

2019 California Floodplain Risk Management Symposium

Results and Recommendations White Paper

Symposium hosted by:

Floodplain Management Association (FMA)

and

Association of State Floodplain Managers (ASFPM)
Foundation

Contents

1. Executive Summary	3
2. Introduction	4
3. Flood Dam Nexus	4
3.1 Public Information Gap.....	5
3.2 Dam Breach Modeling	6
3.3 Public Safety and Communication	6
3.4 Condition of Dams in California.....	7
3.5 Risk Increase as Downstream Areas Develop	7
3.6 Funding.....	8
3.7 Path Forward.....	8
4. Levees.....	8
4.1 Education and Outreach.....	9
4.2 Forecasting and Planning	9
4.3 Operations and Maintenance.....	10
4.4 Path Forward.....	10
5. Post Wildfire Runoff- Flash Flood, Mud and Debris Flow.....	11
5.1 Quantification and Modeling Tools	12
5.2 Communication to the Public.....	13
5.3 Interagency Communication	13
5.4 Tools for Communication	14
5.5 Path Forward.....	14
6. References	14

1. EXECUTIVE SUMMARY

The State of California held a flood risk symposium in April of 2019 at the Governor's Office of Emergency Services (Cal OES) Headquarters in Rancho Cordova. At the event, selected experts convened in an open-discussion, think-tank type environment to explore the program and policy implications of "The Differing California Flood Disasters", including emergency response to levee breaches, flood/alluvial fan/mudflow hazards, and the flood/dam nexus.

The flood/dam nexus breakout session discussed the many dams in California and how a one-size-fits-all approach is not recommended when quantifying, discussing, and presenting the potential safety hazards of the dams. There are over 1,200 jurisdictional dams in California with numerous dam owners. These dams include abandoned gold miners' debris dams, agricultural stock ponds, low-head power generation, water supply, and some of the largest dams in the nation. Every community should have a local hazard mitigation plan that includes the risks posed by dams to their community. Additionally, more funding is needed for dam maintenance and repairs, for inundation mapping, for emergency action plans, for statistical analyses, and for mitigating downstream risk. The breakout group circled back to CRS Activity 630 considering how clear understandable communication of accurate information leads to knowledge and understanding and ultimately to good actions.

Levees provide flood protection to a significant percentage of the population in California, from the levees in the Sacramento and San Joaquin Valleys to levees in the urban areas of Southern California. According to the National Levee Database, there are over 9,000 miles of levees in California (DWR, 2013). From year to year the integrity of the levees is not always put to the test due to variations in seasonal rainfall and drought cycles, but all levees need to be able to perform during a storm event. Unfortunately, most people are not aware they are protected by levees located near their home, work, school, shopping centers, or other public spaces. When examining the issues associated with the levees in California, education and outreach, forecasting and planning, and operations and maintenance are three key areas for improvement. Environmental constraints can often delay or prevent necessary maintenance, compromising public safety. The breakout group discussed how legislation could be considered that requires all property protected by a levee to have flood insurance and to receive annual notification of flood risk. The group decided that 1.) more funding is needed for levee maintenance, 2.) environmental constraints need to be reduced if public safety is at risk due to lack of maintenance on an existing levee, and 3.) further education for property owners is necessary to inform them of the risk of living behind a levee.

Recent, high-intensity fires in various locations across California have been followed by severe erosion and flooding resulting from precipitation over denuded slopes, further resulting in alluvial fan mud and debris flow hazards that have caused loss of life and severe damages to residential structures and infrastructure. In addition, alluvial fan floodplains in urbanized areas are most sensitive to climate change induced increases and post-fire inundation risk. The State is experiencing these events with increasing frequency and is interested in understanding how to more accurately predict the frequency, extent, and volume of mud and debris flow hazards. To reduce the loss of life and property from catastrophic flash flooding, and mud and debris flows, we need to: gauge and monitor watersheds to improve our understanding of post-fire hydrology and debris generation; improve and implement mud and debris flow inundation modeling tools on alluvial fan areas subject to the fire

and flood sequence; and develop communication plans that define risk scenarios with attendant public messaging for emergency response planning.

