Phoenix Stakeholder Forum – April 19, 2017

Welcome: Bill Wiley, Chief Engineer and General Manager, Flood Control District of Maricopa County

Mr. Wiley set the stage for the day's discussion by welcoming stakeholders to the Flood Control District of Maricopa County (FCDMC). He presented a variety of flooding photos so that stakeholders not from Arizona could better understand that flash flooding happens in dry climates like Arizona and can cause debilitating infrastructure issues (e.g., flooding of Interstate 10).

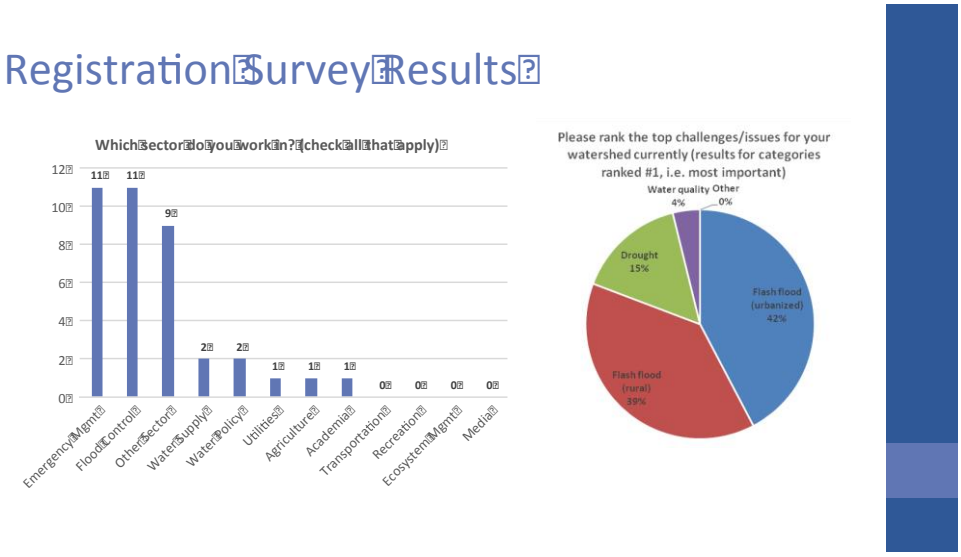
Opening Presentation on Stakeholder Engagement to Inform Hydrologic Prediction Services: Mary Mullusky and Peter Colohan, NOAA NWS

Comments/Questions on the NOAA Water Initiative and National Water Center (NWC)

- The National Water Model (NWM) should incorporate information about fires into forecasting, using satellite data and modeling. This may include the application of burn scar data.
- Flash flood warning services should all be integrated and applied in the National Water Center.
- The NWM should integrate USGS gauge and observational data. There are opportunities to incorporate data from more gages. This includes more than 300 Maricopa County flood gages.
- County level data should be shared with the local WFO. Contact the local WFO to share data.
- The NWM should account for uncertainty in multiple configurations.
- The River Forecasting Centers (RFCs) and WFOs provide official forecasts, not the NWC.

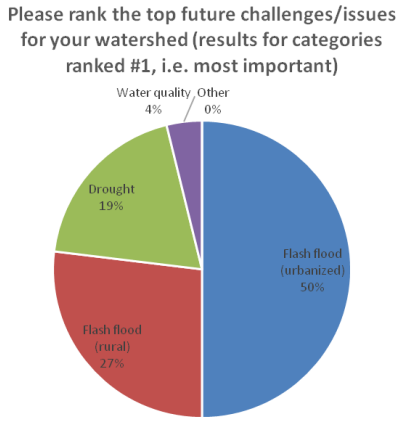
Regional/Local Priority Issues Session

Arleen O'Donnell presented results of the participant poll, which characterized the sectors



represented, and their perspectives and priority challenges (both currently and in the future).

Registration Survey Results



Stephen Waters, FCDMC – Local Perspective

Currently, FCDMC has three mechanisms for decision support on flash flooding for each stream gage or dam in their system:

1. Decision support maps for each location show watershed and surrounding area. Peak flow records are also shown both within and outside Maricopa County. Within these maps, there are summaries of observed data from 3 storm types – 1) monsoon, 2) tropical storms from Gulf of California or eastern Pacific, and 3) winter rainy season from the Pacific. FCDMC staff can examine hydrographs and soil moisture prior to the event. Mr. Water noted that ***soil moisture is very important and additional data on soil moisture from the NWM would be extremely helpful*** as this component significantly impacts the amount of runoff during a flash flood.
2. FCDMC uses a predictive model to anticipate dam volume based on past data, predicted rainfall, and current conditions.
3. ***FCDMC has 50 forecast points in Maricopa County (streams and dams) with predictive information. For winter events in larger watersheds, these have been very helpful, but for flash storms within small watersheds, the predictive capacity is not sufficient.***

Chris Wanamaker, Pinal County Flood Control District (PCFCD) – Local Perspective

Maricopa County maintains 300 flood gages, while PCFCD maintains 35 flood gages. The PCFCD program is still in early stages and work needs to be done. As a first step, PCFCD has made their information available to the public on their website. Pinal County is roughly the size of Connecticut and situated between Phoenix and Tucson. PCFCD employs only 5 staff members. The Sheriff's office helps with emergency management procedures when needed and initiates emergency action plans.

