

Workshop Report

IMPROVING THE EFFECTIVENESS

OF

FLOODPLAIN MANAGEMENT

IN

WESTERN STATE HIGH RISK AREAS

Alluvial Fans, Mudflows, Mud Floods

Conducted February 15, 16, 1984

in Palm Springs, California

by

-- The Association of State Floodplain Managers, Inc.

in Cooperation with

-- The Federal Emergency Management Agency

-- The California Department of Water Resources

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Foreword

This two-day workshop was held in Palm Springs, California in February, 1984 to investigate approaches for improving the effectiveness of floodplain management in alluvial fan, mud-flow and mud flood areas. The workshop brought together 40 experts from federal agencies, states, local governments, universities and the private sector to address three issues:

- (1) How serious are alluvial fan, mud flood and mudflow problems, taking into account overall flood problems in the West, existing development, and future development?
- (2) How adequate are existing maps, regulations, insurance and other approaches for managing such areas?
- (3) Given limited budgets at all levels of government, how should the states, FEMA, other federal agencies, and communities best improve the effectiveness of management for these areas?

As one might expect, there were differing points of view, yet there was also considerable agreement, if not consensus on major issues. The discussion comprised many thoughtful comments and suggestions.

Before workshop there had been no plan for proceedings and papers were not requested from speakers. However, due to the usefulness of the discussion, speakers were asked to prepare summaries; most but not all did. This report contains the speakers' papers and a summary of the discussion.

Acknowledgements

This workshop is one of several regional meetings held by the Association to investigate the effectiveness of floodplain management in high risk areas and to build state, federal and local capability to more effectively deal with such areas. High risk areas include those subject to mudflows and mudfloods, coastal erosion and flooding, ice jam flooding, lake flooding, flooding due to subsidence and liquefaction as well as areas behind unsafe levees, below unsafe dams and on and around alluvial fans.

The information gathered including conclusions and recommendations from this workshop will be reflected in the report of the broader study.

This workshop was a cooperative effort of the Association of State Floodplain Managers, the Federal Emergency Management Agency and the State of California Department of Water Resources. It would not have been possible without FEMA's funding support, which is gratefully acknowledged, and the individual efforts of Dale Peterson, Region 9, FEMA and Jean Brown, of the California Department of Water Resources, and Dr. Jon Kusler, a consultant to the Association. Nor could it have taken place without the participation of all speakers and participants. Thanks to all.

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Executive Summary

Workshop attendees generally agreed* that:

- (1) Alluvial fan and mudflow/mud flood problems are extensive and severe in the West and Southwest and will result in severe future losses due to high growth in these areas. Alluvial fan and mudflow/mud flood problems are extensive (perhaps 20-30% of the total floodplain); such hazards affect a large number of individuals and structures (e.g., 2.6 million people may be at risk from mud/water related phenomena in Los Angeles County); such problems pose a special threat to life and property (5 to 1 or 10 to 1 greater threat to life than clear water flooding); and such hazards are particularly serious in developing and high growth areas such as Marin, Contra Costa, Los Angeles, San Bernardino, Orange, Riverside, Ventura, Santa Barbara, and Imperial Counties in California; Clark County, Nevada; Davis, Salt Lake and Utah Counties in Utah; and Pima and Maricopa Counties in Arizona; and Bernalillo County in New Mexico. Most flood disasters in the West and Southwest have involved a substantial alluvial fan flooding and mudflow/mud flood component.

- (2) Although some progress has been made in developing mapping and regulatory standards for alluvial fan and mudflood areas, little "on the ground" implementation has taken place. Existing mapping, regulation, and insurance rating approaches developed to address eastern and midwestern clear water flood problems understate hazards due to inadequate consideration of
 - . velocities,
 - . debris, and
 - . water-related erosion.

Many alluvial fans have been mapped as shallow flood hazard areas, seriously understating the risks they pose.

*See workshop summary and papers. Workshop participant assessments of the magnitude of the problems in particular areas differed.

Mapping for mud flood and mudflow areas is less extensive.

Inadequacies will contribute to disaster losses in alluvial fan and mud flood areas and may result in community liability. They also undermine the credibility of floodplain management efforts at all levels of government.

- (3) Despite continued methodological problems for detailed mapping and establishing performance standards for hazard areas, enough is known to take new action now at federal, state, and local levels to better control development in these areas. Given the severe nature of the hazards, the high growth rates and growth potential in these areas, and the increasing threats of legal liability for failure to adequately consider them, immediate and rather simplistic planning, regulatory and insurance-rating approaches should be applied to reduce risk while additional research is conducted on mapping and analytical methodologies, performance guidelines and insurance rating. Such action should be a cooperative federal effort (FEMA, USGS, the Corps, etc.) along with the states and communities. Priority should be given to technical assistance for communities with severe problems and wishing to carry out planning, regulation and management that exceeds minimum federal, state and local standards.

There was some disagreement in the workshop over:

- (1) Appropriate federal, state and local roles in improving the effectiveness of regulations;
- (2) The adequacy of existing mapping methodologies and regulatory criteria for the purpose of requiring state or local regulation; and
- (3) Specific proposed actions such as reinstatement of the AF Zone for alluvial fans.

Principal suggestions* for immediate and longer term action to improve the effectiveness of management included:

- (1) Simultaneous consideration of mapping, regulation and insurance rating. Mapping, regulation, and insurance rating needs should be addressed simultaneously in federal policy-setting and research to help fashion a

*See the workshop and individual papers for more detail.

coherent package. This may best be accomplished on a multiagency basis and should include hydrologic, geologic and engineering expertise.

