Post-Fire Science Needs Symposium
May 19, 2020

Science Needs Panel

Cara Farr		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	We need to increase engagement with social scientists so we can effectively communicate with the public pre-fire, about post-fire risks. Better technology and a formulated approach to sharing post-fire science data is crucial to supporting cross-boundry work. We also need to refine soil burn severity mapping; looking at the impacts of reburns and ecological processes on soil post-fire.
	How can the research community share information with practitioners? Do you struggle with looking at research and finding too many answers?	Any forum (like the webinar) that allows for researchers and practioners to communicate, connecting the science and needs on-the-ground is useful. There is a great availability of information out there, but the approachability of that information, as well as determining if approaches recomended are appropriate, is challenging. These forms of open discussion and building communications for the applicaiton of research is needed.
	Of all your post-fire science needs, where do you feel the most comfortable?	We have a good understanding of the effectiveness of standard post-fire risk mitigtion treaments within the perspective of federal land management; we know what treatments to implement quickly, reducing risk, but also understand there isn't much that can be done to prevent debris flow events.
Don Lindsay		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	The scale and magnitude of debris flows are difficult to predict and comprehend and inondation limits can be mischaracterised. Crossing structures need to be designed to accommodate debris flow, and structured to avoid diversion and excessive scour. The biggest issues in understanding how to create accommodating structures boils down to a better understanding and prediction of runoff depth, density of flows, velocity, size range of material, and total volumn of flow.
Stephen Brown		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	The biggest concern is multi-year risk mitigation; understanding how watersheds evolve over the course of each year after the fire. Monitoring precipitation intensitity. There is a lack of resources such as rain gages within watersheds. We do not have an understanding of how downstream risks vary based of effects of the wildfire upstream over time. Because of this, it is unsure what stuctures need to be prioritzed for funding (i.e. accumulation of post-fire debris flowing downstream over time effecting levees). There just isn't a clear risk assessment.
	How can the research community share information with practitioners?	Apply actionable intelligence to the research as research goes on to refine models and collection of data.

	Of all your post-fire science needs, where do you feel the most comfortable?	Everyone in this field understands the risk, what we need to do and the direction that needs to be taken, it's just a matter of bringing everyone together to determine who and how.
Rich Schwab		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	We need to have leadership, policies, programs and BAER team members with sound science based backgrounds in order to make informed decsions. We need to do a better job of delivering the science to BAER team members in the field. We need to have a deep understanding of treatment effectivesness; we need science based decision support tools and decision trees to inform those treatments.
Katherine Rowden		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	The fires or portion of fires not assessed by BAER teams (due to many factors) is the biggest worry. We need tools and science to bridge the gap between the time of no information when the landscape is changed to when we have the assesment and models from BAER and other sources (if it comes depending on the fire). There is the continued need of pre-fire assessment information (i.e. GIS mapping exercise with terrain, alluvial fans, or location of homes and infrastructure in relation to stream channels). We need better rainfall detection and science in detecting rainfall thresholds that cause debris flow. What's the difference between a nuisance event and catastrophic event? We need advancements in how we predict events in a burn scar to we can adjust public warnings a necessary; every scar is different. And social science is also a huge need. We need to think about monitoring and collecting data from areas that have not yet burned, but will in the future.
	For Katherine Rowden: How often does flash flood guidance change after fires burn?	Ideally, guidance would change every year as the science dictated, based on how the landscape was recovering over time. But currently, in most cases, guidance is adjusted after a fire based on best professional judgement and/or after storms hit it and we see how it responds. More science is definitely needed in this area so that we aren't waiting for an event to happen to determine whether the rainfall threshold is too low or high.
Dave Callery		

