Assessment of Proposed Partnerships to Implement a National Landslide Hazards Mitigation Strategy: Interim Report

Committee on the Review of National Landslide Hazards Mitigation Strategy, National Research Council

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Assessment of Proposed Partnerships to Implement a National Landslide Hazards Mitigation Strategy

Interim Report

Committee on the Review of National Landslide Hazards Mitigation Strategy
Board on Earth Sciences and Resources
Division on Earth and Life Studies
National Research Council

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Preface

Landslides are a component of those agents of nature that transport rock and soil from mountains or hillsides to streams, lakes and seas, where new sedimentary rocks begin to form. Therefore, as well as destructive forces that can be induced by human activity, landslides are part of the earth's natural cyclic process of uplift, erosion, and sedimentation.

With the growth of human population and the increasing habitation of ever-steeper slopes and higher altitudes, Man is both experiencing the effects of landslides and causing landslides with increasing frequency. These adverse effects include loss of life, injury, and damage to public and private works, as well as environmental damage. Accordingly, it is an opportune time to address the hazard posed by landslides, and to assess strategies to mitigate that hazard.

The present report is an interim statement addressing the U.S. Geological Survey's proposal for a national landslide hazards mitigation strategy. The scope of this interim report is constrained to assessing whether all the partners necessary for such a national strategy have been identified by the proposal—conclusions and recommendations to address the remainder of the statement of task will be presented in the committee's final report (e.g., will include comments regarding effective partnership implementation; funding strategies required for an effective mitigation program; and the balance between different components of a national strategy). In addition, in this interim report the committee offers a number of comments intended as interim guidance for the U.S. Geological Survey as it continues to plan a national strategy.

The committee is pleased to acknowledge the many members of the interested community who, at short notice, briefed the committee or provided other information and guidance (see Appendix A). As chair of the committee, I applaud the members of the committee for their hard work in a short time to prepare this interim report.

J.Freeman Gilbert
Chair

Acknowledgments

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Genevieve Atwood, Department of Geography, University of Utah, Salt Lake City

Richard E.Goodman, Department of Civil & Environmental Engineering *(emeritus),* University of California, Berkeley

George Machan, Cornforth Consultants, Portland, OR

George A.Thompson, Department of Geophysics *(emeritus),* Stanford University, CA.

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations nor did they see the final draft of the report before its release. The review of this report was overseen by William L.Fisher, Department of Geological Sciences, University of Texas, Austin. Appointed by the National Research Council, the coordinator was responsible for ensuring that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Executive Summary

Each year, landslides throughout the United States result in numerous deaths and injuries, and considerable property loss, ecological damage, and economic disruption. The committee is convinced that a more aggressive national program to mitigate landslide hazards is needed, and commends the U.S. Geological Survey (USGS) for taking a leadership role by compiling a National Landslide Hazards Mitigation Strategy. This strategy describes a range of partnerships in broad outline—with state and local governments to assess and map landslide hazards; with other federal agencies to increase agency capabilities to address landslide hazards; and with universities, local governments, and the private sector to support research and implementation efforts.

The committee considers that the USGS proposal is both timely and conceptually sound in broad outline, and agrees that the emphasis on partnerships is appropriate and necessary. It should be considered as an initial approach to a significant challenge— how to bring together the substantial but uncoordinated efforts of various agencies, researchers, and consultants throughout the country to understand, identify, and mitigate landslides. The committee concurs that an integrated program where the roles and responsibilities of multiple agencies are defined must be developed. The committee is satisfied that the proposed USGS national strategy has identified most major partners, and notes that some detail concerning the potential USGS role in a national program has been presented. Additional definition of the roles and responsibilities of the other major partners will be required. The committee suggests that the proposed strategy would benefit from development of additional partnerships with the financial community, educators at all levels, and Canadian and Mexican authorities.

As different states, and different agencies within states, have variable approaches to hazard mapping and mitigation, any comprehensive national approach must accept and work with this absence of uniformity. The national strategy must be based upon strong cooperative programs with state geological surveys, highway departments and other responsible state and local agencies. A national landslide hazard mitigation strategy should include extensive outreach, educational, and technology transfer components if it is to successfully address the diversity and breadth of landslide hazards.