PCFCD Challenges –

- Getting the information to the public, though their website is a first major step.

- During flood events, PCFCD takes on more of a support role while local emergency management agency (EMA) takes the lead. PCFCD provides information to the local EMA based on gage data. PCFCD manually reads hydrographs at peak times, which falls short of real-time forecasting.
- PCFCD has a lot of rural area, and has difficulty deploying staff to close roads.

Brian Cosson, Arizona Department of Water Resources (ADWR) – State Perspective

ADWR's primary roles are to provide support to stakeholders across the state, provide data to the NWS, and provide data to local jurisdictions. ADWR has broadened its network of gages since major flooding in 1993. The department maintains the current gage system and is involved in the post wildfire activities – usually for identifying where gages should be added. ADWR transmits that data to NWS. As an agency, ADWR does not actively monitor rainfall from gages and then contact the local EMA, but ADWR ensures that county and NWS has access to the ADWR data. Visit http://afws.org for more information.

Arizona counties have developed flood-warning websites so that residents and local EMAs can view up-to-date information. ADWR is currently trying to gather data from all of those websites to display it on a centralized website.

Discussion

- ADWR is the liaison to the federal government. As such, the Bureau of Reclamation can help to obtain the information and assistance to install the actual rain gages.
- A Tohono O'odham Nation representative indicated that ***most tribes have the rain gage infrastructure being discussed but intergovernmental agreements need to be in place to move that data back and forth***. Currently Tohono O'odham Nation has an agreement with NWS to share their real time gage data, but that data is not public. Tohono O'odham received funding for their rain gages from the Bureau of Indian Affairs.
- The addition of gauges (rain or streamflow) will transition us from ungauged to somewhat gauged, but the NWM will need that info to make the model more accurate.

Overview of NWS Water Services from the Local NWS Offices

Mike Schaffner, Phoenix WFO, NWS

Mr. Shaffner provided an overview of the WFO services available, including: Advanced Hydrologic Prediction Service (AHPS), establishment of flood stages for ALERT gauges to provide local level decision support, issuing of post wildfire flood watches and warnings. The WFO examines debris flows and flash floods from burn areas, and historic evolution of flash flood warnings at a local level.

Michelle Stokes, Colorado Basin River Forecast Center (CBRFC), NWS

Ms. Stokes explained the types of forecasts available to local communities, including: CBRFC short term forecasts (hourly time step), CBRFC water supply forecasts (monthly and seasonal time step). The RFC needs a significant amount of data for what needs to be done. This information is available to users via the RFC website. Data is aggregated for maps.

Limitations:

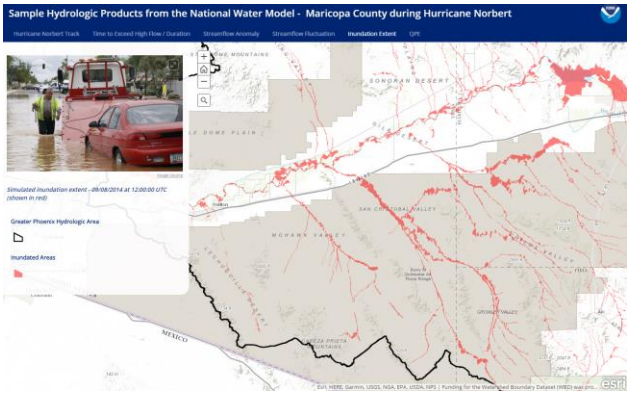
- The quality of streamflow forecasts depends on precipitation forecasts; diversions/reservoir releases (information not always available); snow information (trying to get satellite information); and data density.
- Data only provided from gaged locations, so there are coverage gaps.

Session Discussion - Themes

- Be transparent about the difference between the NWM and the RFC forecast (official). The RFC data comes from aggregated model data from gage data only.
- The RFC model will not go away while the NWM is in development, and the RFC data will continually inform the NWM data outputs.
- The NWM integrates results from the RFC models. The RFCs will be evaluating the NWM, and NWS will be on that path for some time to capture the regional differences.
- Leverage the USGS StreamStats model topographic data as part of the USGS topographic data used in the NWM.
    - ***Action item: Follow up with Thomas Loomis offline (FCDMC) to see if the StreamStats data could be incorporated into the NWM.***

Rotation Stations

Inundation



Uses/Decisions to Inform

- Inundation extent and depth are helpful attributes.
    - The depth output product would be useful when gauges are flooded. For example, USGS would not waste time sending teams to check gauges if the roads are flooded.
    - Researchers also need to sample during storms. They could also use the depth output product to check if gauges might be flooded.
- Seems like this could be helpful to inform emergency management decisions prior to hurricanes.

What else could be useful?

- Given that so much surface water in the west is managed (dams, reservoirs, etc.), it would be helpful if regulated control structures were considered in the model.
- Velocity? Not in this product but the NWM does illustrate velocity.
- This information could be useful if archived. Not all NWM runs will be archived but some sort of interval will be archived in the National Centers for Environmental Information.