	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	Who should the USFS BAER teams turn to with issues beyond the control of the USFS? Though we have seen areas of outstanding coordination among local communities, this is probably the greatest need. The USFS can only do so much. Leadership in post-fire, cross-boundary action and coordination within local communities is needed. Models and equations are best used to estimate relative change between pre and post-fire conditions verses providing reliable flow value probabilities. Also, most models do not include eslimates of low volume bulk by sediment and debris. There is a lack of accurate precipitation data in large parts of the county; lack of case studies on runoff events and the precipitation events triggering them. We need to allow experienced, post-fire specialists to be on-the-ground, making sure prediction models make sense.
	How can the research community share information with practitioners?	Research plans should be carried out with more consideration and input from practitioners, on-the-ground, through every phase of the project.
	Dave - Do you find annual recurrence interval rainfall info helpful, or does it matter?	Dave: Most Forest Service, DOI and BAER hydrologists use this information. Unfortunately, it is reported in increments that are longer than the events triggering runoff, which is a problem. The NOAA atlas provides equations for each region of the country to scale down return intervals to shorter duration events, but these are not overly reliable. The USGS is looking into maching learning in regards to modeling streamflow and it seems likely that could be transferable to post-fire.
		Recurrence interval rainfall information is often used in post-fire runoff prediction. The modeler is typically interested in knowing the magnitude of change between pre-fire and post-fire runoff for a range of rain events. Knowing the probability of a given rain event will assist post-fire planners in determining the level of risk of damage or loss for a critical value. In some parts of the West, the most common type of storm to cause a damaging post-fire flood or debris flow is a short-duration, high-intensity summer thunderstorm. Recurrence intervals for short-duration storms (e.g. 15-minute) is not as widely available as longer-duration events (e.g. 1-hour or 24-hour). Having more accurate storm probability information at a range of temporal scales will improve our ability to predict runoff response.
Jeremy Lancaster		
	Thinking about post-fire hazards: Where do you feel "blind" and it scares you?	There needs to be a greater understanding of the general distribution of alluvial fans and their relative state of activity. In a changing climate, we can do better than rely on FEMA's flood insurance rate mapping as the sole source of hazard delination.
	How can the research community share information with practitioners?	Researchers and practitioners need more engagement, methods of sharing information, and face-to-face interaction (i.e. research workshops or presentations).

	Do you struggle with looking at research and finding too many answers?	From research, I would like to see tools that become relational with long lasting support.
	Of all your post-fire science needs, where do you feel the most comfortable?	I feel comfortable with how USFS scientists and teams have been leading the way in helping us to understand burn area hydrology and hillside erosion.
	Jeremy- do all States is use same method to map alluvial fans?	The simple answer is no. Many states implement FEMA maps at the community level, but those maps only address regulatory floodplains where there is community participation in the NFIP. For the other ~95% of the fans that are unmapped by FEMA, a multitude of mapping methods are used. At the basic level, some might map a simple polygon to represent the fan landform. The problem with this simple level of detail is that the hazard is not equal throughout that polygon. Others use geomorphology or two-dimensional models to differentiate hazard areas. California is beginning an effort to map all fans using published methods developed in other western states with the ultimate goal of having consistent coverage using a standardized approach and attribution. These maps will help with hazard communication and evacuation planning.
	Jeremy - how is the work on the post fire tool kit in CA addressing science needs identified? Is the task force working on the right things?	The CA Silver Jackets flood after fire toolkit was developed to address three basic phases related to wildfire response to flooding and debris flow. These are pre-fire planning and training, event emergency response, and post-event modeling and local agency support. The document provides a host of tools that might be used in each phase and will be useful in training and implementation. The greatest value in my mind is that the toolkit communicates a framework that has existed among local, state, and federal partners, but that has never been documented. There is great value in using this when working with local agencies affected by their first fire in decades, as they may be unaware of an established process to help them with recovery. The tool kit lays out a nice foundation to raise their awareness.
	Jeremy and Don - are you seeing communities being more willing to stand-by CGS recommendations on post-fire risk/evacuations/re-occupation of impacted areas in the post-Thomas Fire world?	DON: In general, it is my experience that most local emergency response managers have an elevated awareness, respect, and concern regarding potential post-fire impacts following the 1-9-18 debris-flows that emanated from the Thomas Fire and impacted downstream communities, killing 23 people in Montecito. Thus, I do believe emergency response managers, are more aware of potential hazards, pay closer attention to the information provided, and are more receptive to implementing mitigations after the Thomas fire. This was also true for flood control and OEM in Riverside County after the Holy Fire in 2018.
Don and Stephen		