- (2) Better dissemination of existing information. Existing information concerning mapping methodologies, modelling and master planning approaches, and performance standards for buildings and other activities should be better disseminated to

- . FIA map contractors,
- . Local governments wishing to make use of such information,
- . Developers and landowners.

Such dissemination could take the form of workshops, handbooks, model regulations, one-on-one technical assistance, and video tape presentations.

- (3) Encouragement for local governments and states to exceed minimum FIA standards. Local governments and states should be encouraged by FEMA and other federal agencies to plan and regulate alluvial fan and mudflow/mud flood areas with standards exceeding those of the National Flood Insurance Program. Such encouragement could take the form of clear policy endorsement by FEMA (Washington and regional offices), technical assistance, training and education, selective mapping, and a community flood insurance insurance rating system giving communities with approaches exceeding minimum FIA standards a preferential insurance rate.

- (4) Mapping. Preliminary low-cost mapping is needed for alluvial fan and mudflow/mud flood areas to act as a "red flag" for development problems and so local governments and states could require developers to seek more detailed engineering, hydrologic, and geological analysis and design assistance before receiving a permit. Such preliminary mapping could be based upon historical evidence of flooding or gross parameters (e.g., slope, soil and bedrock type). Such maps are needed for areas with both serious hazards and development pressure, constituting only a small portion of the total alluvial fan and mud flood areas. They would include urban and urbanizing areas already mapped by the NFIP without consideration of the special risk factors, areas now being mapped by the NFIP, and additional special hazard areas.

The maps could take the form of overlays, eliminating the need to reissue existing maps.

(5) Improved performance standards for land uses.

Improved performance standards for land uses should be developed by FEMA in cooperation with other federal agencies and the states. Such guidelines should address:

- . the preparation and implementation of master plans for alluvial fans and mudflow/mud flood areas;
- . performance standards for buildings and other activities reflecting not only flood depth but also velocities, debris and sediment, and erosion.

Guidelines are needed both for new structures and for retrofitting existing structures. Such guidelines could build upon the experience of several states (Colorado and California) and communities with experience in regulating alluvial fan and mud flood areas.

(6) Increases in flood insurance rates. Flood insurance rates for alluvial fan areas should be upgraded to more accurately reflect risk. Such upgrading could be based upon preliminary maps where more detailed maps are impractical. Relatively high rates may be appropriate for fans as a whole with the provision that rates will be lowered if the community adopts and implements a master plan reducing flood damages on the fan, or the floodplain occupant designs and constructs buildings consistent with the anticipated velocities, erosion, depths and debris.

Flood insurance for mudflow/mud flood areas should also be upgraded to reflect actual risk based upon existing maps. However, definitional problems pertaining to mudflow/mud flood versus landslide still need to be resolved before any extensive new mapping effort is undertaken for flood insurance purposes. Such broader mapping would, however, be appropriate for land management purposes.

A community rating system that would lower overall flood insurance rates for communities that adopted plans, maps, and regulations exceeding minimum FIA standards for their alluvial fan and mudflow/mud flood areas would also be desirable.

7. Additional problem-oriented research. Additional

"problem-oriented" research is needed to improve mapping methodologies for both alluvial fan and mudflow/mud flood areas, develop performance guidelines for building and other activities, prepare standards and techniques for retrofitting existing structures, improve modelling capabilities to assess the nature of risks and the impacts of development, assist communities in preparing master plans, develop and test mitigation strategies other than planning and regulation (e.g., warning systems, dewatering of potential mudflow areas, debris basins, and land treatment after forest fires.)

A systematic flood insurance and disaster assistance reporting system is also needed to help identify the full magnitude of alluvial fan and mud flood problems and to test the adequacy of management approaches. Such a system should involve more precise identification more precisely of mudflood and alluvial fan losses and the comparison of disaster assistance and flood insurance data. Field studies should be conducted after floods to determine the precise nature and types of losses and the adequacy of mitigation approaches.

- (8) Pilot studies and demonstration projects. Pilot mapping, regulation, and insurance rating studies should be conducted by FEMA in cooperation with other federal agencies (the Corps, the USGS) and the States to test the practicality and feasibility of particular approaches. Such pilot or demonstration projects could also help meet immediate "on the ground" needs if conducted in communities with severe problems such as Clark County, Los Angeles County, Marin and Contra Costa County, and Salt Lake County.

In summary, workshop participants agreed that alluvial fan and mud flood problems in the fast-growing West and Southwestern areas were too serious to delay new management initiatives until all methodological research is completed and detailed maps can be developed. Reasonable additional mitigation actions can and should be under consideration now. Additional problem-oriented research to perfect risk assessment and hazard mitigation methods and techniques should take place simultaneously. FEMA should provide leadership in such efforts but other federal agencies (USGS, the Corps, SCS, TVA) should provide technical assistance and scientific knowhow. Enhanced state and local roles should be encouraged.

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FLOODPLAIN MANAGEMENT AND
UNIQUE HAZARDS IN ARIZONA

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During the past year, Arizona suffered disastrous floods in 13 of her 15 counties. Although only a small portion of the damages (which approach \$1 billion) resulted from failures in floodplain management, these floods pointed out several of the unique hazards we face. Most experienced floodplain managers realize that these hazards are not really "unique"; they simply lie outside the purview of classical floodplain management procedures.

Most of the problems we have with floodplain mapping and management are related to the movement of solid materials during a flood; aggradation, degradation, braided channels, and channel migration. Landslides, mudflows, and other hazards faced elsewhere have not affected urban development in Arizona.