2. INTRODUCTION

The State of California was selected by the Association of State Floodplain Managers (ASFPM) Foundation to hold a Flood Risk Management symposium. The symposium was held in April 2019 at the Governor's Office of Emergency Services (Cal OES) Headquarters in Rancho Cordova. This event was hosted by the Floodplain Management Association (FMA) and the ASFPM Foundation. The location of ASFPM Foundation's annual symposium is competitive; this was the first one in California. The intent of the one-day symposium was to delve deeper into key topics found at FMA's conferences and document the symposium discussion in a white paper. Selected experts convened in an open-discussion, think-tank type environment to explore the program and policy implications of "The Differing California Flood Disasters", including emergency response to levee breaches, flood/alluvial fan/mudflow hazards, and the flood/dam nexus. The objective of the symposium was to identify solutions to reduce flood damages across California.

This idea of state/chapter Flood Risk Management symposia is a follow-on from the ASFPM Foundation's national Flood Risk Symposia and Forum, where 100 national and international experts and leaders convened over the span of a decade through a series of three events: Symposium 1 on September 16, 2004, addressed "Defining and Measuring Flood Risk and Floodplain Resources;" Symposium 2 on November 4, 2009, explored "Flood Risk Perception, Communication, and Behavior;" and the 3rd Gilbert F. White Forum which was held in March 2010 at George Washington University. The Gilbert F. White Forum facilitated discussion on the topic of flood risk to establish priorities for improving policy and program implementation and to formulate recommendations and directions for the future.

Based on the success of the national forum in 2011, the ASFPM Foundation began promoting similar meetings at the state level. The goal of the state/chapter level program is to develop meaningful indicators to measure progress in flood risk management. These symposia are co-hosted by the ASFPM Foundation and the state chapters. These symposia are designed to focus on flood risk management issues at the state level. With the guidance of ASFPM Foundation trustees, the host chapter chooses the topic of focus for the symposium and develops the list of invitees. The symposia provide a venue for productive discussions and relationship building. They emphasize developing proposed action items on quantitative and qualitative measurements to assess progress in flood risk management at the community level.

Notes from the breakout sessions at the California Symposium discussing "The Differing California Flood Disasters" were used to develop this white paper. The purpose of this white paper is to use the Symposium flood risk discussion to shape future flood management in California.

3. FLOOD/DAM NEXUS

There are over 1,200 jurisdictional dams in California with numerous dam owners. These dams include abandoned gold miners' debris dams, agricultural stock ponds, low-head power generating, water supply, and some of the largest dams in the nation. Every community should have a local hazard mitigation plan that includes the risks posed by dams to their community. Most large dams

are in satisfactory condition but with the spillway failure at Oroville Dam, there is an elevated concern about the risk dams can pose to downstream communities.

Topics discussed included the public information gap related to dam risk, dam breach modeling requirements, public safety and communication, condition of dams in California, dam risk as downstream areas develop, funding, and Activity 630 credit for CRS communities.

There is a lack of funding for the maintenance and improvement of the aging dams in California. The risk dams may pose to the downstream community increases as development is allowed. The local floodplain manager often knows little about the risks dams pose to his/her community. Merely outreaching the 100-year floodplain maps and the sunny-day dam failure inundation maps for dams and critical appurtenant structures leaves out many hazard scenarios related to the dam. Public information improves the filling of data gaps.

3.1 Public Information Gap

The public and local governments can make better decisions when armed with better information.

After the spillway failure at Oroville Dam in February 2017, dams in California were in the state and national spotlight. Infrastructure in the state's backyard was higher priority in the state legislature and in the general public's minds. Before the Oroville Dam incident, people would enjoy the reservoir but likely give little or no thought to the dam.

The state of California emergency regulations required that jurisdictional dams¹ in California develop inundation maps for sunny day failure of dams and their critical appurtenant structures. In addition to the inundation maps, jurisdictional dam owners are required to develop an emergency action plan (EAP) approved by California Governor's Office of Emergency Services (Cal OES). These regulations were enacted as a response to the spillway failure at Oroville Dam. During the EAP development process, dam owners are encouraged to consider outreaching to the public downstream of their dam. They partner with local public safety agencies to protect life and property in the event of an incident at the dam.