	Both Don and Stephen alluded to sizing structures for post-fire conditions, has consideration been given to temporary structures or crossings to accommodate the changing conditions prior to sizing a permanent structure?	Don: Most temporary crossing structures are generally on grade and constructed in a way where they will be sacrificed in the event of a flood flow. Stephen: We need to focus more so on better managed watersheds vs. building bigger structures as a way to mitigating risk. Focused techniques in post-fire watershed restoration to reduce future damaging flows, would be more efficient than spending millions on infrastructure.
All		
	We heard of many concerns and issues. What issue would Each panelist like to see addressed first? What is their priority#1?	Rich: BAER's prority is the the protection of life and property. We need to have decision support tools and models to help us to determine that those values are at risk.
		Katherine: Being able to see all the rainfall and having better science on thresholds.
		Stephen: Complete model data that is ready to use (unfortunately, there are often holes) when an emergecy happens would be a great benefit.
		Cara: Better technology to share post-fire data.
		Dave: Getting a better grasp on precipitation patterns and event probabilites which will make predictions of runoff response more accurate.
		Jeremy: Research advancements in debris flow modeling for risk mapping that can be employed rapidly after fire. Or from a pre-fire planning perspective, it would help us address the lack of hazard recognition. Maps are powerful!
		Don: Make advancement in predicting post-fire runoff; to develop a hydrograph for particular rainfall events pre and post-fire. I would also like to see more done in monitoring recovery rates.
Modeling		
	To the best of your knowledge, has anyone adopted machine learning modeling for runoff for post fire environments?	Stephen: The Corps has been working to advance this modeling and machine modeling would refine the direction that needs to be taken.
		Don: There is currently a student at San Diego State University, Brent Wilder, who is currently conducting post-fire research. Machine learning to help predict post-fire runoff plays a part in his research.
	How would you like uncertainty be presented in model estimates? color code map, probability, likelihood, the model is right or wrong	
	How useful are wildfires prediction for the following season, based on, e.g., satellite soil moisture data.	

	Do we need to prioritize designing interactive tools/models for post-fire hazards? Or are static products (e.g. maps) more beneficial?	Katherine: For NWS, interactive tools that can be combined with weather forecast models, radar observations, rain gage observations, shapefiles of infrastructure, etc, would be helpful. Static maps will also always be useful.
		Stephen: On demand, calibrated and validated, real-time models would be extremely helpful for many public and private activities. Interactive operational dashboards have the capacity to delivery PDF maps based on specific use templates.
		Rich: We have several decision support tools to assess post-fire hazards. For example, USGS provides a landslide analysis and makes it available on their website: https://landslides.usgs.gov/hazards/postfire_debrisflow/ The Automated Geospatial Watershed Assessment (AGWA) Tool helps us to estimate increased post-fire runoff and erosion https://www.epa.gov/water-research/automated-geospatial-watershed-assessment-agwa-tool Satellite platforms give us burn severity data to determine impacts of a fire using a technique called Burned Area Reflectance Classification https://wiki.landscapetoolbox.org/doku.php/remote_sensing_methods:burned_area_reflectance_classification_barc There are many other examples and static maps are useful, too. The selection of a tool or combination of tools depends on the nature of the threat to a value at risk. BAER team specialists in various disciplines are experienced in conducting this analysis and selecting the tools.
		Don: I have found that conditions often change as new information is acquired within the first year or two following fire. The key types of information we focus on includes the spatial extend and intensity of storm events, the runoff response, and changing conditions on hillslopes and within channels over time, particularly related to vegetation recovery and channel conveyance capacity, respectively. This process is largely affected by the rainfall intensity and quantity in the years following the fire (e.g. vegetation will recover slower in drought conditions, and the amount of sediment removed from the hillslopes and channels each year after the fire affect the potential for future events). As this information is obtained, we get a better understanding on how the burned slopes respond and where the threat of channel avulsion is greatest. Thus, as we monitor storm events and quantify the response, we test our initial models and alter our recommendations/emergency response plan based on the perceived threat and risk to life and infrastructure. This processes is relatively dynamic and it is best to have an interactive tool that is flexible and can be adjusted to convey information effectively to key stakeholder. I have found that web-based dashboards linked to emergency response plans are the best way to convey information.