However, the summer flooding of 1983 on the Colorado River pointed out a problem that has not been addressed in Arizona, and one that is not handled by floodplain management under the National Flood Insurance Program rules: damage resulting from flood-related high water table. Except for the delivery of water to downstream users, the Colorado River has been an ephemeral stream below Hoover Dam since 1929. In 1983, Lake Powell filled for the first time, and there were sustained releases below Hoover Dam of about 40,000 cfs. The actual structural damages caused by these releases were generally the result of poor floodplain management but they were minor. The problem which has a far greater impact is that of high groundwater in large areas adjacent to the Colorado River. In areas with levees adequate to contain the 100-year flood, there are many square miles of land that now have groundwater within a few feet of the surface. Because these areas are outside the 100-year floodplain, our enabling statutes for floodplain management do not apply. The Department of Water Resources is discussing with the Arizona Department of Health Services the possibility of regulating such uses as sewage facilities and landfills in these areas on the basis of water quality.

The Colorado River flood had only a peak discharge with a 10-year to 25-year recurrence interval. It was unexpected from the public standpoint because Lake Meade and Lake Powell have provided almost total flood control for the lower Colorado since 1929. However, since 1978, we have experienced 50-year or larger floods on every other major river in Arizona.

On the Salt River through Phoenix, Arizona, the 100-year flood in 1980 was preceded by 25-year and 50-year floods in 1978. This combination of events caused scour which reduced the 100-year flood elevation by as much as two feet and several square miles of densely developed land was not flooded as forecast by the FIRM. The study of the Salt River used the HEC-2 hydraulic model which assumes a fixed bed. A new study by the Corps of Engineers is using HEC-2 with revised topography. It will provide the profiles and maps for floodplain management until the next major flood, after which a new floodplain management standard will have to be established. In using a fixed-bed model for most streams in Arizona, we are not accurately assessing the elevation and areal extent of the event which has a one percent chance of being equalled or exceeded in a given year.

That same series of floods caused deposition of material downstream in the Gila River. A dense stand of salt cedars along the thalweg of the Gila River slowed the floodwater in the 1978 floods, causing deposition of as much as 12 feet. The 1980 flood cut new channels through agricultural land in the floodplain, moving the main channel of the Gila River as much as a mile laterally. A project is underway to remove the salt cedars and put the channel back to its approximate 1978 location.

The October 1983 floods gave us new reason to examine channel migration. Problems had been observed in the 1980 flood on the Agua Fria River where the channel migrated at least 200 feet in the Black Canyon city area. Near Tucson, Arizona, the channels of the Santa Cruz River and Rillito River are sufficiently incised to contain the 100-year flood. In many reaches, the banks are stabilized. However, channel migration caused serious problems for some structures that were not within the delineated 100-year floodplain. Pima County and Tucson have regulations requiring a setback from streambanks, but I am concerned that the courts might say that they exceed their statutory authority where these setbacks are outside the 100-year floodplain.

The October 1983 flood also provided evidence of sheet flooding in areas where there is essentially no channel. Fifty or sixty miles of the Santa Cruz River in Pinal County was flooded to widths as great as eight miles. The U.S. Geological Survey does not even show the location of the Santa Cruz River on its maps because there is no single channel. A building code could easily reduce flood damage in an area like this, but mapping is almost impossible. Any continuous obstruction, such as highways, dense crops, or irrigation canals, causes dramatic changes in the depth and location of a flood of this type. Such obstructions are usually not regulated, and their impact is almost impossible to assess until a major flood occurs.

This problem is not dissimilar to the shallow flooding on the lower portions of alluvial fans and other distributary systems. There are many alluvial fans in the rapidly urbanizing areas of Maricopa and Pima counties. In many of these, the incised and meandering portions of the fans are federal and state land, and only the sheet flow areas are subject to imminent development. This situation also exists in Cochise, Pinal and Yuma counties, although the development pressure is not as great.

Our worst alluvial fan problems are along the Colorado River in La Paz and Mohave counties where many alluvial fans are truncated by the Colorado River. In Mohave County, the Federal Emergency Management

Agency (FEMA), over the objections of the state and the county, mapped alluvial channels as AO Zones with depths up to five feet and velocities of 11 feet per second. AO Zones, according to the FEMA definition, have depths of only one to three feet. Mohave County asked that the entire width of the channels be designated as "floodway", which a community can do in a riverine situation. However, since FEMA had already designated them as AO Zones, they would not map a floodway.

All flood waters in Arizona streams are loaded with sediment. In Clifton, Arizona, the October 1983 flood left four feet of sediment in houses that were flooded with eight feet of water.

An underlying factor that aggravated all of our problems in floodplain management is the rapid rate of development in Arizona. This has three negative aspects. First, our communities' maps are always out of date because of the constant expansion of corporate limits. Second, the flood insurance study process takes so long that by the time a study is completed, new development has gone beyond the areas studied. Third, this development alters the hydrology and hydraulics to such an extent that downstream studies are inaccurate. Our more sophisticated communities require developers to produce studies and minimize the effect of their activities, but many communities do not have the technical capability to review such studies.

Magnitude of Unique Flood Problems in Arizona

<u>Problem</u>	<u>Areal Extent</u>	<u>Number of Structures</u>
Water table	20,000 acres	3,000
Aggradation/ degradation	thousands of miles of channel	hundreds
Channel migration	100 miles of channel	hundreds
Sheet flooding	tens of thousands of acres	thousands
Alluvial fans and distributary systems	thousands of acres	hundreds
Rapid development	thousands of acres per year	thousands per year

(Estimates are within an order of magnitude.)