Local floodplain managers use flood insurance rate maps to determine their community's flood risk. These flood insurance rate maps display the 1 percent annual recurrence flood hazard and may even show the 0.5 percent and 0.2 percent recurrence intervals flood hazards. Risk is a relationship between the extent of damage a hazard might cause and the probability of it happening. These regulatory floodplain maps typically contain little or no information on flood risks posed by dams. Local floodplain managers now have the opportunity to partner with dam owners to better understand the flood risk posed by dams and provide flood risk information to the community.

In Activity 630, the Community Rating System encourages outreach regarding dam safety. This is an opportunity for the local jurisdiction to educate the public on the beneficial function and risk posed by dams.

¹ Jurisdictional dams are dams that are under the regulatory powers of the State of California, as defined in Sections 6002 and 6003 of the California Water Code.

3.2 Dam Breach Modeling

Senate Bill 92 added Sections 6160 and 6161 to the Water Code that became effective on June 27, 2017, requiring owners of State regulated dams, except those classified as low hazard, to prepare emergency action plans (EAPs) containing inundation maps for emergency preparedness. Section 6161(a)(1) requires owners of a state jurisdictional dam to electronically submit inundation maps that show the area that would be subject to flooding under failure scenarios unique to the dam and the critical appurtenant structures of the dam to the Division of Safety of Dams. Final DWR Inundation Mapping Regulations, Title 23 of California Code of Regulations §335 are effective July 18, 2018.

Existing Federal floodplain mapping standards include FEMA requiring 100-year (1 percent annual recurrence) flood maps and FERC requiring dam inundation maps for sunny day failure and probable maximum flood (PMF). Floodplain managers can partner with dam owners to quantify the risks posed by their dams. For floodplain managers to better understand the impacts of dam failure, dam modeling efforts could be coupled with FEMA flood maps.

Additional modeling can be done for infrastructure at the dam including but not limited to principal spillways, emergency spillways, and outlet structures. There are dams with oversized spillways, which have the ability to reduce the reservoir depth quickly, though possibly overwhelming the downstream river capacity. In this case, the chance of dam failure is very unlikely. The outreach efforts, to the public, the local floodplain manager and the local land use decision makers should be based on realistic concerns.

3.3 Public Safety and Communication

On the local level, floodplain managers have the opportunity to participate in communicating public safety risk posed by dams. Releasing dam inundation maps without clear risk communication could lead to an unintended level of public concern. Impacts from dam failure can be communicated for both California jurisdictional dams and federal dams without compromising the dam's security. Once floodplain managers understand the risks posed by dams on their communities, they can communicate to the public. City and county departments can make educated land planning decisions based on dams upstream of their communities. Locals can consider a brochure about living below a dam, describe where the dam is, what it does, how it works, flood safety and flood protection that is geared toward CRS Activity 630 credit.

There are opportunities to incorporate natural disaster safety into school curriculum. This curriculum could include flood control and the function of a dam and reservoir. Local floodplain managers can reach out to schools to educate students who will hopefully educate their parents after returning home from school regarding dam safety topics.

On the state level, California is developing a 'My Hazard' website (flood, fire, earthquake, tsunami, and volcano). It will include dam inundation zones except they will not be allowed to include federal facilities. Approved inundation maps can be found on the following website: https://fmds.water.ca.gov/webgis/?appid=dam_prototype_v2. California Dept of Water Resources has regional flood preparedness events and pre-flood season coordination meetings with agencies. It has media day, high water mark events, coordinated resources, and social media. This could all tie

into existing efforts and programs working with local agencies. California implemented Flood Preparedness Week. This week is an opportunity to remind the public and the elected local governing bodies of the risk of flooding. Dam safety could be added to the public outreach efforts or separately on national dam safety day, May 31. Watershed University, a webinar-based project sponsored by CA DWR, could be used to include local community officials in the conversation regarding the risks dams pose to communities. DWR can partner with federal agencies to provide public outreach related to dam safety as a Silver Jackets activity.