Introduction

A recent NRC report estimated the annual national loss due to landslides to approach $2 billion (NRC, 1996). The magnitude of this loss, and the stipulation by the Disaster Relief Act of 1974 (Stafford Act) of the responsibility of the Director of the United States Geological Survey (USGS) for landslide hazard warning, provides a basis for the USGS to assume a prominent leadership role in national landslide hazard mitigation. The USGS Landslide Program has hitherto been funded at a modest level, but impetus for an increased emphasis on this program was provided by the House Report accompanying the Interior Appropriations Bill for FY2000. This report directed the USGS to develop a comprehensive strategy to address landslide problems. During 1999–2000 the USGS convened a series of workshops and meetings to plan and develop a national strategy, resulting in the compilation of U.S. Geological Survey Open-File Report 00–450, "National Landslide Hazards Mitigation Strategy—A Framework for Loss Reduction" (Spiker and Gori, 2000). This report proposed a national strategy based on partnerships between the USGS, as the responsible federal agency, with an array of federal, state, local, community, and industry partners. This partnership strategy envisioned a substantially increased federal investment for the USGS Landslide Hazards Program, requiring almost an order of magnitude increase from the present annual funding level of $2.6 million to at least $20 million. Of this total, $10 million would support increased USGS activities and $10 million would be provided to partners.

To be assured that the strategy advanced by the USGS was the most appropriate approach to this problem, the USGS requested the National Academies to conduct a review with the following charge:

STATEMENT OF TASK

"In response to a request from the U.S. Geological Survey, an ad hoc committee established under the auspices of the Board on Earth Sciences and Resources will provide advice regarding the optimum approaches and strategies that could be applied to implement federal-state-local-private partnerships to mitigate the effects of landslides and other ground failures. The study committee will:

- Assess the approach described in USGS Open-file Report 00–450, National Landslide Hazards Mitigation Strategy, comment on the federal-state-local-private partnership concept described in that report, and evaluate whether all the appropriate partners that should be involved in a national landslide hazard mitigation strategy are identified. This assessment should be provided in the form of a brief interim report.
- Consider the potential roles for each of the federal, state, local, and private sectors, and provide advice regarding implementation and funding strategies to stimulate productive, effective, coordinated partnerships.

As part of its analysis, the committee will provide an overview of research priorities required to support the activities of each sector."

This interim report is presented in response to the request for the committee to

determine "…whether all the appropriate partners that should be involved in a national landslide hazard mitigation program (had) been identified" and to provide interim comments on the proposed partnership strategy. Other aspects of the charge will be addressed in the committee's final report.

The report "National Landslide Hazards Mitigation Strategy—A Framework for Loss Reduction" (Spiker and Gori, 2000) presents an outline of the elements required for a national approach to the problem, with the 10-year goal of reducing the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources from landslides. The report identifies nine elements of a national landslide hazard mitigation program: (1) research to develop a predictive understanding of landslide processes; (2) hazard mapping to delineate susceptible areas; (3) real-time monitoring of active landslides; (4) loss assessment to determine economic impacts of landslide hazards; (5) information collection, interpretation, and dissemination to provide an effective system for information transfer; (6) guidelines and training for scientists, engineers, and decision makers; (7) public awareness and education; (8) implementation of loss reduction measures; and (9) emergency preparedness, response, and recovery to build resilient communities. The strategy presented by the USGS, and the review presented here, is focused on landslides—downhill earth movements ranging from rock avalanches and debris flows to more slowly-moving earth slides— but recognizing that the strategy provides a framework that could be applied to other ground failure hazards.

The partnerships referred to in the USGS strategy document (Spiker and Gori, 2000) are only described in broad outline:

- Partnerships with state and local governments to assess and map landslide hazards, to be funded through competitive grants ($8 million annual allocation, requiring 30% matching funds).
- Partnerships with other federal agencies (e.g., National Park Service [NPS], United States Forest Service [USFS], Bureau of Land Management [BLM]) to increase agency capabilities to address landslide hazards ($2 million for USGS participation as requested by other agencies).
- Partnerships with universities, local governments, and the private sector to support research and implementation efforts ($2 million annually, distributed through competitive grants).

