

FIRO Workshop: Q&A from participants

DAY 1

Opening Remarks: Karla Nemeth

Q: How do you plan for wildfire suppression?

A: Climate is forcing us to fine tune and integrate water management and forest management. We need to collaborate with fire and forest managers. Water wholesalers account for estimated allocations for emergency situations. FEMA can help us innovate to help us avoid emergencies. We want to work with FEMA to get credit for forest and fire management.

FIRO Project Updates (John James, John Leahigh, Greg Volkhardt, Don Seymour, Kevin Shaffer, USACE)

Q: What are major challenges you've faced with your respective projects?

A (Don): Given that Mendocino was the first project, the biggest challenge was the paradigm shift that required so many local, state, and federal partners to get on board. All of these partners have continued to be involved in subsequent FIRO projects.

A (Robin Webb): Even though Howard Hanson is focused on species benefits, you should still consider how to further improve flood control. This was a finding of Lake Mendocino.

Q: What forecasts have proven to be best at the pilot sites?

A (Kevin): Currently focused on NRFC models. It is hard to predict where AR will land so the team would like to see these forecasts advance.

A (John Leahigh): While it is good to increase lead time of forecast, we need to understand the skill.

Q: How aware are your consumers of your FIRO efforts?

A (Greg): Tacoma Water's primary consumers are 19 pumpers. There is a great outreach program, and the pumpers are quite interested.

A (John Leahigh): John explained that they have diverse stakeholders and consumers. Residents have been focused on flood risk reduction benefits. However, we can still aim to optimize water supply, flood risk, and environmental benefits. Some water supply gains could be directed to instream flows for fish.

A (Greg): Greg said their customers are residential and industrial. Residential customers do not know much about their water source. The water district speaks to industrial consumers regularly. In the Pacific Northwest, there is a major interest in fish. The National Water Supply Alliance is keenly interested in this work.

A (John James): Sonoma Water has had many opportunities to discuss FIRO with consumers. Sonoma Water is a wholesale provider of water to cities and districts. He cannot say how much cities and districts talk to their customers. There are nearly 1,000 water rights. Sonoma Water has a lot of engagement with those water rights holders.

Applying Climate Change Science to FIRO

Talk by Scott Steinschneider, Cornell University

Q: Did you apply cross-validation in evaluating the synthetic forecasts? The utility of the model is predicated on the notion that forecast skills for "similar" events are similar - this is questionable with climate change and changes in skills of weather models.

A (Scott): In the current study, they have not cross-validated yet, but past studies have been cross-validated. They have found that 15 years of events are needed or the forecast degrades. If you think the forecast degrades in certain instances, you can train the model to show that and simulate changing forecast skill.

Talk by Mike Sierks, CW3E

Q (Julie): You mentioned a couple approaches you tried?

Answer (Mike): This perfect FIRO approach gets pretty close under RCP8.5. The other approach that gets close is increasing the size of the reservoir by 15%. This is obviously much more expensive. Approaches like shifting the rule curve can get you closer to the water supply benefit but decreases flood risk management.

Q: Have you investigated the rate of forecast skill improvement over time?

A (Jay Cordeira): The skill of AR forecasting is more or less improving at the same rate as global models. The true forecast problems are predicting 10 days out and the situation in which you're not sure 4 days out.

Q: Have you checked with the Bureau of Reclamation on rule curve?

A (Mike): The flood operation rules are coded into the model. The reservoir operation model includes the major rules, but there are many that are probably not reflected.

Panel Discussion (Scott Steinschneider, Mike Sierks, Mike Dettinger, Karla Nemeth, John Leahigh, Sean Smith)

Q (Mike Anderson): There is a notion of progressive evolution of families of events. For example, what was once an extreme becomes episodic which then becomes common. As we find new extremes, do we have a way to start describing change in terms of evolution? What value does that information (predictions 10 years out) have for an agency?

A (Mike Dettinger): We should make climate change adaptation decisions around what we are seeing now (rather than stating expected conditions in 2050) and seeing now in terms of future directionality. All model results are different so it is hard to say what climate will look like in 2050.

A (John Leahigh): We have found that forecast skill can help us better predict storms under current conditions, but under a changing climate, we need these skills to ensure the forecasts do not degrade. This is running to stand still.