3.4 Condition of Dams in California

'What if it takes \$2.5 billion to improve California's existing dams? Wouldn't that be a worthwhile public investment?' Dam owners are squeezed for money now there are increased Division of Safety of Dams fees, and the owners are required to develop inundation maps and emergency action plans. Dam owners have limited funds available for repair and maintenance of facilities. Downstream development has added pressure on dam operators to maintain their facilities to ensure public safety.

Infrastructure is aging in California and across the United States of America. Like other infrastructure, dams have a design life. Dam owners need to consider when it would make sense to rebuild existing dams. Continual maintenance is essential for the continued use of the dams in California. 1111On the federal level, federal dam safety information can be saved to local emergency management agencies to add in their efforts to ensure public safety.

3.5 Risk Increase as Downstream Areas Develop

The California real estate transfer disclosure requires a seller disclose to a buyer if they are within the dam risk inundation area. However, local jurisdictions are not required to consider flooding that is less likely than 1 percent annual recurrence (0.5 percent in the Central Valley). Local jurisdictions have opportunities to consider flood risk from dams when they make land use decisions downstream of existing dams.

Other states have requirements related to downstream dam risk. Wisconsin² has hydraulic shadow³ downstream of dam. This requires the analysis of the dam in place and functional, the dam non-existent, and the dam in place but failing. Colorado requires inundation maps be filed with counties and development projects are circulated to the state dam safety agency.

In California, sunny day dam inundation mapping is available for planning decisions, but not understanding the probabilities makes it difficult for a land use planner to use this information. There could be clear development standards when it comes to dam flood safety. A state lead effort could help better manage local governments concern. Dam safety discussions and inundation maps

² <https://dnr.wi.gov/topic/dams/documentsDFA.html>

³ The hydraulic shadow is defined as the inundation area or the extent of the dam failure floodplain for the dam if it was to fail.

can be included in a community's hazard mitigation plan and floodplain management plan. Communities can make general plan decisions related to risks posed to their community by dams. With additional information regarding the impacts of high flows and imminent failure scenarios, communities can better plan downstream development, in addition to emergency response.

3.6 Funding

More funding is needed for dam maintenance and repairs, for inundation mapping, for emergency action plans, for statistical analyses, and for mitigating downstream risk. Federally, FEMA is launching a \$10 million dam rehabilitation grant program. This is a pilot program with 35 percent non-federal cost share. FEMA could expand their mitigation grant program to allow funding for flood control improvements including dams and levees on smaller watersheds. In California, as well as in other states, funding is limited. The Division of Safety of Dams exists on fees from dam owners but does not provide funding for dam owners to perform inundation studies, draft EAPs, or maintain their facilities. However, there are bonds issued for revolving loan funds to dam operators. New development downstream could help finance needed dam improvements if they are in the best interest of downstream communities as a condition of entitlement. California Silver Jackets⁴ could add dam safety and analysis activities. The US Army Corps of Engineers could offer evacuation planning assistance, risk assessment, inundation mapping. State and Federal programs could provide additional assistance to low income communities.

3.7 Path Forward

There are many dams in California and a one-size fits all approach is not herein recommended. The group circled back to CRS Activity 630 considering how clear understandable communication of accurate information leads to knowledge and understanding and ultimately to good actions.

4. LEVEES

Levees provide flood protection to a significant percentage of the population in California, from the levees in the Sacramento and San Joaquin Valleys to levees in the urban areas of Southern California. According to the National Levee Database, there are over 9,000 miles of levees in California (DWR, 2013). From year to year the integrity of the levees is not always put to the test due to variations in seasonal rainfall and drought cycles, but all levees need to be able to perform during a storm event. Recent large magnitude floods around the nation have caused severe flooding and a renewed response for levee breaches during these catastrophic events. These events have typically occurred in the South and Midwest, where they have long lead times before the high-water event. In California the floods tend to be "flashier" where there is often little to no lead time before the event. The national events raise awareness for a short time but focus fades as time passes and other issues dominate the media. Unfortunately, most people are not aware they are protected by levees located near their home, work, school, shopping centers, or other public spaces. When examining the issues associated with the levees in California, education and outreach, forecasting and planning, and operations and maintenance are three key areas for improvement.

