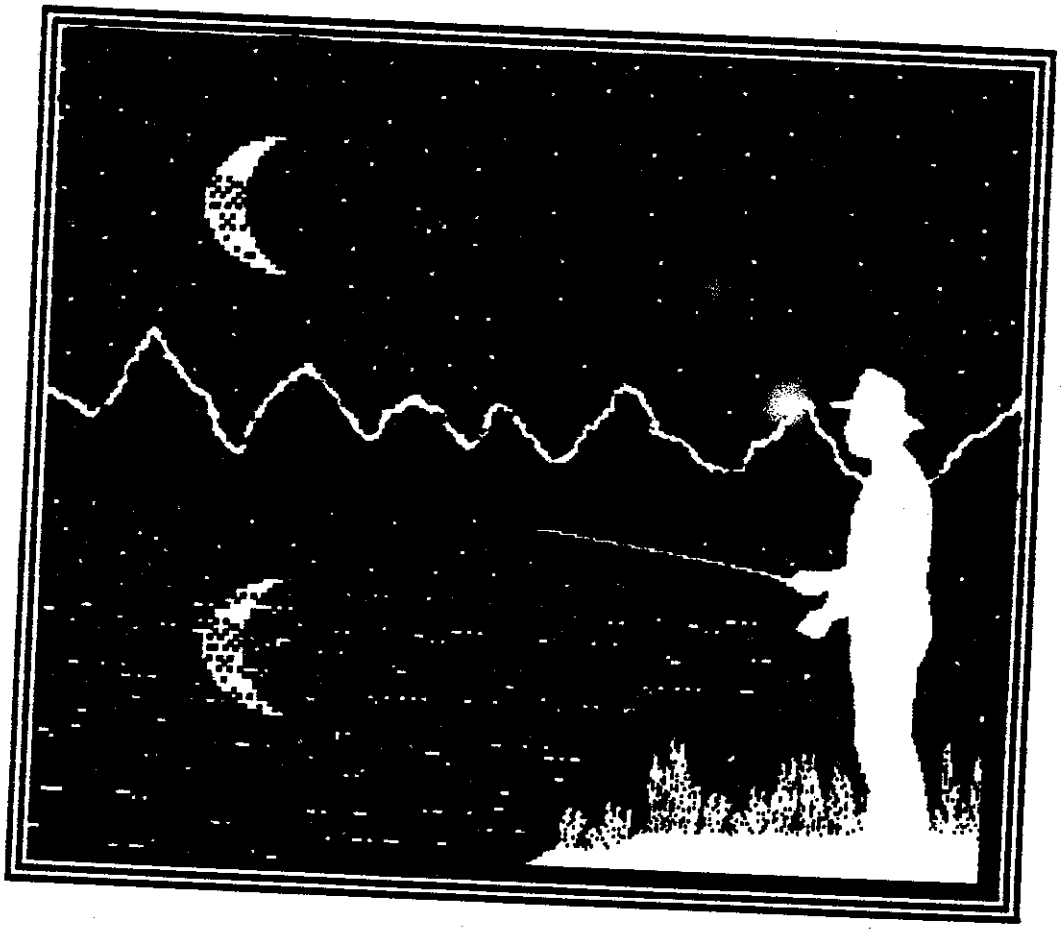
Over the long-term, provisions must be made for funding basic hydrology research at sufficent levels to maintain adequate sets of long-term data and to provide the increase in knowledge necessary to foresee problems, to develop conceptual models, and to formulate hypotheses.

BENEFITS OF DISCOVERIES

Do we want to understand how ecosystems function? Do we want to understand how alternative management scenarios affect the movement and quality of water? Do we want to manage forest and range lands such that soil and water resources are protected? Do we want to understand and be able to predict the cumulative effects of forest land management activities on water quality and fish habitats? Do we want to understand how global climate change will affect forest ecosystems and the production of high-quality water? If we do, then being able to accomplish these things will depend on much more complete understanding of how water move through the landscape.

PROCEEDINGS

WATERSHED AND AQUATIC HABITAT WORKSHOP



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FOREWARD

The science of wildland hydrology has its roots in the first decade of the 20th century. Early hydrologic studies were started at Wagon Wheel Gap, Colorado in 1910 to document fundamental principles governing relationships between precipitation, vegetation, and streamflow dynamics. From these early and somewhat primitive beginnings watershed science has evolved into a complex multifaceted set or scientific disciplines that relates to virtually every aspect of wildland management. Now, in the closing decade of this century watershed science has matured. The knowledge gained over the years is now an integral part of natural resource decisions, and provides a framework for solution of many emerging environmental issues.

In March of 1990, over 70 Forest Service scientists and resource specialist met at Fort Bragg, California to explore the role of watershed scientists in several emerging issues of the day. The papers presented here represent the perspective of the meeting participants. The collection is a useful guide for scientists and research managers alike.

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