		Dave - Maps are pretty useful for conveying risk of post-fire hazards, and can be hung on the wall at public meetings or emailed around pretty easily. However, I think that interactive tools—especially web-based—are able to convey greater amounts of information in potentially more intuitive or useful ways for a wider variety of end users.
		Cara: Both interactive tools and models as well as static products are useful in assessing and communicating post-fire hazards. Having a diverse set of tools available is ideal for many of the hazards that we are dealing with in the post-fire landscape. For example, a static map of soil burn severity is a tremendous communication tool, especially in combination with hydrologic flood and debris flow modelling.
	How do we make sure that we differentiate modeling threats that can be mitigated with treatments from threats like larger debris flows that cannot be mitigated?	Rich: Informed expert opinion based on the best available research and science helps BAER team specialists to differentiate the threats that can be mitigated or not deemed viable for treatment. Keep in mind that mitigation takes all forms from no treatment, to closures and avoidance, to actual treatments including point protection. Each case is different and depends on the nature of the threat. The potential for landslides takes into consideration many factors including soil types, topography, vegetation, expected rainfall events, location of the values at risk on the landscape, and burn severity. BAER team members assess these factors to differentiate the threats and how to mitigate the risk.
		Don: Current models provide information on post-fire runoff, flood- and debris-flow triggering probability, and debris-flow sediment yield. Some models are physics-based, but most are empirical-based using data from specific regions. As such, modeled results should always be confirmed using historic information and field-based indicators, including soil availability, both on hillslopes and in channels, as well as geomorphic indicators of past debris-flow and flood-flow events. From this type of assessment, the magnitude of potential events estimated and mitigations are proposed accordingly. In areas of potentially high-magnitude flood and debris flows with high avulsion potential, the only reasonable mitigation may be to evacuate the area.
		Stephen: Conducting Monte Carlo simulations incorporating climate and regional precipitation variability may help inform probabilities of risk reduction by selected mitigation measures. Basically, conducting sensitivity analysis by running the model 1,000,000 times while choosing from random but appropriate sets of input parameters.

		Dave - Thinking broadly, there are probably mitigation measures for just about any magnitude of event, but reducing risk from extreme (low probability) events is typically not feasible due to excessive cost, community disruption, etc. Post-fire analysts and planners will usually select a probability of risk that will trigger a response, and acknowledge that the measures employed to mitigate that risk will not be as effective for lower-probability (larger in magnitude) events. Effectively communicating this information to potentially affected people is critical, and generally requires coordination between multiple agencies.
		Cara: Two of the most effective mitigation tools that we have are communication of the hazards and early warning systems. In many cases, mitigation is cost-prohibitive for events like debris flows and lower-probability events (e.g. 100 year floods). In these specific cases, federal, state and local agencies need to work together to provide hazard communication and education in addition to setting up effective early warning systems for at-risk communities.
Communication		
	My take is that community planners think of alluvial fans as dormant like volcanos. How do we improve our messaging?	Jeremy: First, you need to map alluvial fans. We need to identify the relative activity state and advance our innundation models, then develop risk based innundation maps on alluvial fans (including debris flows).
		Katherine: Showing google terrain maps, historical images and using educational materials.
	What are some ways you suggest sharing of information can be done efficiently between agencies - between federal agencies, between federal and state and from fed to state to local? is there/should there be a single repository? Who would manage?	Cara: This is one of our biggest challenges. There are lots of ways to do this, it's just a matter of finding the best repository and who to manage it. This is already happening in the field of fire management/suppression, it's now a matter of expanding the sharing of data from suppression to post-fire events.
		Rich: There is research coming from universities and nonfederal partners that do not get to federal agencies. There is a work being done on the development of a national wildland fire coordinating group website to house publications, share resources and information.
	How could the Federal agencies better coordinate the interagency development of post-fire products, services, and science.	Katherine: Perhaps have some kind of recurring meeting to discuss specific needs and share new information. If a national post-fire science needs work group is spun up to support the WGA / WFLC endeavor, I imagine that could serve this purpose.