⁴ The Silver Jackets are a team that brings together multiple state, federal, and sometimes tribal and local agencies to learn from one another and apply their knowledge to reduce the risk of dam failure and enhance response and recovery efforts when such events do occur.

4.1 Education and Outreach

As with all potential public safety issues, the first step in dealing with flood risk is outreach. Outreach is always easier after a major event, like Hurricane Katrina, and outreach efforts need to take advantage of these large events that capture the attention of the general public and elected officials. The general public is often not well informed of their actual flood risk. Current legislation requires Title Reports for properties to specify if they are in a Special Flood Hazard Area (SFHA) or dam inundation area, however, this does not address all property owners. Legislation could be considered that requires all property protected by a levee to have flood insurance and to receive annual notification of flood risk. Outreach should use language that is better understood by the general public. The term "levee" means more to the average homeowner than the term "SFHA". Additionally, as a property behind a levee might be more at risk than a property in a SFHA, all factors contributing to flood risk should be communicated.

Unfortunately, the public is either unaware, or assumes the government, engineers, and developers have taken care of flood risk, but this is not always the case. Often identifying the flood zone is just a checkmark on the building permit and new developments in outdated flood zones or areas adjacent to levees can easily obtain building permits. In relation to levees and flood risk areas if land use is considered when master planning, the risk can be reduced by appropriate land use management. Coordination meetings can be better structured to get all the right parties in the same room to ensure development decisions include planning for flood risk. California Water Code Sections 9140 & 9141 were added by the adoption of Assembly Bill (AB) 156 that requires local levee maintaining agencies to submit annual reports to the State of California Department of Water Resources (DWR) and the Central Valley Flood Protection Board, summarizing the levees they maintain (CWC, 2013). Perhaps making portions of these reports (the sections that do not compromise security) or a general summary of the report public would inform the public of risks associated with their properties.

4.2 Forecasting and Planning

With more robust forecasting and planning, upstream watersheds flowing into levee systems can be monitored to better inform decisions to operate reservoirs to reduce stress (and, therefore, risk) on the leveed systems. DWR is currently managing flood impacts by implementing system-wide improvements, developing better tools for river stage and flow forecasting, and managing emergency response grants for local agencies. Through these actions, the key decision makers are better equipped to make decisions prior to and during a flood event. With longer forecasts and flood-based forecast operations, downstream communities have greater insight into future high-water elevations so they can plan appropriately. In a real flood event, having a prepared decision matrix can help for evacuation planning when decisions are being made. Local agencies are using DWR grants to develop emergency response plans (similar to those for dams) that can incorporate a matrix for decisions based on predefined triggers. The appropriate public agencies (including emergency response) need to be educated and trained on implementing these plans.

Decision criteria development needs to occur before a flood event with a plan and process in place to support the difficult decisions, not only understanding the probability from the rating curves and hydraulic models, but the physical conditions of the waterways.

4.3 Operations and Maintenance

The operation and maintenance of a levee system is crucial to its performance in a flood event. When levee systems are designed and constructed, the initial construction cost is considered, but maintenance costs are often underfunded over time. New construction projects need to consider long-term maintenance and how it will be funded and implemented to ensure public safety during the life of the project.

Animal burrows and encroachments (such as access stairs, structures on the levee toe, and drainage pipe/water supply pipe penetrations) can undermine the assumed structural performance of a levee, with a large percentage of levees in California having either an animal burrow or a penetration. Unfortunately, there is a lack of funding for inspections and actions to deal with encroachments and animal burrows. The Central Valley Flood Protection Board adopted a 2017 update to the Central Valley Flood Protection Plan documenting that the underfunding of State levee and floodway O&M and Levee Maintaining Agency assessments can only be raised with a vote of a majority of the property owners as required by Proposition 218. As mentioned earlier, the public often is uninformed of flood risk and therefore may not elect to vote for a tax, or, they have the expectation that the State should pay for the maintenance. With insufficient funding, maintenance is being deferred which only increases the cost. Local maintaining agencies do not have maintenance funds and definitely do not have funding or the clout to lobby the State legislature for maintenance funds. Additionally, an increase in human activity and illegal camping along levees has increased maintenance costs.