The committee concurs that there is a pressing need for a national program to address the deaths (estimated to be 25 to 50 people each year), injuries, property losses, ecological consequences, and economic disruption that are attributable to landslides throughout the United States (Schuster, 1996). Landslide risks are particularly noteworthy in Alaska and Hawaii, the Pacific Coast states, the Appalachian Mountain states, the Rocky Mountain states, and in the island territories of American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands. Landslides affect individuals through injuries or property loss; private entities that have lost property and suffered business disruption; and state and local governments that have had to rebuild roads, utility systems, and other damaged infrastructure. In addition to the effects in the immediate vicinity of landslides, there are individuals and businesses, often some distance from landslide sites, who are affected by loss of services such as power, water and/or sewer lines as a consequence of landslides. Losses attributable to landslides have been increasing as a result of rapid development within landslide-prone areas, often because of the scenic value of such sites, and because of the increased value of property at risk. Furthermore, landuse activity, such as timber harvesting and access road construction, has led to accelerated landsliding, which has had

deleterious effects on downstream aquatic ecosystems and water quality. There has been considerable debate about effective delineation and mitigation measures for such landslides.

Reducing risks posed by landslides through appropriate land use, engineering, and other interventions will help protect individuals and property from harm as well as reduce the repair and recovery costs that landslides pose for federal, state, and local governments and private individuals and businesses. The substantial public impacts attributable to landslides provide justification for governmental action to reduce both harmful impacts and costs to government. An effective and coordinated federal effort should build upon existing efforts by federal and state authorities to address these risks by providing leadership, knowledge, and other assistance to institute more effective state and local landslide risk reduction programs. Such efforts could be part of a broader agenda to address risks posed by multiple types of natural hazards, as was proposed as part of the International Decade for Natural Disaster Reduction (NRC, 1991).

Commentary on Characteristics and Implementation of a National Landslide Hazards Mitigation Strategy

Landslides are widely distributed geographically, and pose differing types of hazards depending on geologic setting and terrain type. Landslide problems involve a wide range of issues that are of concern to government agencies at all levels—federal, state, and local. Addressing landslide hazard mitigation issues will require a substantial outreach effort to achieve effective integration and coordination amongst these agencies, with their differing responsibilities and capabilities. The diversity of landslide problems, and the breadth of the needed elements of a national landslide hazard reduction program, can be illustrated by examples:

- Debris flows triggered by extreme rainfall events have had devastating effects in mountainous regions of the United States. Improved understanding of the initiation and propagation of these flow events is needed in order to reduce the hazard they pose.
- Rock falls pose severe hazards, particularly along transportation corridors, in many mountainous states. The science related to rock falls is relatively well understood, but improvement is needed in standards of risk management in many areas, and this can be achieved by encouraging more widespread adoption of established techniques through technology transfer.
- Bedrock slides occur in many locations throughout the United States. Although bedrock slides can be mapped readily if the needed resources are available, they nevertheless continue to cause extensive economic losses due to ineffective regulatory controls on development in slide-prone areas.

Prioritizing Landslide Hazard Mitigation Activities

In general, improved risk assessment is needed for all types of landslide hazards, as are advances in methods of cost-effective mitigation that might include hazard insurance and other financial instruments. More specifically, the establishment of priorities should take existing knowledge and the potential for cost-effective results into consideration. A matrix illustrating some of the major activities that would be embraced in an effective national strategy to address the diversity of landslide hazard problems is shown below, evaluating five typical landslide types against five activities that could be applied to address landslide problems:

- Adequate understanding of landslide triggering and landslide movement mechanisms are a fundamental requirement for other activities, and improvement of the science base is an essential first step to fill gaps in the current understanding.
- Technology integration and transfer is important for both dissemination of scientific understanding of the hazard and the identification of appropriate mitigation methods.
- Mapping provides the fundamental database for identification and delineation of landslide hazards.

- Risk assessment integrates the many factors relating to slide occurrence and consequence. It can be applied at various levels, ranging from qualitative to quantitative.
- Mitigation takes many forms, with land use regulation being the most important. Other mitigation activities include stabilization through engineering activities and construction of diversion works.

Activity / Type	Improve Science Base	Technology Transfer	Mapping	Risk Assessment	Mitigation
Debris Flow	■		■	■	■
Rock Fall		■		■	■
Bedrock Slide			■	■	■
Liquefaction Flow			■	■	■
Soft Clay Slides				■	■

Shaded boxes indicate activities with the highest payoff potential.