Special Mapping and Regulation

<u>Problem</u>	<u>Current Solutions</u>
Water table	Drainage wells in most highly impacted areas.
Aggradation/ degradation	New fixed-bed model studies, some structural measures (drop structures, channel clearing).
Channel migration	Local regulations, structural measures.
Sheet flooding	None
Alluvial fans and distributary systems	None
Rapid development	Local regulations on new development in some communities.

Problems with Existing Approaches

The existing studies and maps do not accurately forecast the extent or depth of flooding and flood-related problems, either for present conditions or for the future. Development standards that can be applied by a small community with limited technical capabilities are unavailable. Structural solutions, where applicable, are prohibitively expensive as an alternative to proper land-use planning. Flood insurance maps are usually out of date due to changes in corporate limits, modified runoff characteristics and new development in unmapped areas.

Plans for Strengthened Approaches

Current budget constraints limit the state's ability to implement any innovative or progressive measures. Proposed legislation may enable the Arizona Department of Water Resources to look for innovation in floodplain management and mapping, but lack of funding will almost certainly forestall any real progress. Since these problems are not unique to Arizona, it is difficult to promote a unilateral solution in the face of scarce state resources.

Federal Agency Response

I think it is important to remember how far we have come, and how we got here. In the last 15 years, tremendous progress has been made toward "A Unified Approach to Floodplain Management." According to FEMA, some 8,000 communities have flood insurance rate maps, the only maps which are really useful for floodplain management. Another 2,000 studies are underway. The total expenditures for mapping since 1969 are just over \$600 million. These studies are a terrific national asset. Aside from their use by communities for floodplain management, they provide topographic mapping and hydrology which can be used for a wide range of purposes, such as the design of bridges and other public facilities. However, floodplain management may well be the only discipline that allows no safety factor. We begin with an inadequate data base, apply generalized

stochastic methods to it, run the results through empirically derived models whose parameters we cannot accurately measure, run those results through another model whose basic assumptions are grossly violated and then use the results to regulate to 1/100th of a foot. Just using the upper 95 percent confidence limit on the 100-year quantity of flow would (in Arizona) increase it by 50 percent to 200 percent in most cases.

Recommendations

A major change that is required is a separation of mapping for insurance purposes and mapping for management. Insurance rates must be based on current conditions and current risks. To maintain the same acceptable level of risk in the future, management must consider future conditions.

A renewed mapping effort is needed in Arizona and other rapidly developing states. Arizona's population has increased 70 percent since the flood insurance studies began in 1969, and it is expected to almost double in the next 25 years. If floodplain mapping is not done ahead of this growth, the potential for future damages is great.

Mapping should be produced on a county-wide basis and revised as needed for both floodplain changes and changes in corporate limits of communities. Revisions should be made on a sheet-by-sheet basis as needed.

Finally, an all-out research program is needed to develop methods for forecasting sediment transport and its impacts on floodplain management: aggradation, degradation, channel migration and the behavior of alluvial fans and other distributary systems. The cost of these studies is dwarfed by the potential damage if they are not done.

Despite the weaknesses I have mentioned in Arizona's floodplain management program, we are still far ahead of the national actuarial experience in insured structures. Through 1981, insurance claims in Arizona totalled only 63 percent of the premiums paid. In fact, the total deficit in the National Flood Insurance Program is less than the deficit for three Gulf Coast states. The insurance rate zones where the highest actuarial losses have been experienced are: unnumbered A Zones, where detailed studies were not done; B Zones, where flooding should be shallow and infrequent; C Zones, which are supposed to be free of flooding; D Zones, which have not been studied; and A99 Zones, where structural measures are supposed to provide protection (see Table 1). All of these have a higher loss ratio than numbered A Zones and numbered V Zones. This tells me that the way to an actuarial flood insurance program and reduced damages is through better mapping rather than higher premiums.

TABLE 1

NATIONAL FLOOD INSURANCE PROGRAM
ACTUARIAL EXPERIENCE
JANUARY 1, 1978 - DECEMBER 31, 1981

ZONE	A1 - A30		U1 - U30		UNNUMBERED A	A0	B	C	D	A99	EMERGENCY PROGRAM
	PRE-FIRM	POST-FIRM	PRE-FIRM	POST-FIRM							
<u>\$ LOSS</u>											
\$ PREMIUM	1.45	0.80	1.09	1.61	1.67	0.39	1.89	2.87	1.30	1.18	2.26

NOTE: IN THIS TABLE, 1.00 WOULD BE "ACTUARIALLY SOUND", NOT COUNTING OPERATING EXPENSES.

A VALUE LESS THAN 1.00 INDICATES A PROGRAM "PROFIT", WHILE A VALUE GREATER THAN 1.00 INDICATES A PROGRAM "LOSS".

STATE PERSPECTIVES: SUMMARY REMARKS

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The Western Unique Hazards Workshop was an important event for those concerned about the quality and extent of hazard identification for regional flood conditions throughout the United States. A knowledgeable and dedicated group of individuals gathered to address the unique floods hazards common to the western part of the country, and reached a number of positive conclusions and recommendations.

One prominent conclusion of the workshop was that alluvial fan flooding and sediment transport problems are not "unique hazards" as such, but rather particular types of flooding that are common to every flood event in the west. At present, the identification and regulation of these regional hazards is somewhat overlooked because of their "uniqueness", or rather the fact that they do not relate to the standard national concept of flooding. This is a condition of great concern and one that merits immediate attention.

It was agreed that before any effective mitigation measures can be taken, the hazard must be properly identified. To map and label an alluvial fan as an area with little chance of flooding reflects a perception of the problem that is simply inaccurate. It is regionally known that extensive property damage from flooding will occur, due to recent development trends in the west. Therefore, the area should be mapped accordingly. This is important not only for map credibility and hazard awareness but also from the perspective of proper insurance rating and the goal of actuarial soundness in the insurance program.