		Stephen: Coordinating source data curation, storage, and delivery (NOAA, USDA, NASA, etc) with model development and planning (USACE, USDA, USGS, etc) to provide repeatable, curated source to model workflows which deliver running models populated with the best, readily available data. At the initiation of the event, analysts will start with a running model and increase the confidence via real time calibration instead of starting from scratch.
		Rich: As mentioned at the end of the conference, the Western Governors Association and the Wildland Fire Leadership Council are undertaking an initiative for post-fire responders at all levels of government to better coordinate assessments and post-fire emergency response services. This includes federal, state, county and local levels of governments and has involved non-governmental organizations.
		Don: I believe the best way the federal agencies could better coordinate with interagency teams conducting post-fire assessments is through open communication. The California Geological Survey has an open line of communication with the USGS post-fire landslide hazards group, the National Weather Service (NWS), and BAER team coordinators (USFS and DOI) that has proven to be mutually beneficial. However, I believe we would all benefit by having more frequent opportunities to meet and discuss what each other is doing, where the science is, and where the needs are the greatest.
		Dave: That's a good question. Each of those items (products, services, and science) will have different answers. Regarding services, one of the problems facing federal agencies is the limited ability to work across boundaries. Different agencies and programs apply on different land jurisdictions. Another issue facing services is the inconsistent level of funding some federal programs have from year to year—particularly those programs intended to support private landowners. Regarding science, perhaps developing a post-fire science coordinator position (or panel) would help to avoid duplication of effort or projects with little tangible value, and improve efficiency. In practice, I think that such a position would be difficult to pull off effectively.
		Cara: Coordination and communication between agencies can always be improved. Unfortunately, one item that hampers the exchange of information is the lack of a consistent data sharing platform for post-fire assessments and activities. Having a sharing platform that is accessible for federal, state and local agencies to access quickly for efficient sharing of post-fire data would be a large step forward for coordination.

	Inciweb can be an effective way of communicating post-fire information with all cooperating agencies able to post information and contacts. The public has access to it also.	
	to the panel: What is the best way to relay your science results to managers dealing with these issues, and helping them to apply it quickly and efficiently?	Katherine: If it's to managers in the local community, face to face meetings to discuss - like the BAER stakeholder meetings after a team is done - work really well and allow for lots of questions and engagement. For more general science and research, working closely with the managers / practitioners beforehand and throughout the process would help ensure the science is addressing the urgent needs and at the end of the process it can be more easily translated directly into practice.
		Stephen: Practice. Participate in tabletop exercises or live drills. We, as scientists and engineers must be better about getting our analysis in the hands of outreach professionals to incorporate with live or interactive simulations. Our outreach is effective if we feed it.
		Don: I have found that the best way to convey information is by using maps that are spatially linked to a GIS database. This system allows features to be grouped and sorted by type, threat, risk, mitigation, etc. Having the data displayed spatially allows emergency response managers to quickly and efficiently plan a response strategy around. Examples may include areas to pre-stage equipment, establish evacuation zones, identify routes of ingress and egress, etc.
		Rich: We are actively trying to get science results to managers through many initiatives such as this this conference. The Joint Fire Science Program and their fire science exchange networks are other avenues https://www.firescience.gov/ We take this seriously because science is only useful if it is put to use.
		Dave: I am on the management side of the agency, so maybe not the intended audience of this question. But from my perspective, having scientific findings published and disseminated, perhaps with interactive web-based presentations designed for practitioners if warranted, would help get worthwhile information to the ground.
		Cara: Given most post-fire work and analysis comes at a time of high stress and tight deadlines, any way to make the science more accessible and easier to turn into practice on the ground is helpful. Non-traditional methods of sharing like newsletters, blogs, and other easily digestible means would help
	How do you collaborate with biologists (botany/soil/microbial) on post-fire mitigation? Who do you collaborate with?	Cara: From the point of the forest service, having a soil scientist is key since looking into soil burn severity is the basis for all work. We also include botonists to look at invasive

	How can BAER increase collaboration with microbiologists, seeing as how soil microbes can be key to soil aggregation and mitigation efforts?	species and other post-fire threats. We do not have a big focus on mircobiology, just given that the program looks more so into emergency risks; not enough is known on the microbiology side just yet. Rich: BAER teams, by nature, are interdisciplinary teams. These teams are built on values at risk, identified by local line officers requesting services. Field teams may go out seperatly, but come together at the end of the day to discuss findings and build prescriptions to mitigate those values at risk.
	Why don't the BAER teams include a silviculture and fuels specialist that will help in the assessment of risks associated with future fire events and ecological restoration?	
	Has anyone on the panel worked with social scientists before regarding the communication of post-fire hazards issue? How was it implemented and how well did it work?	Don: First time working with social scientisits was after an event in Montesano, where they deveopled a plan for communicating with the public. This event brought recognition to the importance of bringing in that expertise.
		Katherine: Though hasn't worked with them personaly, weather offices in California are working with social scientists.
BAER		
	Why does BAER hydrology seem to always underestimate flooding?	Dave: With those who are new or inexperienced in a post-fire setting, there can be a hestiancy to present large number predictions, especially when they appear to be unrealist. There is also a lack of consideration for bulking. The tools used to estimate post-fire flows do not take into account bulking, which will always lead to low-ball estimates.
	How standardized are BAER reports from various agencies? If not, would that be possible? If standardized , these reports would be easier for machines to parse and analyze.	Rich: From the NPS, all plans address different values at risk. There doesn't need to be an in-depth BAER plan to follow any particular model. I've accepted basic plans without a lot of data, addressing the values at risk and how they want to treat that risk. Other plans may have a vast amount of data to review. There isn't a standardized template, like the USFS, within the NPS.
		Cara: There is a standarized template with USFS BAER reports; they all require a set amount of information. These reports are being moved into a database, where they will be even more standardized and require information that will be more useful. The challenge of standardizing BAER reports across agencies is the difference in agency policies.
		Dave: Ideas on how to input data and get valuable reports from that data is always welcome.