- Debris Flow Investment in basic research to improve understanding of debris flow initiation and movement has a high payoff potential, and should precede additional efforts in technology integration and transfer. The basic scientific advances will also contribute to improved mapping, which is a priority requirement. In addition, clarification of magnitude-frequency-runout characteristics can be anticipated, and these are important for risk assessment and mitigation (including regulation). Improved mitigation methods and the establishment of appropriate risk assessment techniques are needed.
- Rock Fall Rock fall processes are relatively simple and reasonably well understood. The FHWA (Federal Highway Administration) and some state highway departments have made substantial progress in technology integration and transfer. It appears that widespread dissemination of this information would encourage implementation and have a high payoff potential. At the same time, improved mitigation methods and the establishment of appropriate risk assessment techniques are needed.
- Bedrock Slides There is reasonable understanding of the mechanics of bedrock slide initiation, although additional case histories would add significantly to the body of knowledge. Post-failure deformations are less understood. Bedrock slides can be identified with current technology and there is high payoff potential associated with mapping them in areas of high risk, in order to assist regulation. Improved mitigation methods and the establishment of appropriate risk assessment techniques are needed.

- Liquefaction Flow This refers to seismically-induced ground failure. The basic science of this process has received considerable attention in recent years, and liquefaction susceptibility criteria have been established and tested in the field. A high payoff potential can be expected from mapping this hazard. As above, improved mitigation methods and the establishment of appropriate risk assessment techniques are needed.
- Soft Clay Slides Geotechnical engineers have devoted substantial effort to understanding the mechanics of soft clays, and as a consequence the initiation and movement of landslides in these deposits are the best understood of all landslide types. Mapping is straight-forward. Improved mitigation methods and the establishment of appropriate risk assessment techniques are needed.

The development of a national strategy to reduce landslide hazards does not mean that all geographic areas need mapping, that all areas mapped need to be mapped at the same level of detail, or that all research topics need to be pursued. Rather, the strategy should be selective in its approach, and devised so as to concentrate efforts on geographic areas and topics for which mapping and research will have the greatest payoffs in reducing vulnerability and losses. One fundamental question that must be answered in a national strategy is the balance between research and mapping. The strategy should identify those topics most in need of research that have the highest probability of being applied to reduce the risk from landslides. The strategy should also call for mapping areas where hazards are high and the risks to infrastructure and population are great.

National Strategy Participants and Roles

The overall effort needed to mitigate the effects of landslides is extremely large and of necessity requires the cooperation of federal, state and local governments as well as the private sector (NRC, 2001). The different parties should have their individual interests expressed in the strategy so that a clear picture of the total needs of the nation is obtained. It is critical to arrive at a division of responsibilities for implementing the strategy. As a national program, this translates into defining the federal role in the allocation of funds in order to achieve the overall objectives of the program. An appropriate federal role would address the following topics: funding or undertaking critical research that would not otherwise be undertaken; stimulating and coordinating federal agencies in their missions; providing financial and technical assistance to state governments for mapping projects or assisting in mapping; and assisting selected local governments to develop innovative landslide risk-reduction demonstration programs. In the research area, funding and collaboration among the government labs and with universities should be a part of the strategy.

The success of the strategy will be no greater than the quality of the earth science, engineering, and social science components of the program. The best and most recent advances in these fields need to be employed. This can only be achieved when there is a full and open flow of information between participants, requiring a coordinated system for information storage and communication.

Public and private decisions with respect to land use and development must of necessity take into account the existing landslide hazard and potential risk to development, as well as the potential for landslide risk to be exacerbated by human activities. Risk is inherent in virtually all decisions made by society, whether consciously stated and understood or not. Recent advances in risk analysis that

incorporate an understanding of the hazard, the range of risks, and the uncertainties associated with both need to be a central part of a national landslide strategy in order to guide appropriate decisions by public and private sectors. Risk analysis tools have value at all levels of government as well as in the private sector. Provisions should be included in a national strategy to support the development and application of appropriate risk analysis techniques for the range of landslide situations.