At present, when determining priority areas for a detailed flood study, two of the overriding factors are the number of flood insurance policies sold in the area and the number of claims submitted for flood damage. Without these supporting data, a detailed flood study has not been justified. It is clear, however, that without the proper identification of the area in relation to its respective hazard, neither property owners nor lenders will realize the need for flood insurance and, as a result, there will be no policies in force and no claims to submit. While this policy saves federal mapping costs, it does nothing for the property owners who are unprepared for a flood and the disaster assistance burden on the country. The number of claims and policies in force should not be the major factors in determining the need for detailed studies of non-standard riverine and coastal flooding conditions. In those situa-

tion greater emphasis needs to be placed on the potential for loss and the need to prevent future development.

There is a very real need for immediate mapping of the hazard areas—even by approximate methods. Conditions are ideal in a great many western communities to prevent unwise development: high hazard areas there are still uninhabited, but neither are they identified as being flood-prone. This opportunity to implement predevelopment and predisaster mitigation measures should not be lost.

Finally, by the end of the workshop it had become obvious that the only way these regional problems would improve would be for FEMA/FIA to take the lead. As the sole agency capable of changing the way these hazards have been treated, FEMA has the responsibility to listen to the technical experts and to adjust its thinking and programs accordingly. New programs and techniques are needed that emphasize identification and rating of hazards as they actually exist throughout the country rather than overlooking those that do not fit the standard flood mold.

Workshop Discussion

Given the diverse backgrounds of the workshop participants and the number of states and local governments represented, there was a surprising degree of agreement concerning the principal questions posed to participants.

Question 1:

How serious are alluvial fan, mud flood and mudflow problems in the West and Southwest, existing development, and growth potential?

Answer:

Workshop participants agreed that alluvial fan flooding, mudfloods and mudflows are major flooding problems in much of the arid and mountainous areas of Southern California, Utah, Nevada, New Mexico, Arizona, parts of Colorado, parts of Idaho and some areas in Washington State, Wyoming, and Montana. Clear water flooding where depth of inundation was the sole or principal damage factor may be a "unique" hazard in much of this area.

Ben Roberts, Consultant

"A study by the U.S. Army Corps of Engineers Natick Lab identified over 3,800 alluvial fans within a 19,500 square mile area of the Southwestern United States and estimated that over 30% of American Southwest deserts are occupied by alluvial fans."

Jim Slosson, Consultant, Southern California

"The total dollar loss from clear water flooding likely will continue to somewhat exceed mudflow and debris flow losses. However, the loss of life will probably continue to range from 5 to 1 to 10 to 1 greater from mudflows and debris flows."

Estimates of the magnitude of the problems provided by speakers or participants in their presentations and papers include (note this is not an exhaustive list)

Susan Santarcangelo, Flood Insurance Coordinator, Nevada:

"About 75-90% of the developable land in the state is susceptible to alluvial fan flooding of varying severities, depending on the size of the watershed and length of the fan."

Viki Thompson, FEMA Region 9. "Nine out of 10 disaster declarations with which I have worked since 1979 have had alluvial fan or mudflow components".

Dale Peterson, FEMA Region 9. "Traditional (clear water) flooding accounts for less than 10% of this region's flood threat."

Carl Blum, Los Angeles County Flood Control District. "2.6 million individuals live in areas potentially affected by mud hazards in Los Angeles County. In 1978 and 1980 flood disaster damage from mud exceeded \$100 million".

Joseph Flynn, FEMA's General Counsel Office. Development in mud flood areas will create "a later problem of major proportion. There are some communities, such as in the San Francisco Bay area, which are becoming more sophisticated about the availability of mudflow coverage. They are beginning to appreciate that coverage is essentially free."

Les Bond, Flood Insurance Coordinator, Arizona. "Unique flood hazards (not confined to alluvial fan flooding or mud floods) predominate in 13 out of 15 of Arizona's counties.

A number of speakers (e.g., John Tetteimer, Dennis Bechtel, Susan Santarcangelo, Dave Dawdy, Dale Peterson, Jean Brown, and others) emphasized that alluvial fan and mud flood areas were under rapid development in many high-growth areas like Clark County, Nevada; Salt Lake City, Utah; (and other communities along the Wasatch front); Los Angeles County, Marin County, Contra Costa County, San Diego County, Riverside County, San Bernardino County, Santa Barbara County, Monterey and Santa Cruz County and other counties in California, and many counties in Colorado (e.g., Telluride). Les Bond from Arizona suggested that these and other "unique flood hazards" predominated in 13 out of 15 of Arizona's counties. It was suggested that it would only be a matter of time before massive flood insurance claims would be forthcoming as landowners become aware that extremely low cost insurance was available for such areas.

Several speakers (Jim Slosson, Mike Richman) indicated a concern with the legal implications of permitting development in alluvial fan and mudflow areas in light of the inadequate mapping and regulatory standards for such areas and noted that many communities in California were now being sued as a result of flooding in 1978, 1980, 1982 and 1983.

Mike Richman (attorney, Salt Lake) described a recent California Supreme Court decision, Sprecher v Adamson, which

opened the door for potential private landowner and local government liability due to natural flooding or mud flood/mudslide conditions on landowners' land which damages other lands.

Only Carl Cook (Oregon) indicated that alluvial fan or mud flood problems were not a serious problem in his state. He noted that fans occurred in Oregon but little development was occurring on them.