The cost of flood management O&M has also been exacerbated by environmental laws and regulations that have been implemented without providing corresponding increases in funding to comply with these laws or regulations, leading to a back log in deferred maintenance. In addition, the floodplain is often critical habitat for endangered species. For example, the presence of habitat for the giant garter snake and the valley longhorn elderberry beetle can delay and/or stop levee maintenance projects, or make them cost prohibitive. Even if the species is not present, environmental regulations state that their natural habitat needs to be protected. The permitting process for making levee repairs when habitat is present are onerous and can delay maintenance actions until the next flood season. If the maintenance actions are delayed and there is a large flood event, the public is at risk due to the delay. There needs to be a balance between public safety and environmental constraints. An effort needs to be made to reduce and/or expedite permitting requirements for public safety projects. If California Environmental Quality Act (CEQA) exemptions can be granted for sports arenas, the same exemptions should be granted when the public is at catastrophic risk due to levee deficiencies or deferred maintenance.

4.4 Path Forward

To reduce the loss of life and property damage from a catastrophic flooding disaster when a levee is present, we need to take the following actions:

- Further educate the general public by notifying property owners and residents that are behind a levee and making annual reports on the levees more readily available to the public.
- Provide more funding for levee maintenance.

- Reduce environmental constraints if public safety is at risk due to lack of maintenance on an existing levee.

5. POST WILDFIRE RUNOFF- FLASH FLOOD, MUD AND DEBRIS FLOW

Recent, high-intensity fires in various locations across California have been followed by severe erosion and flooding resulting from precipitation over denuded slopes, further resulting in alluvial fan mud and debris flow hazards that have caused loss of life and severe damages to residential structures and infrastructure. In addition, alluvial fan floodplains in urbanized areas are most sensitive to climate change induced increases and post-fire inundation risk. The California's Statewide Hazard Mitigation Plan (CalOES, 2018) indicates that, "As climate change affects the length of the wildfire season, it is possible that a higher frequency of large fires may occur into late fall, when conditions remain dry, and then be followed immediately by intense rains early in the winter, as occurred with the Thomas Fire in December 2017 and subsequent Montecito and Carpinteria debris flows in January 2018." The SHMP also identifies critical life-safety information gaps in the State's hazard mitigation efforts, concluding that, "there has been no state program to evaluate or map the types of landslides that cause the most casualties...."

The State is experiencing these events with increasing frequency and is interested in understanding how to more accurately predict the frequency, extent, and volume of mud and debris flow hazards.