In most cases, land use and development decisions that affect the vast urban development occurring throughout the country are made locally, normally at city or county level. Most of the population will have the level of risk that they may be exposed to established by decisions of city councils and boards of supervisors, or their equivalents. These officials do not and cannot be expected to have a sophisticated knowledge of the risks of landslides. The strategy must therefore include the information, tools, and training that will help ensure enlightened local decisions that adequately reflect the desires of relevant stakeholders In many instances, informed local decisions can only be made when state levels of government encourage and require local actions that seek to reduce landslide risk.

Responses to landslide and other hazards are usually conditioned by the financial implications of decisions. The financing industry can determine what properties to insure if they have reliable and useable information concerning landslide hazards and risks. The insurance industry can also potentially play a critical role if the risks from landslides are known and conveyed. Both the lending and insurance industries have only been marginally involved in the landslide hazard area, but the potential for these sectors to have a more significant role in addressing landslide risks should be explored.

Implementation of a National Strategy

In order to implement a national strategy, the goals of the program need to be clearly stated and justified. They also need to be translated into specific targets against which progress can be measured. This should serve not only to measure the degree of success, as assessed by the usefulness and effectiveness of the strategy, but also would provide a basis for course corrections as needed.

The implementation plan for a national landslide hazards mitigation strategy must recognize the capabilities of ongoing programs within the federal, state, university, and local structures. A primary objective must be to develop a cohesive program from these individual distributed components, with specific assignments, funding, and scheduling. The lead federal agency must accept this responsibility unequivocally, and provide the administrative structure, guidance, and funding. Funding for each sector or unit of work can be established using existing interagency procedures to establish formalized cooperative programs between federal, state, and local entities (e.g. cooperative water resources agreements and mapping programs between the USGS and state geological surveys). A national mitigation strategy should recognize the need for an inter-agency organizational structure to ensure that the broad spectrum of needed activities is implemented effectively.

Summary Observations

Landslides occur in many geographic regions, in response to a wide variety of conditions and processes, and result in substantial damages. Losses include significant environmental and societal costs as well as direct and indirect financial losses. The committee is convinced that a national program to coordinate efforts to reduce the risks posed by landslides is required, and commends the USGS for taking a leadership role by proposing a National Landslide Hazards Mitigation Strategy. The national program presented in USGS Open-File Report 00–450 (Spiker and Gori, 2000) represents an initial approach to the challenging problem of establishing a mechanism to bring together the substantial but uncoordinated efforts of various agencies, researchers, and consultants throughout the country to understand, identify, and mitigate landslides. The committee considers that the strategy proposed by the USGS is both timely and conceptually sound in broad outline, and agrees that the emphasis on partnerships is appropriate and necessary.

Although some landslides are due to human activity, others are unavoidable natural processes that occur on apparently undisturbed land, and this differing causality may require attention by a number of different regulating authorities. Complexities inevitably arise when landslides cross ownership and jurisdictional boundaries and cause damage to both public and private resources. Therefore, an integrated program where the roles and responsibilities of multiple agencies are defined must be developed. The committee is satisfied that the proposed USGS national strategy has identified most major partners, and notes that some detail concerning the potential USGS role in a national program has been presented. Additional definition of the roles and responsibilities of the other major partners will be required. The committee recognizes the considerable challenge involved in formulating a partnership strategy of such complexity. Different states, and different agencies within states, have variable approaches to hazard mapping and mitigation, and any comprehensive national approach must accept and work with this absence of uniformity.

Although more detailed advice concerning implementation and funding strategies will be the focus of the committee's final report, the following comments are offered as interim guidance:

- In general, the strategy is structured in a top-down fashion with the USGS taking a lead and providing service and guidance to other agencies. Other structures may provide more effective or cost-efficient landslide hazard risk reduction.
- To produce mitigation of landslide risk at the local level, the program will need to support state and local mapping, hazard reduction, and education projects. Strong cooperative programs will be required with state geological surveys, highway departments and other responsible agencies. Although

the proposed USGS program does incorporate cooperative projects with state and local agencies and with private industry, the committee believes that even greater emphasis is needed in this area.