Howard Leiken (FEMA central office) stated that flood insurance data did not indicate severe alluvial fan or mud flood losses. John Gibson (FEMA's mapping program) indicated that both alluvial fan flooding and mudflows and mud floods were a concern but the number of flood insurance losses for such areas was small; that there were continued problems in achieving acceptable mapping criteria and that FIA was faced with other competing needs. However, several participants questioned the low FIA figures on alluvial fan and mudflow/mud flood problems and suggested that alluvial fan and mudflow and mud flood insurance losses were likely much greater than FIA central office believed due to lack of sufficiently specific claims information, that many losses were in fact disaster assistance rather than flood insurance loss and that the real issue was potential future losses due to the high growth in these areas and existing claims.

Several participants suggested that, given the widespread seriousness of alluvial fan and mud flood problems and the high growth potential for these areas, FEMA or other agencies should look carefully at disaster assistance and insurance claim data to determine the magnitude of the problems and should begin gathering such loss data more specifically.

Question 2: How adequate are existing mapping, regulation, insurance and other approaches for managing and reducing losses in such areas?

Answer: There was virtual consensus by speakers and panelists and in the discussion that followed that existing federal mapping, regulatory standard-setting, and insurance rating approaches for such areas were inadequate and, in some instances, misleading, (depending on the circumstances) because the approaches failed to consider:

- . velocity of the water,
- . debris, and
- . erosion and deposition during a flood.

It was noted that, in general, many alluvial fans have been

designated "shallow flooding" areas in FEMA mapping (Dave Dawdy, Dale Peterson) and that such designation does not reflect the severe hazards posed by high velocity and debris laden flows on the fan or sudden changes in channels.

Les Bond, Flood Insurance Coordinator, Arizona. "Most of the problems we have with floodplain mapping and management are related to the movement of solid materials during a flood; aggradation, degradation, braided channels, and channel migration.

In Mojave County, FEMA, over the objections of the state and the county, mapped alluvial channels as AO Zones with depths up to five feet and velocities of 11 feet per second. AO Zones, according to FEMA definition, have depths of only one to three feet. Mojave County asked that the entire width of the channels be designated as "floodway," which a community can do in a riverine situation. However, since FEMA had already designated them as AO Zones they would not map a floodway."

Dale Peterson, FEMA Region 9. "Seventy percent of the region's hazard areas are subject to flow depths of one to four feet...Existing FEMA shallow flooding regulations aggravate flooding and subject greater areas to risk. Existing approaches by FEMA policy makers have resulted in a lack of program credibility within the region because we cannot adjust or tailor our program to meet the specific needs of a community."

Les Bond, Flood Insurance Coordinator, Arizona. "The existing studies and maps do not accurately forecast the extent or depth of flooding and flood-related problems, either for present conditions or for the future."

Carl Blum, Los Angeles County Flood Control District. FEMA mapping does not consider debris or future development "because these two factors are not considered in the standard clear water method, the maps have a somewhat misleading effect on planners and publications in the area. There has been a push to use the federal mapping standards rather than local standards, which take into account future development and debris. This has resulted in nationwide criteria being used as evidence against local standards rather than as support to help communities identify their real hazards.

Mike Richman, Attorney, Salt Lake City. "From my vantage point as an attorney,...I am chagrined by the professional's insistence on exactitude in mapping. For want of exact mapping criteria, projects are being

permitted when common sense dictates limitations be imposed...Reliance on existing mapping known to be inadequate will be no defense when a geologically hazardous project subsequently fails. The purpose of planning commissions, building departments and the like, is to protect the public safety. The duty is not dependent upon the specificity of mapping. It is dependent upon facts that are known, or should have been known. It is therefore suggested that reliance upon mapping is misplaced. Mapping is not a substitute for judgement".

Dennis Becketl, County Government, Clark County, Nevada.

"The major problem faced by Clark County (Las Vegas metropolitan area) is the fact that alluvial fan flooding has not been adequately addressed in the National Flood Insurance Program.

"Another major weakness in the program is its failure to consider sediment as a component of the total discharge in evaluating the hydraulics of flooding.

"Other regional differences often are not taken into consideration in floodplain studies. One example is rainfall distribution."

Jerry Olson, FEMA Region 8, observed that a number of alluvial fan areas in Colorado were being restudied due to the inadequacy of the original methodologies.

Several speakers (John Tetteimer, Jerry Olson) suggested that part of the problem was that FEMA mapping, regulatory standards, and insurance rating criteria had been prepared with Eastern and Midwestern problems in mind and that the hydrologic and geologic problems of the arid west were quite different. Some frustration was also expressed that little progress had been made in modifying such criteria to reflect regional needs despite directives from Congress as early as 1969 that mudslide areas be mapped and insured.

A number of speakers raised questions concerning the present flood insurance rating as unrealistically low for alluvial fan and mud flow/mudslide areas:

Jim Slosson, Consultant. "The insurance rates for mudflow and debris flow coverage do not reflect the degree of the hazard and do not encourage mitigation. As currently applied, it is unfair to those attempting to avoid or mitigate and very generous to the derelict."

Les Bond, Flood Insurance Coordinator, Arizona. "The insurance zone rates [in Arizona] where the highest

actuarial losses have been experienced are: outnumbered A Zones, where detailed studies were not done; B Zones, where flooding should be shallow and infrequent; C Zones, which are supposed to be free of flooding; D-Zones which have not been studied; and A99 Zones where structural measures were supposed to provide protection. All of these have a higher loss ratio than numbered A Zones and numbered V Zones."

The reasons for lack of progress suggested by workshop participants included: continued problems with mapping methodologies; failure to develop land management standards, limited budgets; lack of coordination in insurance, land management guidelines and mapping; and a perception that alluvial fans and mudfloods were a low priority problem.