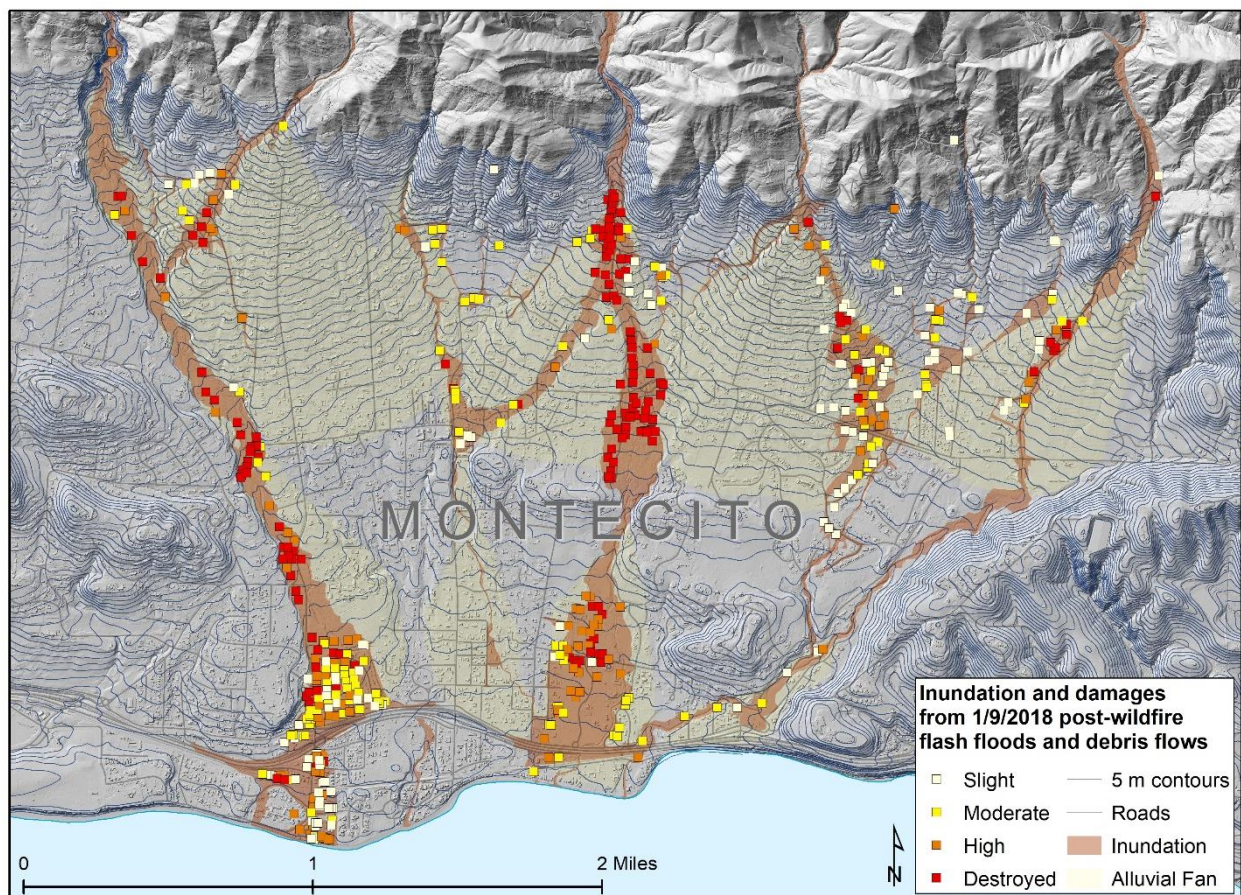


Figure 1. Inundation and damages from post-wildfire flash floods and debris flow

This information can then be used by local floodplain managers and emergency managers to effectively communicate with communities at risk during such events, and to develop mitigation measures that will reduce the impacts of mud and debris flows following fire in the future.

5.1 Quantification and Modeling Tools

Our understanding of the post-fire mud and debris flow hazards would benefit from improvements to rainfall monitoring in burn areas, evaluations of sediment erosion from hillslopes and channels, volume estimation of entrained debris at the fan apex, and inundation modeling. Sediment evaluation tools are limited, ranging from local empirical models, used to develop sediment bulking factors such as those developed by the U.S. Army Corps of Engineers and by the counties of Los Angeles and Ventura, to hillslope post-fire sedimentation models such as the Watershed Erosion Prediction Project and the Erosion Risk Management Information Tool developed by the U.S. Department of Agriculture. Debris flow hazard empirical models developed by the U.S. Geological Survey (USGS) provide reasonable estimates, but the models are based on historic records from southern California and therefore do not account for differing climatic and geologic regimes in other parts of the state. Additional data acquisition and study are needed to improve or develop these models for other parts of California. The estimation of rainfall intensity that triggers flash floods, and mud and debris flows, would be improved with the use of additional rain gages in burned watersheds. Such data coupled with additional in-channel gages would help define the timing between peak rainfall and flash flooding, and mud and debris flow peaks, as well as present data that may be used to estimate bulking factors.

Inundation modeling may be used to predict the probable runout paths of debris flows from mountain catchments onto urbanized alluvial fans. Several two-dimensional models are available to model flash floods and debris flows. However, these models are computationally intensive, require parameters that are difficult to constrain, require lead-time prior to incoming storms, and can be costly to purchase. Inundation modeling would be improved by further refining parameters of viscosity, sediment transport mechanisms, velocity, and volume from data collected in recent events.

Beyond the need for increased documentation of field observations to improve debris flow modeling, another important constraint for a practitioner is the time necessary to run models and complete an evaluation. In some cases, there may not be time to perform modeling or a rapid geomorphic assessment immediately after a fire; this situation necessitates inundation modeling prior to fires occurring.