A (Sean Smith): FIRO allows us flexibility. This kind of approach is essential in the absence of perfect models. We want to avoid investing in things we will regret later. We need to figure out how to describe

information on climate change that is actionable and makes sense. Is it the new 500-year flood or a single event?

Q: What do you see as some near-term steps to integrate FIRO with climate adaptation planning?

A (Karla Nemeth): We can implement a lot more green infrastructure/engineering with nature projects—this integrates well with FIRO and allow us to test things out. We can work better with our existing landscape. We have done a lot lately in terms of looking at the historical record, layering on risk, and then making decisions.

A (John Leahigh): We use forecasts today—both long term and daily—in our reservoir operations. We have implemented an enhanced spillway which is an adaptation measure. We can look at drought. There is a process for minor deviations that allow us to be better prepared for the dry season.

A (Sean Smith): The Corps has had some reoccurring rounds of deviations annually year after year. That is what caused the Corps to change its drought policy.

Q: What do you see as barriers in integrating climate into reservoir operations? What to do?

A (Sean Smith): The biggest issue is helping people have comfort with uncertainty. How do we put drought on the same playing field as flood? USACE does deep analyses of flood management and flood risk reduction. Should we have the same level of scrutiny for drought?

A (Karla Nemeth): The Department needs to provide a lot more precise guidance for new local water managers on integrating climate change. In 2021, the Feather watershed was very dry and Shasta did well. In other years, the situation is the opposite. We need to think carefully about how to account for watersheds under different conditions. This is really important when we consider changes to our water right systems.

A (Mike Dettinger): When FIRO first started, the Corps was saying that WCM updates cost a billion dollars and take many years. Look where we are today—it shows the ability of systems to evolve.

A (Luca Del Monache): Our forecasts will improve a lot over the next decade because a) we will run our dynamic models at much higher resolutions; b) we are just starting to understand use of machine learning; c) atmospheric observations will improve.

A (Mike Dettinger): We will be losing the ocean's memory of the atmosphere. Climate change will be pushing back against our forecast improvements.

DAY 2

Tuesday Keynote: Sean Smith

Q (Don): Can we move NEPA with deviations?

A (Sean): Sometimes resource agencies can approve deviation if it is just for a couple years. If it is a permanent change, they may be more hesitant. It is important to get the agencies to the table early enough so that they understand what impacts might look like. In addition, their involvement will also influence the alternatives we develop.

Integration of FIRO and WCMs: Moderated by Elissa Yeates

Rob Hartman presentation

Q (Elissa): Have you thought about ways to benchmark forecast improvement? How do we trigger a change in a WCM and FIRO implementation?

A (Rob): Yes, it is possible to create forecast skill metrics. You may even be able to improve on benefits received without further WCM updates—you just need to be clever about how you use the forecast. The key is that we need to establish specific targets that we are trying to achieve. It is really difficult to pinpoint desired outcomes for flood risk management—we need to articulate desired outcomes (e.g., can handle 200 yr flood, or a different objective).

Panel discussion (Rob Hartman, Joe Forbis, Jennifer Fromm, Nicholas Malasavage, Chris Delaney)

Q: You recently got funding for updating WCMs at other reservoirs. Some updates will include FIRO-type approaches (e.g., Folsom). How can we integrate adaptive management into the projects that are not “full FIRO”?

A (Joe Forbis): At Folsom, we used existing forecast information and skills to develop alternatives and test them against a more traditional approach. The project just lacked all of the intensive forecast research (like in a full FIRO project). Some of these WCM updates will follow a similar path as Folsom. FIRO2.0 can help us streamline the process of integrating improvements without going through a several year update process.

A (Chris Delaney): It is multi-tiered. Ideally you want improved skill into the hydro model so that operations models can leverage it. It is somewhat surprising when you evaluate a hindcast with a given forecast, what the results are. If you have an extreme event and the reservoir operation is already potentially encroached in a zone where you are at a max release, improved forecast skill won't help you. It is multi-tiered and requires evaluation.

A (Rob): It is forecast informed, not forecast dictated decision making. The operator needs to understand the uncertainty and context around the forecast.

Comment (Drew Loney-online participant): One way of handling that is to use contingent metrics and tie your risk criteria to your skills across your event magnitudes.

Q: What are our opportunities for streamlining the NEPA process?