- A variety of approaches to establishing landslide inventories, with mapping forming an important but not the sole component, should be included in a national landslide hazard mitigation strategy.
- The committee suggests that the proposed strategy would benefit from development of additional partnerships: with the financial community, as an important element for reducing financial loss caused by landslides; with educators at all levels; and with Canadian and Mexican authorities, both for mitigating risk that extends across national borders, and to promote mutually beneficial information exchange.
- Landslide mitigation typically involves decisions at the local level, and a lack of information about landslide distribution and degree of hazard appears to be a major constraint to providing better mitigation in many areas. Informed decisions require adequate information concerning landslide mechanisms and mitigation alternatives, and this information must be available to all sectors of society. A national landslide hazard mitigation strategy must include extensive outreach, educational, and technology transfer components if it is to successfully address the diversity and breadth of landslide hazards.

In addition, the committee anticipates that salient issues to be addressed in its final report will include the following:

- The status of the science of landslide processes and future research directions.
- The role and application of landslide hazard susceptibility mapping and landslide monitoring.
- Potential administrative structures to enable participation by the diverse range of stakeholders and partners in funding and implementation decisions.
- Improved education and information transfer: for decision-makers to assist the regulatory environment; for planners, scientists, and engineers involved with landslide mitigation; and for the general public.
- The role and application of risk assessment methods to the prioritization of landslide hazard mitigation activities.

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Appendix A

Attendees and Presentations at Meetings

Meeting 1
Colorado School of Mines, Golden, Colorado
January 28–30, 2002

COMMITTEE MEMBERS

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J.Michael Duncan, Virginia Polytechnic Institute and State University
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David A.Feary, Study Director
Shannon L.Ruddy, Sr. Project Assistant

PRESENTERS AND ATTENDEES

Rex Baum, U.S. Geological Survey, CO
Karen Berry, Jefferson County Planning, CO
Maeve Boland and students, Colorado School of Mines, CO
Steve Briggs, Cincinnatti City Planning Department, OH
Vicki Cowart, Colorado Geological Survey, Denver, CO
Jerome DeGraff, U.S. Forest Service, Clovis, CA
Paula Gori, U.S. Geological Survey, Reston, VA
Ed Harp, U.S. Geological Survey, Golden, CO
Rex Hickling, Rocky Mountain Insurance Information Association, Boulder, CO
Jerry Higgins, Colorado School of Mines, Golden, CO
Sanjay Jeer, American Planning Association, Chicago, IL
Jeff Keaton, AMEC Earth & Environmental, Anaheim, CA
David Noe, Colorado Geological Survey, Denver, CO
Steve Olson, Federal Emergency Management Agency, Denver, CO
John Pallister, U.S. Geological Survey, Reston, VA

Scott Roscoe, Federal Emergency Management Agency, Denver, CO
Barry Siel, Federal Highway Administration, Denver, CO
Lawson Smith, U.S. Army Corps of Engineers, Vicksburg, MS
Dave Steensen, National Park Service, Denver, CO
Jeff Weissel, Lamont-Doherty Earth Observatory of Columbia University, NY
William Ypsilantis, Bureau of Land Management, Denver, CO

PRESENTATION TITLES AND PRESENTERS

The U.S. National Landslides Hazards Mitigation Strategy—A Framework for Loss Prevention
John Pallister
U.S. Geological Survey, Reston, Virginia
Landslide Hazard Mapping in Seattle
Ed Harp
U.S. Geological Survey, Golden, Colorado
National Landslide Hazard Mitigation Strategy and National Forest System Lands
Jerome DeGraff
U.S. Forest Service, Clovis, California
Landslide Hazard Mitigation in the National Park System
David Steensen
National Park Service, Denver, Colorado
Bureau of Land Management Landslide Issues
Bill Ypsilantis
Bureau of Land Management, Denver, Colorado
Landslide Mitigation Activities of the U.S. Army Corps of Engineers
Lawson Smith
U.S. Army Corps of Engineers, Vicksburg, Mississippi
Cincinnati Landslide Mitigation
Steve Briggs
Cincinnati City Planning Department, Cincinnati, Ohio
The Sixth Avenue Estates Landslide: A Breakdown in Hazards Mitigation?
Jerry Higgins
Colorado School of Mines, Golden, Colorado
Federal Highway Administration Presentation
Barry Siel
Federal Highway Administration, Denver, Colorado
FEMA Today
Steve Olsen
Federal Emergency Management Agency, Denver, Colorado
An RMIIA insurance perspective on landslides
Rex Hickling
Rocky Mountain Insurance Information Association
SAFECO Insurance, Boulder, Colorado