	How can we get federal agencies BAER teams to look at downstream impacts that are off of federal lands? Change policy to allow them to look at those needs where work on federal lands can make positive impacts off federal land.	Rich: As mentioned at the end of the conference, the Western Governors Association and the Wildland Fire Leadership Council are undertaking an initiative for post-fire responders at all levels of government to better coordinate assessments and post-fire emergency response services. This includes federal, state, county and local levels of governments and has also involved non-governmental organizations. This initiative is looking at policy gaps and roadblocks that hinder federal BAER teams from assessing and treating non-federal lands.
		Cara: The restriction limiting federal agency BAER teams to federal lands and values comes in the appropriations language guiding the use of wildfire suppression funding. For federal BAER teams to assess and/or address non-federal lands and values, post-fire emergency actions would need to be added to the fire suppression master agreements and be reimbursable items paid for by state or local governments, or Congress would need to expand the agencies' authority in appropriations language.
	do you think stream stats needs updating to better support BAER model estimates? how?	Stephen: Stream Stats updating to support the BAER team is beyond my experience as USACE does not currently have a defined role in wildfire response. That being said, if StreamStats exported a base level HEC-HMS model for a given watershed delineation, I would be quite happy. Same with any other models as well. If multiple models could be exported with the same source data, an ensemble could be run, similar to climate simulations.
		Don: I frequently use StreamStats to quickly quantify pre-fire clearwater flows at key sites and obtain basin morphometrics. Currently the Streamstats automated basin delineation tool uses a coarse resolution DEM (30 or 90m) that produces inaccurate basin delineations in certain areas of California. While this is a great tool, I recommend improvements to the elevation data, using a minimum 10m input DEM. To maximize its utility, we also need to develop a correlation between pre-fire flows generated with StreamStats (i.e. USGS regional regression equations) and bulked post-fire flows based on soil burn severity. The California Geological Survey and other scientists are actively trying to determine if such a relationship exists. In the long term, we need more stream and rainfall gages to help quantify the rainfall-runoff relationships under pre- and post -fire conditions.

		Dave: StreamStats has the potential to be more valuable to post-fire flow estimates. The current pilot effort in Colorado is an incremental step in that direction, but at this point provides information using approaches similar to those already in use. Expanding the ability to fine-tune inputs to the current approaches, and perhaps having other methods of runoff estimation available, has potential to make this interface more useful. I have also discussed with USGS employees in Montana the possibility of evaluating long-term streamflow records against historic climate and wildfire extent and severity information, to determine whether any post-fire signals might be evident.
	I''m concerned with apparent lack of follow-through from BAER to longer-term (6 months to 4 years post-fire) rehab and management, particularly discounting of hydrologic concerns that may inhibit timber salvage.	Rich: By policy, BAER teams are tasked to assess immediate post-fire threats to life and property. The federal funds that finance their work comes out of fire suppression emergency operations accounts. Appropriators have made it clear that other post-fire actions such as timber salvage are not emergencies that threaten life and property and must be funded out of normal operations or supplemental funding.
		Dave: I can only really speak to the Forest Service side of this question (vs DOI agencies). There is often a lack of continuity between BAER and longer-term post-fire efforts. This is partly the nature of BAER—an emergency program meant to address immediate threats to certain critical values, completed no later than one year following fire containment. Information produced by the BAER team is frequently used in planning longer-term post-fire work. How post-fire efforts are addressed following BAER is up to each individual administrative unit. Hydrologic concerns related to the fire and potential management activities (like timber salvage) are often related to the concerns addressed in the BAER assessment, but will usually need to be addressed differently than what was done for the BAER, as the questions and concerns are often different.
		Cara: BAER is intended to address the post-fire immediate emergency needs created by the burned landscape. The impacts of the fire will last for years to decades after the flames are out and additional analysis and funding post-BAER is needed to complete additional rehabilitation and restoration actions. The BAER analysis is often used to provide information to the subsequent analysis for long-term actions.
Debris Flows/Runoff		