A (Joe): For NBB-ORO We're looking at different approaches to the NEPA process such as phased (we know this now, we'll know that later). We're trying to save time there.

Comment (online participant: Elizabeth Salomone, General Manager of the Mendocino County Russian River Flood Control & Water Conservation Improvement District) I want to thank you for all the hard work and collaboration that happens to make FIRO successful. Farmers and water suppliers in the Upper Russian River dependent on Lake Mendocino are keenly aware of the initiative of Sonoma Water to bring FIRO to our shared reservoir and appreciative of the real-life impact it made for them in 2021. FIRO saved farms and families from going without running water.

Q (Angela Hogan-online participant): All, What are some of the challenges you've faced with using the various types of models (operations, atmospheric, etc) across the different FIRO pilot sites, and how did you overcome these challenges?

Not yet answered. Panelists, please email response to eliza.berry@erg.com. We will make sure your response is shared.

Q (George Modini-online participant): Joe, besides current improvements could the NEPA process also include future improvements thereby providing NEPA coverage in an adaptive way?

Not yet answered. Panelists, please email response to eliza.berry@erg.com. We will make sure your response is shared.

Q (David Reynolds-online participant): All, How do you reduce the anxiety of the reservoir operator looking at these spaghetti plots of inflow that may or may not be realistic representations of reality? Seems like the EFO does this for the operator.

Not yet answered. Panelists, please email response to eliza.berry@erg.com. We will make sure your response is shared.

Q (Yu Zhang-online participant): Chris, What is the range of lead times for which the ensemble forecasts were demonstrated useful in the context of FIRO at Lake Mendocino?

Not yet answered. Panelists, please email response to eliza.berry@erg.com. We will make sure your response is shared.

FIRO Screening Process: Moderated by Elissa Yeates

Q: What is unique about your district?

A (Joe): We have four dozen reservoirs in our district. They are in a very diverse watershed. The screening process is an interesting test bed across diverse watersheds. 2/3 are section 7 projects that are operated by partners.

A (Nabil): Most of the dams are in watersheds fed primarily by snowmelt. The screening process is helping us identify projects that are appropriate for FIRO. They must deal with cross-state stream compacts. This creates some unique challenges.

A (Patrick Sing): We cover the smallest area (of all panelists). There are only 3 reservoirs. They are not snow melt reservoirs which makes it simpler. Mendocino is rain fed. Del Valle receives water from state water project.

A (Angela Hogan): We chose 3 projects in Southern California. Two of those are section seven dams. Hanson is operated by the Corps.

Q: Are rivers in your district flowing all year?

Nabil: The Rio Grande is dry in the winter.

Jenny: Since we have such a large portfolio, we have a primary and backup project manager for each project. They sat down together for Screening Assessment A. Jenny and Joe sat down with them to review screening B. They provided feedback. All four of them are being prioritized, in part, as they are funded for WCM updates.

Patrick: For the level B questionnaire, he learned a lot when evaluating the section 7 dam. It really shined the light on need to collaborate on this. At Del Valle, increasing the flood control pool could make recreation facilities inoperable. This reminded him that this process requires collaboration with recreational operators.

Angela: Level A was more direct. They went through their 21 dams and 6 were eliminated because of physical barriers. Reviewing the Stage B questionnaire helped them narrow down to the three dams. We will need more collaboration across agencies with level C.

Q (Robin Web): Success of all FIRO activities to date have been because of stakeholder interest and energy. How is this captured in the screening process? We need to capture NEPA/CEQA stakeholders earlier.

A (Joe): Early engagement is essential for FIRO and WCM update. Based on people's level of FIRO understanding, they may not be 100% clear on why some of the questions are being asked. Even if it is a USACE document, many stakeholders are impacted by changes to a WCM update.

Q: Environmental justice and equitable distribution of benefits were missing from the questionnaire. What are your ideas for integration?

A (Angela): For guidance, she looks to FEMA and other agencies that are working to ensure benefits for disadvantaged communities. She recommended that our reports need start by including demographic information and look at benefits to communities downstream of projects (in terms of flood risk reduction and water quality).

Q (Arleen): For projects moving to stage C: What is your timing and approach for integrating water supply agencies into the process?

A (Elissa): Our SC is currently grappling with this issue.

A (Curt): Pull them in with stage B or stage C and educate them about FIRO.