Figure 1. Scarred hillsides from recent wildfire

5.2 *Communication to the Public*

Proper communication about debris flow danger to the public requires a defined criteria for analyzing levels of potential damage and risk. These defined criteria are also needed to explain unacceptable types of damage to floodplain managers.

When communicating information about a high-risk event to the public, there are barriers of understanding. For example, it has been seen that the public responds better to inundation mapping rather than a statement predicting “15 feet of flooding.”

It is possible that the public may respond to a comparison of the upcoming event to a well-known historical event, a well-documented observed storm, or a storm of defined frequency. It would be useful to define a wide array of historical events and associated damages for public messaging.

With high-risk events, it is necessary to be clearer about evacuations. Information about where a safe location is, how to get to safety, and what to expect during an event needs to be easily understandable and delivered through a widely understood messaging standard. Studies have shown that the public needs three sources of information to be convinced of hazards; therefore it is necessary for agencies to partner together to provide parallel messages using consistent language. FEMA’s “Turn around, don’t drown” campaign could easily serve as a model for a defined communication criteria.

Concerning debris flows, it is necessary to educate the public about imminent risk versus a probability of eventual risk. Different communication methods could be used to segregate risk categories by flow type. Long-term mitigation goals and short-term emergency goals must be separated by terminology to prevent confusion when communicating about hazards.

5.3 *Interagency Communication*

Hazard maps that translate between agencies are essential when communicating risk about debris flow events. When creating hazard maps, it is necessary to consider how politics and the community

come into play; for example, hazard risk could affect local building codes. Local governments have limited influence on mapping hazard areas and believe that local decision makers may be more accepting if they are provided with mapping from a state or federal source. Local adoption could be increased through enactment of a state model ordinance.

When it comes to complicated issues such as preventing construction in floodplains and other high-hazard areas, support by the community is essential. Local communities are much more receptive to these necessary regulations when a damaging event has recently occurred.

5.4 Tools for Communication

The public and government workers at all agencies would benefit from a compilation of educational resources, such as an information management system that can be shared between federal, state, and local levels as part of an emergency management toolkit. Products with staying power improve communication with the public. A playbook of scenarios for flash floods and flows based on different burn scenarios could also be distributed. The Central Valley Flood Protection Board, Water Commission, Delta Protection Commission, and other entities conduct regular public meetings that can disseminate information which can be used as a start for an information management system. Finally, making a cache of videos for educational purposes readily available increases the effectiveness of hazard-risk communication. Videos demonstrating a debris flow and what to expect in hazard areas during potential events could easily convey necessary information to those facing impending hazard conditions.

5.5 Path Forward

The State is experiencing extreme rainfall in fire scarred areas with increasing frequency, as scarred areas increase. To reduce the loss of life and property from catastrophic flash flooding, and mud and debris flows, we need to take the following actions:

- Gauge and monitor watersheds to improve our understanding of post-fire hydrology and debris generation
- Improve and implement mud and debris flow inundation modeling tools on alluvial fan areas subject to the fire and flood sequence
- Develop consistent products across county boundaries of scenario-based hazard and risk products using common methods and terms
- Develop communication plans that define risk scenarios with attendant public messaging for emergency response planning

6. REFERENCES

(CWC, 2013). https://water.ca.gov/LegacyFiles/floodmgmt/docs/Local_Agency_Factsheet_2011.pdf

(DWR, 2013). https://water.ca.gov/LegacyFiles/sfmp/resources/California_Flood_Future.pdf

(CalOES, 2018). <https://www.caloes.ca.gov/cal-oes-divisions/hazard-mitigation/hazard-mitigation-planning/state-hazard-mitigation-plan>

Silver Jackets Videos:

<https://www.youtube.com/watch?v=kcs8rmK7a8c>

<https://vimeo.com/188360924>

Montecito Video: <https://www.youtube.com/watch?v=hNA3Z2y2kSI>

USGS Debris Flow Video: <https://www.youtube.com/watch?v=8mKC3eID074>