There was also considerable discussion during the workshop of efforts to develop mapping and analytical methods and land use standards exceeding those of FEMA. Some of the innovative efforts and new studies described included:

- (1) FEMA's new alluvial fan mapping methodologies for study contractors.
- (2) A study by Anderson, Nichols, Inc. under contract to FEMA to develop and test alluvial fan mapping methodologies and land management standards for fan areas.
- (3) Studies by the USGS in San Francisco region and Utah to map mudflow, mudslide and other landslide areas and to develop and test mapping methodologies.
- (4) Efforts of Los Angeles County to develop mapping methodology and regulatory standards for alluvial fan and mud flood areas.
- (5) Efforts by Clark County, Nevada and other areas in Nevada to develop a management plan and regulations for alluvial fans.
- (6) The efforts of Salt Lake City, the state of Utah and the USGS to map and develop management guidelines for debris floods, lake flooding, and other hazards along the Wasatch front.
- (7) The efforts of Riverside County, Kern County, Santa Barbara County and San Bernardino County and the cities of Rancho Mirage and Palm Desert in California to map, regulate and otherwise manage alluvial fan and mud flood areas.

Question 3: Given limited budgets at all levels of government, how should states, FEMA or other federal agencies, and communities best improve the effectiveness of management for these areas?

Answer: Workshop participants agreed that the state of knowledge concerning mapping methodologies and regulatory standards for alluvial fan areas had progressed sufficiently to permit considerable improvement over existing approaches.

Suggestions for improving the effectiveness of management offered by speakers and participants included:

- (1) Document successes. Several speakers suggested that success stories in implementing improved maps, regulations and other management approaches should be documented and emphasized.

John Tetterer, Consultant. "Let us accentuate successes rather than glamorize failures."

- (2) Simultaneously address insurance, mapping and regulation. Flood insurance, mapping and regulatory standards should be simultaneously addressed (e.g., Frank Thomas, Bob Hendrix).

- (3) Prepare development standards and guidelines. Improved development standards should be developed and applied by FEMA, states and localities for alluvial fan and mudflood areas.

Jim Slosson, Consultant. "It is...recommended that others follow the lead of the City of Los Angeles and require professional technical reports that address both the problem and the mitigation."

Kenneth Edwards and David Sheldon, Riverside County Flood Control and Water Conservation District. "Establish appropriate building standards for AO (depth) (velocity) zones...Erosion should be recognized as a velocity-induced hazard to development...Velocity should be considered one parameter by which scour and hence scour protection requirements can be established...Guidelines should be developed to address the density of development in AO Zones."

Tim Yeh, U.S. Army Corps of Engineers. "(A) set of design criteria for floodproofing structures that would resist high velocity flow with movable debris loads on alluvium (is needed).

Dale Peterson, FEMA Region 9. "Revise, not rewrite, current floodplain management regulations to incorporate specific standards that address depth, slope, velocity and sediment transport for areas subject to alluvial fan and

sheet flow or shallow flooding."

- (4) Improve Post-Disaster Mitigation. Better post disaster and mitigation guidelines and technique are needed for high risk areas.

Viki Thompson, FEMA Region 9. Additional requisition of high risk areas with funds from FEMA's Section 1362 may be appropriate. States and local governments should better assess hazards and implement mitigation standards and carry out their 406 responsibilities.

- (5) Strengthen mapping criteria. Mapping criteria should be strengthened and study contractors better trained in assessment of special hazards.

Les Bond, Flood Insurance Coordinator, Arizona. "Separate mapping is needed for insurance and mapping for management...Mapping should occur on a county-wide basis."

Tim Yeh, U.S. Army Corps of Engineers. "Reinstate the AF zone classification for the entire fan."

Dennis Bechtel, Clark County, Nevada. "The AF zone should be reinstated. The AF zone should include a floodway designator (in an area of active alluvial flooding) that could enable a community to preclude development from these potentially dangerous areas."

"Mapping should be on a hydrologic unit basis."

John Tetteimer, Consultant. "Alluvial cones, mudflows and sediment-laden streams need to be mapped as Special Flood Hazard Areas requiring special management. Management considerations include radial flow, sensitivity to diversion and collection, erosion and sedimentation. The entire cone or floodplain should be identified for management, based on topographic and geologic evidence of previous flows, not just a limited area based on clear water hydraulics."

Dennis Bechtel, Clark County, Nevada. "Maps generated by hydrologic basis and not by political boundary will facilitate review and ensure that nothing important is missed."

Kenneth Edwards and David Sheldon. "Allow with local concurrence, floodplain mapping consultants to exceed federal mapping standards by using more advanced hydraulic analysis techniques such as moveable bed models that would predict otherwise undetectable stream breakouts and channel migration."

Bob Hendrix, Flood Insurance Coordinator, Nebraska. "The number of claims and policies in force should not be the major factors in determining the need for detailed studies of nonstandard riverine and coastal flooding conditions. In these situations, greater emphasis needs to be placed on the potential for loss and the need to prevent future development...there is a very real need for immediate mapping of the hazard areas--even by approximate methods."

- (6) Undertake preliminary mapping. Preliminary mapping based upon historical or other data should be carried out for alluvial fans and mud flood areas.

Carl Blum, Los Angeles Flood Control District. "Let's start with what we have."

John Tettemer, Consultant. "We cannot wait for refined procedures. Let's get these areas identified, even approximately, and give floodplain managers, local politicians, and developers improved visibility over potentially hazardous areas. We recommend adoption of a pilot program..."