A (Joe): We initially focused on Corps dams with WCM funding. To answer question of whether or not there is a FIRO champion, you may need to start by educating stakeholders about FIRO to see if there *could* be a champion.

Q: What's next after the screening process?

A (Patrick): For Lake Del Valle, he would need to go through the operations chain to request funds. He expects that decisions on whether to go through a full PVA process would happen beyond USACE. DWR support is needed as they operate the dam.

A (Nabil): The next step is to evaluate forecast skill. His district has funding for a WCM manual update at one of their FIRO priority reservoirs. However, they need to complete update in 2 years which is likely too quick for FIRO. So, their priority is evaluating forecast skill.

Reducing Precipitation Forecast Uncertainty - Progress and Future Directions (Moderator: Jay Cordeira, CW3E)

Presentations by Marty Ralph, CW3E; Brian Hurley, NWS Water Prediction Center; Anna Wilson, CW3E; Rachel Weihs, CW3E

Q & A on all presentations:

Q: Do you anticipate further increases in lead time?

Q (Marty): The science is in. We can better predict ARs when we study them offshore. We're focused on the northeastern Pacific. If we focused on the western Pacific too, we could improve lead time by 3-4 days. AR recon is being considered in the western Pacific.

A: What about using satellites to observe ARs?

There are radio-occultation satellites out there. Those data are being assimilated. Our observations are in the context of those data already being available. There are variety of other satellites. Data assimilation has been a big challenge. We need to use all of the observing systems possible: satellites, buoys, and AR recon. All are needed.

Q (Mike Anderson): What are people's thoughts on scale at which the terrain is received by the atmosphere? How are we improving our understanding of the depth of IVT?

A (Rachel): We look at individual storms and we can understand that the static stability and the related heat exchanges between latent heat release and precipitation and the effect on the environment. You can destabilize the atmosphere by just rain. These are critical questions. We can play sandbox games with the resolution to see what kind of variability we're capturing during evolution of AR in terms of height. We've improved our capability to answer those questions since 2013.

A (Jay Cordeira): The terrain could be a reason the threat scores are so high over the western part of the U.S.

A (Marty): We went from 9km to 3km resolution enabling us to represent the Sierra barrier jet more accurately. We're resolving the orographic winds better. This improved resolution is important. Changes in winds results in changes in precipitation.

Q: Any insight into the physical processes causing the cutoff flow breakdown?

A (Rachel): We're doing a deep dive for Prado. An early look indicates that the cutoff flow breakdown was a resulting dynamical feature. Stalling it would prevent the precipitation that did generate over the ocean (and propagating northward) from propagating east-west into Prado.

Improving Inflow Forecasts - Progress on Hydrologic Forecasting (Moderator: Alan Haynes, NOAA NWS CNRFC)

Presentations by Ed Clark, NOAA National Water Center; Ming Pan, CW3E; Steve Turnbull, USACE ERDC; Alan Haynes, NOAA

Q & A on all presentations:

Q (Arleen O'Donnell): Alan, if you had one wish for improving inflow forecast, what would it be?

A (Alan Haynes): The most important thing is getting future weather right it will automatically translate into the hydrology. The AR recon work is huge. It directly improves our hydrologic models.

Q (Mimi Hughes-online participant): Ed, aside from making the NextGen open-source, is the NWC taking other steps to enable the research community to best-align its hydrological modeling

development and research to be compatible with the NextGen framework (e.g., training opportunities, identification of gaps in the model's skill, etc.)?

A (Alan Haynes): Answered in place of Ed. He would probably say yes. We've broadly working on accessibility in our agency. This needs to be tackled to get community involvement.

Partially answered. Panelists, please email response to eliza.berry@erg.com. We will make sure your response is shared.

DAY 3

Tuesday Keynote: Steve LaMar

Q (Marty): What can we do to avoid surprises?

A (Steve LaMar): Steve reflected on a talk he recently joined a call related to drought and declining snowpack on the CO River. We need to take steps beyond just infrastructure. DWR says they're seeing things now that they didn't expect to see until midcentury. Irvine Water District has effectively focused on water conservation.

With ACWA, he wants to do a scenario-based approach to climate so we can consider the range of possible outcomes. DWR's update to its water resilience portfolio is important. Irvine Water District has been a leader in water storage. We need water managers to ensure creative thinking on future water management, not simply repeat what we've done in the past.