Colorado Geological Survey Perspective on a National Landslide Program
Vicki Cowart
Colorado Geological Survey, Denver, Colorado
Overview of NASA ESE Activities in Landslide Hazards Research and Applications Development
Timothy Gubbels and Jeffrey Weissel
NASA Headquarters, and Lamont-Doherty Earth Observatory
Washington, DC, and New York
Jefferson County planning perspective
Karen Berry
Jefferson County Planning Department, Colorado
Landslide Hazards and Planning: An approach adopted for the APA—USGS Project
Sanjay Jeer
American Planning Association, Chicago, Illinois
Suggestions to the National Research Council Committee on National Landslide Hazard Mitigation Strategy
Jeffrey Keaton
AMEC Earth & Environmental, Anaheim, California

Meeting 2
State Office Building
Oregon Department of Geology and Mineral Industries
Portland, Oregon
March 14–16, 2002

COMMITTEE MEMBERS

J.Freeman Gilbert, *Chair,* University of California, San Diego
William Dietrich, University of California, Berkeley
J.Michael Duncan, Virginia Polytechnic Institute and State University
William F.Marcuson III, W.F.Marcuson III & Associates, Inc., MS
Norbert R.Morgenstern, University of Alberta, Edmonton, Canada
Jane Preuss, GeoEngineers Inc., Redmond, WA
A.Keith Turner, Colorado School of Mines, Golden
T.Leslie Youd, Brigham Young University, Provo, UT

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David A.Feary, Study Director
Shannon L.Ruddy, Sr. Project Assistant

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James Bela, Oregon Earthquake Awareness, Portland
Jerry Fish, Stoel Rives LLP, Portland, OR
R.Jon Hofmeister, Oregon Department of Geology, Portland
Jim Kennedy, OEM, Portland, OR
Paul Logan, Stoel Rives, Portland, OR
Michael Long, Oregon Department of Transportation
John Pallister, U.S. Geological Survey, Reston, VA
Bob Schuster, U.S. Geological Survey *(emeritus),* Colorado
Joan Van Velsor, California Department of Transportation
Yumei Wang, Oregon Department of Geology, Portland

PRESENTATION TITLES AND PRESENTERS

U.S. Geological Survey perspective (teleconference)
Pat Leahy
U.S. Geological Survey, Reston, VA
Overview of DOGAMI's Landslide Efforts
Yumei Wang
Oregon Department of Geology & Mineral Industries, Portland, OR
California Department of Transportation Perspective on Landslides
Joan Van Velsor,
California Department of Transportation, Sacramento, CA
Landslide Management in the Transportation Environment
Mike Long,
Oregon Department of Transportation, Portland, OR

International Landslide Programs
Bob Schuster,
U.S. Geological Survey (emeritus), Denver, CO
Hong Kong Landslide Management/Mitigation
Norbert Morgenstern,
University of Alberta, Canada

Meeting 3
National Research Council
Foundry Building, 1055 Thomas Jefferson Street
Washington, DC
May 20–22, 2002

COMMITTEE MEMBERS

J.Freeman Gilbert, *Chair,* University of California, San Diego
William Dietrich, University of California, Berkeley
J.Michael Duncan, Virginia Polytechnic Institute and State University
George G.Mader, Spangle Associates, CA
William F.Marcuson III, W.F.Marcuson III & Associates, Inc., MS
Peter J.May, University of Washington, WA
Norbert R.Morgenstern, University of Alberta, Edmonton, Canada
Jane Preuss, GeoEngineers Inc., Redmond, WA
A.Keith Turner, Colorado School of Mines, Golden
T.Leslie Youd, Brigham Young University, Provo, UT

National Research Council Staff

David A.Feary, Study Director
Shannon L.Ruddy, Sr. Project Assistant

PRESENTERS AND ATTENDEES

Peter Bobrowsky, Natural Resources Canada, Ottawa, Ontario
Chris Doyle, FEMA, Washington, DC
Paula Gori, U.S. Geological Survey, Reston, VA
Donald Plotkin, Federal Railroad Administration, Washington, DC
Gerry Wieczorek, U.S. Geological Survey, Reston, VA