	What is being done in the Southwest to better predict runoff?	Stephen: We're doing as much as we possibly can. I have been working on methods of increasing resolution of nexrad radar coverge, getting better at predicting StormTrack (predicting impacts of precipitation), understanding antecedent loading and how this alters the tipping point of flood response. This is a complicated topic, especially in the southwest, where there are high intensity and fast storms. All of the quantified precipitation is collected in one hour intervals, making it hard to refine accuracy in prediciton models. These issues are all being addressed and worked through.
	Given the uncertainties in clear water modeling and bulking factors should we consider alternative methods to evaluate risk from post fire flooding/debris flows. Colorado has developed a fluvial hazard zone mapping program that may be a good alternat	Don: You are correct, there is a large amount of uncertainty surrounding post-fire runoff hydrology and hydraulics. For this reason, we need to continue to improve our understanding of post-fire runoff through conducting post-fire research and exploring other options such as Flow-R, which is a distributed empirical model that identifies areas susceptible to debris flows. The California Geological Survey is currently using Flow-R as a screening tool to delineate alluvial fan areas as the basis for conducting more focused field work. Additionally, after the rapid evaluation, more robust modeling needs to be conducted in the weeks following the initial assessment to refine the initial data. The California SilverJackets will be releasing an After the Fire Toolkit in August which will help address this need.
		Dave: I'm not familiar with the Colorado program, though it sounds promising. However, any prediction of post-fire flooding hazard will generally require estimation of flow volumes/rates for given precipitation/snowmelt events. Minimizing uncertainty and then conservatively accounting for that uncertainty will continue to be the best approach to identifying hazards and associated risks.
	What is the point in running both hydrologic models and debris flow models? What r the key differences?	Don: Post-fire hydrologic models are required to estimate the magnitude of runoff that will likely occur. Clearwater models are used to estimate increased flows as a result of post-fire effects, including decreased interception, infiltration, and surface roughness. Bulked flows are often used to account for entrained sediment. Debris flows typically have a high soil/water ratio by volume. Therefore, one approach is to estimate the post-fire clearwater flows and then increase them by 50% to 60% to account for sediment. This approach, however, is likely an over-simplification of a complex process and, although simple to perform, may have its limitations. The key difference between clearwater flow and debris flow is the change in rheology with clearwater behaving as a Newtonian fluid and debris flows behaving as a non-Newtonian fluid. For this reason, the empirical relations and/or physics-based processes applied can be dramatically different for each depending on the type of modelling you are conducting.

		Dave: Debris flows can be viewed as one end of a continuum of watershed response to the input of water, with clear water runoff on the other end of the spectrum, and various levels of sediment-bulked flood flows in the middle. Hydrologic models used in post-fire risk assessments generally route an input of water through a basin to its outlet. Stream runoff is less of a threshold-influenced process than a debris flow: if it rains, we generally expect streamflow as a result (intermittent/ephemeral channels are the occasional exception). The questions the hydrologist is trying to answer is usually the flow rate and duration of the peak flow, and sometimes the amount of entrained sediment. Debris flows occur (or not) based on a more complex set of variables, which are specifically addressed by debris flow models. The questions answered by each type of model are different, though related.
	At some point I would like to hear a discussion about the use of runoff models verses debris flow models. What are the differences in the two and why use both? Or why not?	Don: I would be happy to discuss the use of runoff verses debris flow models. The response to the previous question touches on the basic differences.
	Given a lot of the research on alluvial fan flooding post fire is across SoCal. What's the best way for Norcal to address questions partners have, since not all debris flows are the same?	Don: The way I approach this problem is by discussing the unique differences in geologic, geomorphic, and climatic conditions present by geomorphic province in the north compared to those in the south. For example, the Klamath Mountains and Cascade Range have drastically different physical conditions present than those in the Transverse Range and Peninsular Range, and preliminary data suggests that the types of post-fire response are also different. In addition, the mapping of alluvial fan landforms in northern California can also be used to provide an indication of where hazard and risk may be the highest in the absence of any other data.
Precip		
	Has any one looked at using space based rainfall data? I am not sure if it is available fast enough?	Katherine: There is a lot of research looking into satellite precipitation estimates. Unfortunately, there are areas without sufficient satellite coverge, so satellite estimates cannot provide sufficient information. The data is there to retreive information about storms, it's just not quite there yet to estimate rainfall intensity over time.
		Don: In the North Bay fires, we used x-ban radar that provided high resolution radar of lower elevations. These did a better job at correlating with actual rainfall hitting the ground rather than nexrad radar (looking at higher elevations, usually over predicting rainfall).