Q: We have to get away from the model of looking at benefits for one species at a time. The model has been to look at biological opinions for one ESA listed species at a time. How can FIRO engage more with NGOs that are looking at broader landscape/habitat management?

A (Steve): Natural Community Conservation Plans were set up to be multispecies from the beginning. He thinks it is critical to include NGOs in this work. Managing Salmon in this era of low reservoir levels and high temperatures is a big challenge. We need to do the best we can. We are successful when we take a broader approach to habitat management. We need to create the best environment we can under new conditions. ESA will continue to have a lot of influence over California water management.

Q: If you could change one thing about CA water management, what would it be?

A: Bring back snowpack! The complexities of getting new policy through our legislature is hard given how many bills they review each year. He cannot think of many other issue areas where you have such broad support from each level of government. All should be proud to be involved with FIRO.

Q (Greg Volkhardt): FIRO has proven itself in addressing west coast water issues. Will there be pressure to push it in a certain direction? Is there a tension of moving the research forward vs. solving the practical applications?

A (Marty): Keep in mind two fundamental things: 1) innovation and research are done in parallel and connection with evaluation and implementation; 2) FIRO may not look the same in 10 years. We are learning how to apply FIRO at USACE reservoirs. We need to learn to sync research and evaluation and implementation in diverse agencies managing the other half of reservoirs in the country.

Comment (Andy Martin-online participant): If anybody is interested in a great example of private public partnership in the context of fish and wildlife. Here is a link to Save Auburn Ravine Salmon and Steelhead (SARSAS) <https://sarsas.org/> <https://sarsas.org/about-2/supporters-sponsors/>

FloodMAR + FIRO = FIROMAR: What are the Integration Opportunities? (Moderator: Adam Hutchinson)

Presentations by Mike Anderson, CA DWR; Joe Forbis, USACE; David Arrate, CA DWR; Jim Wieking, CA DWR

Q & A on all presentations:

Q (Steve LaMar): Were the GSA consulted at all or just the individual agencies?

A (Jim): Our approach was to focus on the technical studies and then engage the water agencies. Our groundwater consultant does the GSA modeling for the Merced Groundwater Agencies. We're trying to paint a picture of what's possible. We want GSA to understand the range of what's possible and the possibilities for additional study that may be needed. We're not providing an implementation plan. We're showing what water that is physically available. The waterboard assesses legally available water. There is a gap there. There is potentially for trading of water rights that aren't currently in use.

Q (Greg): Joe, have you considered the possibility of using the authorized purposes component of the Groundwater Act to expand authorization? Are there different approaches to authorized uses that we can consider?

A (Joe): Adding an authorized purposes might not be necessary for all sites. For example, water conservation authorization could be expanded to include groundwater. There may be cases in which new authorization is the only way.

Q (Marty): At the Yolo Bypass, flooding can have benefits to fish. In FLOOD-MAR, there will be less water making it to the ocean and estuaries. Are people thinking through the environmental impacts to estuaries?

A (David Arrate): We have consultants digging into those issues. In the Merced River, there are not huge habitat opportunities. The flow reduction is bad but there were not that many environmental opportunities to begin with. We have been trying to set up Flood MAR scenarios to at least do no harm to the environment. Each watershed is unique, so we need to figure out the uniqueness and maintain it.

Future Directions for FIRO (Moderator: Arleen O'Donnell, ERG/CW3E)

Panelists: Marty Ralph, CW3E; Don Seymour, Sonoma Water; Greg Woodside, Orange County Water District; John James, Yuba Water; John Leahigh, CA DWR; Cary Talbot, USACE ERDC; Mike Anderson, CA DWR

Q: What are the key takeaways?

A (Greg Woodside): Drought impacts are extremely costly. There is going to be more and more pressure to capture water in reservoirs. The Corps sets maximum stream flows very conservatively. That puts the dam operator in a tough position: the public says why are releasing water during a drought? But people also expect no floods. How can we give dam operators another framework that is not so conservative?

We likely need better tools, maybe an act of Congress. We need dam operators to be incentivized to store water.

A (Mike Anderson): If we can reduce uncertainty, we can clarify the decision space.

A (Don Seymour): At Lake Mendocino, we (along with CW3E and USACE) developed tools that enabled our dam operation to have additional water in storage leading into a historic drought.