PRESENTATION TITLES AND PRESENTERS

Structure and functioning of NEHRP and NEP Programs
Chris Doyle,
FEMA, Washington, DC
Federal Railroad Administration (FRA) landslide mitigation activities
Don Plotkin,
FRA, Washington, DC
Regional Aspects to Landslide Mitigation
Gerry Wieczorek,
U.S. Geological Survey, Reston, VA
Canadian plans and activities for national landslide hazard mitigation
Peter Bobrowsky,
Natural Resources Canada, Ottawa, Ontario

Appendix B

Committee Biographies

J. Freeman Gilbert (NAS) is a Research Professor at the Scripps Institution of Oceanography, University of California, San Diego. His research interests include theoretical, inferential and computational geophysics. He is one of the founders of the San Diego Supercomputer Center and the National Partnership for Advanced Computational Infrastructure, sponsored by the National Science Foundation.

William E. Dietrich is professor of Geomorphology at the University of California, Berkeley. He has appointments in the Earth and Planetary Science Department, the Department of Geography, and the Earth Sciences Division of Lawrence Berkeley National Laboratory. His current research includes mechanistic analysis of landscape processes and evolution, identifying linkages between ecological and geomorphic processes, as well as building tools to tackle pressing environmental problems.

J. Michael Duncan (NAE) is a University Distinguished Professor in the Department of Civil and Environmental Engineering at the Virginia Polytechnic Institute and State University. Dr. Duncan is a geotechnical engineer specializing in problems of soil-structure interaction, stability, and seepage.

Philip E. LaMoreaux (NAE) is now a hydrogeology and environmental geology consultant, after retiring following service as Chief of the Groundwater Branch of the U.S. Geological Survey, State Geologist of Alabama, Professor of Geology at the University of Alabama, and Director of the Environmental Institute for Waste Management Studies for Alabama.

George G. Mader is a city planner and president of Spangle Associates, Inc., a city planning and research consulting firm in the San Francisco Bay region. He has specialized in using city planning to reduce risks from geologic hazards. His activities have included teaching, research, and planning in this country and abroad.

William F. Marcuson III (NAE) is President of W.F.Marcuson III and Associates, Inc. and Director *emeritus* of the Geotechnical Laboratory, U.S. Army Engineer Research and Development Center. His research activities have focused on experimental and analytical studies of soil behavior related to geotechnical engineering problems, seismic design, analysis, and remediation of embankment dams, and seismically induced liquefaction of soils.

Peter J. May is professor of political science at the University of Washington. His research is concerned with regulatory policy design and implementation, with particular attention to environmental regulation and policymaking regarding natural hazards.

Norbert R. Morgenstern, (NAE), is a University Professor of Civil Engineering *(emeritus)* at the University of Alberta, and an internationally recognized authority in the field of geotechnical engineering. He has considerable experience with landslides at both theoretical and applied levels.

Jane Preuss (AICP) is a Principal with GeoEngineers, a company specializing in geotechnical engineering and engineering geology. She has over 20 years of experience as a practicing urban planner, working with clients from both public and private sectors. Her main areas of interest include land use and environmental planning for mitigation and preparedness against the effects of natural hazards such as floods, landslides, earthquakes, tsunamis, and high winds.

A. Keith Turner holds concurrent appointments as Professor of Geological Engineering at the Colorado School of Mines and Professor of Engineering Geology at Delft University of Technology in The Netherlands. His chief research interest involves computer applications to geological and environmental studies; including landslide assessments in Colorado and Canada.

T. Leslie Youd is Professor of Civil Engineering at Brigham Young University, where he teaches courses in geotechnical and earthquake engineering and conducts research on liquefaction and ground failure. Dr. Youd was formerly (1967 to 1984) a Research Civil Engineer with the U.S. Geological Survey, Menlo Park, California.

NRC STAFF

David A. Feary is a Senior Staff Scientist with the NRC's Board on Earth Sciences and Resources. His research activities have focused on the geological and geophysical evolution of continental margins, particularly the factors controlling carbonate deposition and reef development within different climatic regimes.

Appendix C

Acronyms

BLM	Bureau of Land Management
FHWA	Federal Highway Administration
NPS	National Park Service
NRC	National Research Council
USFS	United States Forest Service
USGS	United States Geological Survey