	There has been a lot of work done on probabilities for debris flows and in creating rainfall thresholds. The NWS in a forecast sense is moving more and more toward probabilistic rainfall forecasts. How can we match up those probailities in practice?	Katherine: This will be an area of active research and iteration with partners (USGS & local entities). The probabilistic short duration rainfall forecasts are an emerging field and will take time to determine how best to use them, particularly in conjunction with another probabilistic product, like the debris flow models.
	Does NWS or others have a detailed database of past post-fire flash floods and debris flows coupled with estimated precipitation rates that generated these? If so, does it include high rainfall intensity non-events?	Katherine: At this time, there is no comprehensive database of post-fire events with or without precipitation rates, although there are some local stand-alone event catalogs with this data. This has been identified as a high priority need by NWS as well as other partners to better understand the hazard and further the science. There are different efforts underway to start addressing this need. All interested parties are welcome to join the effort / discussion!
Funding		
	Wondering if some of the panelists could touch on their thoughts about the use of funds for and benefits of fire suppression compared to post-fire stabilization and rehabilitation.	
	What have been your experiences with funding post fire mitigation projects /actions, and are there improvements to those funding sources being considered to allow a more timely response?	
Community Issues		
	Much pressure to "capture value" in burned dead/dying (or even minimally at-risk) timber, justified by roadside hazard in local National Forest. Also protect roads with culvert installation. How to deal with this as community member?	Rich: A properly managed BAER team should allow for public meetings and community advocacy. Contact the local federal land manager during the incident for details on community involvement. If an incident management team is deployed to the fire, they will have public information officers that can answer questions and provide avenues for public involvement.
		Cara: The best way to get involved with the projects being considered by the local National Forest is to reach out to the staff and ask to be added to the planning process mailing list. Once on the list, you can provide comments to upcoming analysis and projects.
	would pre-disturbance fuels work help to reduce post fire impacts? If so has any work been conducted in an area that has experienced a disturbance?	Rich: Yes, we are actively investigating pre-fire conditions and fuels treatments to mitigate post-fire impacts. This includes a forensic analysis of the effectiveness of fuels treatments on catastrophic wildfires. The USDA Forest Service's Pacific Northwest Research Station has been researching the efficacy of fuels treatments within the footprint of the 2018 Carr Fire in Redding, California. The results will be published.

		Cara: There has been a lot of work on the effectiveness of fuels treatments in reducing impacts of wildfire and improving ecosystem values within federal agencies and the research community. The Adaptive Management Services Enterprise Team of the USFS has been monitoring the effectiveness of fuel treatments since the early 2000s (https://www.fs.fed.us/adaptivemanagement/projects_main_fbat_fueltreat_effectivenes s.php). Most of this work has been focused on the influence of fuel treatments on wildfire, and has not focused on the post-fire impacts. Current research at several universities, including Utah State, are taking a look at whether fuels treatments are affecting post-fire impacts.
Fan Mail		
	Thank you so much for referencing the Joint Fire Science Program - the regionally-based Fire Science Exchanges provide support, online resources and website for exchange of science, briefs, webinars, videos, and links about many wildfire issues -	
	The topics supported by the Fire Science Exchange Networks embrace most issues regarding wildland fire, particularly fire ecology, management, post-fire effects, social science and community preparedness, & many other topics. Glad we can be of help!	