A (Marty): Watersheds across the west are facing severe drought (with concurrent flooding in some). He is hopeful for FIRO work to provide adaptive management as we face weather extremes.

Arleen: How can we provide the kind of incentives that Greg referred to?

Cary: At the Corps, dam operators face a big stick if they make any mistakes with flood risk management. However, there is not enough of a carrot to incentivize taking new approaches. There may be a reversal happening between carrot and stick. When districts look at WCM updates, within agency technical review, there are questions raised of: Are you considering FIRO? If no, why not? These questions are being asked across the country. There are hopeful indicators that incentives are developing to allow operators to take more risks. The WCM tells you what is safe and provides protection if you operate within it. We need to codify new incentives into a WCM. Then dam managers are not taking a risk because the Corps has clearly established new balance between flood risk management and water supply.

A (John Leahigh): A balance between flood risk management and water supply is already in place today. We need to tailor that risk balancing. A big part of the tailoring is the time of year. The risk on the flood side is early. Late winter, you can push the needle towards water supply risk. That needs to be part of the solution.

A (John James): We need to be asking: is there a risk of not implementing FIRO in some areas?

Q (Arleen O'Donnell): How do we integrate climate change consideration into FIRO?

A (Mike Anderson): How do you include climate change and more uncertainty? Look at scenarios/extremes. If a certain climate occurs, how would I adjust my FIRO operations based on triggers?

A (Robin Webb): FIRO is a critical adaptation strategy for managing our way through climate change. FIRO is even more important as we get more extremes in the climate.

A (John Leahigh): FIRO used to be a nice to have and now its essential.

A (Greg Tacoma): He is struck by the need of improving forecast skill as a response to climate change and more extreme events.

A (Marty): FIRO could be viable at some of our western reservoirs. If our lead time increased, FIRO would become viable at more reservoirs. There should be a chart of current skill and current FIRO viable reservoirs, followed by future skill and list of additional viable reservoirs.

Q (Alan): Given the promise of FIRO, could there too much emphasis of FIRO as a silver bullet?

A (Marty): FIRO is an option to use existing infrastructure better. It is important that we not overstate FIRO as THE solution.

A (Greg Woodside): Many water districts understand that they will need many tools to deal with water shortage.

Q (George Modini-online participant): Since climate change is a moving target, couldn't climate change scenarios be used to test the resiliency of a variety of proposed operational changes? Maybe the one that is most resilient and in alignment with policy and guidance may be the best choice?

A (Mike Anderson): We need to establish the metrics we're aiming for. Can we propose strategies that are resilient to various scenarios. What edits are needed as we experience more changes to our climate?

Q (Arleen): How can we get a better sense of reservoirs where FIRO MAR is applicable? What could the grand revision be?

A (Mike Anderson): We need to move from facility study to a watershed study? How does the project function within the broader watershed? DSTs might have to become more flexible to serve more entities?

A (Jim): Improving things wholistically is extremely challenging. When you pair FIRO with MAR, you can tweak your risk. FIRO has an approach of do no harm to water supply or flood risk. If you have additional water in the ground, you have a backstop. It can allow you to take some risks that you might not otherwise be able to take. It can help us accomplish more objectives.

A (Greg Woodside): MAR adds another set of factors to account for in identifying applicable sites.

A (Don): We face the challenge of a huge regulatory framework.

Q (Duncan): We are careful to create research to operation partnerships. We cannot feed the research into operations fast enough. How do we create a process for building a better prototype, faster?

A (Marty): Phase 3 of Corps-FIRO planning is focused at this. This includes: conducting FIRO at a system of reservoirs (Willamette is 14 reservoirs and one process); and accelerating research on quantifying precipitation forecast skill nationally. By doing research and forecast improvements focused in certain regions (identified in screening assessment), we may be able to accelerate FIRO implementation.

Q: When looking at screening assessment, might you look at operational skills? As you expand to different geographies, can you consider: how do they store water besides groundwater? It is important to map and share the viability results.

A (Cary): The viability assessment will be an ongoing process and we've been talking about creating an online dashboard. The screening process can help us decide where to go next and help us identify where investments are needed.

A (Elissa): We have included questions related to operational capacity in our current screening tool. We're determining how public we can make the results of our assessment.