- (7) Revise insurance rates. Flood insurance rates should be revised to more fully reflect risks and encourage sound floodplain management.

John Tettemer, Consultant. "Apply the A-Zone insurance rate over the entire [alluvial] cone."

Joseph Hill, San Diego County. "Provide incentives for good floodplain management by local government through reduced flood insurance rates and support for local floodplain programs."

James Slosson, Consultant. "Equate the insurance rate to the hazard and the mitigation."

Dave Dawdy, Consultant. "The rate structure for flood insurance on alluvial fans should be studied so that it is "actuarial...some serious thinking about how to set actuarial rates in any region is in order. That is where the people are moving, and that is where the development is taking place."

Dale Peterson, FEMA Region 9. "Develop insurance rates that reflect the true risk."

- (8) Better disseminate information. Additional technical assistance on a multiagency basis and dissemination of existing data and information on mapping and management approaches is needed.

Bob MacArther, U.S. Army Corps of Engineers. "A well-organized educational and technology transfer program is greatly needed...A FEMA-sponsored education and training program should consist of: distribution of...a library of video-tapes with support documents and workbooks...[and] follow-up regional workshops to answer questions raised by the tapes and workbooks."

Susan Santarcangelo, Flood Insurance Coordinator, Nevada. "FEMA should provide more technical assistance by sponsoring workshops or classes (taught by experts practicing in the fields) on the technical aspects of regional "unique hazards". This is the perfect opportunity for FEMA to encourage the participation of such other technically oriented agencies as USGS and the Corps of Engineers, as well as persons from the private sector."

- (9) More regional discretion is needed in addressing hazards. FEMA regions should be allowed more discretion in identifying and addressing regional problems and needs.

Susan Santarcangelo, Flood Insurance Coordinator, Nevada. "FEMA should leave more power for dealing with regional problems in the regional office."

- (10) Encourage master planning. FEMA, other agencies and the states should encourage local master planning of alluvial fan and mud flood areas.

Carl Blum, Los Angeles County Flood Control District. "Don't spend money except where a local master plan has been adopted."

John Tetteimer, Consultant. "Require local government to develop a master plan for each alluvial cone, showing the relationship between development and flood flows. The master plan should address development assumptions, erosion and sedimentation, and how the transition from existing conditions to the master plan configuration will be managed...Provide for removal of the Special Flood Hazard designation upon demonstration by local governments that the hazard has been mitigated by the installation of elements of the master plan...Benefits of the NFIP should be dependent on adoption of Master Plan and its management."

- (11) Improve level of expertise. Problems with lack of local expertise could be dealt with better through certification of engineers and geologists (suggested by Mike Richman), improved permit evaluations, use of technical appeals boards (suggested by Jim Slosson),

improved training and education (suggested by many), technical assistance from expert agencies.

Susan Santarcangelo, Flood Insurance Coordinator, Nevada.

"FEMA should not try to be the sole technical advisor. It should identify basic problems it would like to see addressed, then assist communities to find other government agencies with technical capabilities to deal with the problems to allow them to seek outside technical assistance. FEMA should coordinate, not duplicate."

(12) Improved structural approaches are needed. Management approaches other than planning, regulation and insurance should be more fully investigated and utilized in particular circumstances.

Bill Donovan, U.S. Army Corps of Engineers. "Consider the low-cost solution of forming debris retention basins that would capture most of the mud and debris away from the community. Consider construction of concrete chute diversion around developed areas."

(13) Additional research and testing. Additional research and testing of approaches is needed including demonstration projects.

Dave Dawdy, Consultant (referring to mud floods). "Perhaps what is needed is for FEMA to take a limited area outside of Los Angeles County--say the San Gabriels in San Francisco County where mud floods have occurred--and use that area as a test to develop a method that would apply to Los Angeles County as well as the rest of Southern California. That method could then be tested in Utah in some areas just north of Salt Lake City with similar problems."

John Tetterer, Consultant. "Research priorities include:
a. Development of improved engineering design for stabilizers, toe protection, and drop structure;
b. Development of engineering procedures for predicting erosion and mudflow; and
c. Development of standards relating to mudflow behavior."

Les Bond, Flood Insurance Coordinator, Arizona. "(A)n all-out research program is needed to develop methods for forecasting sediment transport and its impacts on floodplain management: aggradation, degradation, channel migration and the behavior of alluvial fans and other distributary systems. The cost of these studies is dwarfed by the potential damage if they are not done."

Carl Blum, Los Angeles County Flood Control District. "A team of experts (FEMA, USGS, Corps of Engineers) needs to be assembled and armed with the best information to develop an acceptable (mud hazard) mapping method as soon as possible."

Although participants agreed on many points, there was disagreement concerning:

- (1) The appropriate future roles for the states, federal government, and local government in improving the effectiveness of management of high risk. All participants agreed that the federal government should not encourage unsound development through unrealistic maps, inadequate regulatory standards or unrealistically low insurance rates. But participants disagreed as to the scope of the federal role. Some favored major new federal mapping and a regulatory standard-setting role. Others suggested that perhaps the federal government had "done all that could be expected of it" and that states and communities should play a larger future role in improving the effectiveness of management. There was agreement that if the federal government was to continue to map, establish regulatory guidelines, and insure such areas, it should do it realistically with appropriate methodologies.
- (2) The adequacy of existing mapping and methodologies and regulatory standards for detailed regulation of such areas, particularly with regard to mudflow and mudflood areas. Continued definitional problems in distinguishing mud floods, mudflows and more traditional mudslides were noted.
- (3) The usefulness of very precise maps identifying hazards on alluvial fans, since human activities affect the hazards greatly and conditions change quickly over time.