- Will all stakeholders be able to access this information? Probably not. From a NWS perspective, we need to provide some sort of capacity if this is a requirement, especially for rural/areas with less GIS capacity. Need to determine the role of the WFOs and RFCs.
- Could the private sector build additional capacity for users for this tool?
- Add a feedback mechanism for local managers to provide input to NWC staff on the NWM inputs.

Concerns

- Elevation input has a significant effect on extent. Need more precise elevation data to achieve a better result. The USGS elevation data needs to be of better quality.
- Much water in Arizona is managed by dams and reservoirs, which are not incorporated into the model, so the inundation mapping is not very accurate.
- Knowing the local properties of the channel is critical for understanding how the ground absorbs the flow. Example: When flow arrives at the Salt River (dry most of the time) during a major storm event, it can absorb the heavy flow.
- Scale – 250 meters is too large to be useful. The 10-meter scale would be more helpful. Washes become incised at higher elevations.
- Lack of local capacity to pull down NWM data in smaller communities. The NWM inundation mapping data is intended to augment the local knowledge. Validate this output against local gage data. The RFC provides the official forecast but is based on gages. If you have no gage, the NWM could be helpful.
- Local managers cannot alter the model inputs.

Uncertainty

Uses/Decisions to Inform

- Information is beneficial for giving an idea of when the flood stage would be exceeded.
- Use for reservoir operations, flash flood watches/warnings, guide to deploy staff for measurements (e.g., USGS)
- Could be used to deploy staff to sample and alert stakeholders. More useful than neighborhood watch apps like “Next Door.”
- Apply to reservoir inflow forecasting.

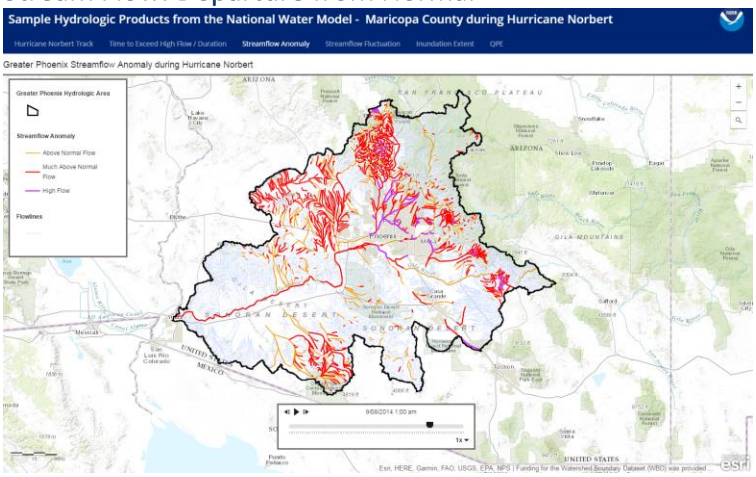
What else could be useful?

- Use of other thresholds, such as 30, 50, 70% (instead of 10/90).
- From a flooding standpoint, a 30-day forecast is not helpful. A five to ten day forecast window would be more helpful.
- Add bank-full and flood stage.
- Provide a 6-hour window, rather than 24-hour window.
- Would be useful to see which tributaries would be more affected.
- Add more detail: zoom in (higher resolution), more detailed precipitation resolution, and 6-hour time step option.
- Shorter duration would be better.

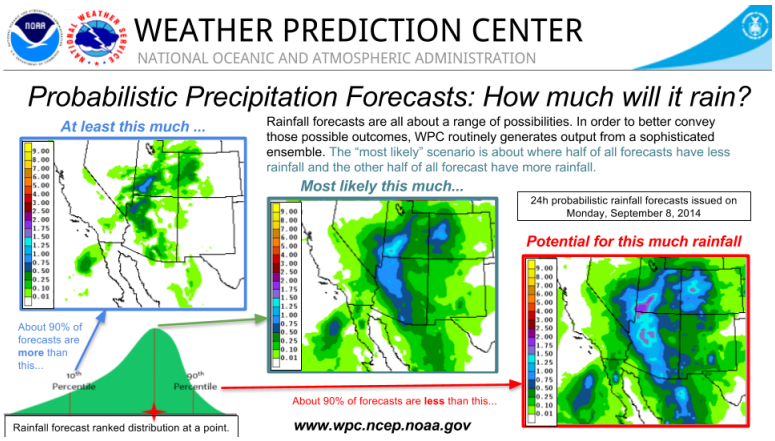
Concerns

- The media and others may focus too much on the 90% exceedance value.
- The range is too wide/great. More accuracy is needed for forecasting to explain the information to responders and managers.
- Not intuitive at first glance; confusing to look at.
- Explain how precipitation is evaluated (i.e., what QPF went into the model).
- Five day lead-time doesn't warrant a response; just a notification that there may be impending precipitation (i.e. heavy precipitation).
- This may not be applicable in the southwest U.S.
- Understandable by scientists, but would not be well interpreted by media and public; too confusing.
- This is only useful for larger rivers.
- The double peak in the 95% line is confusing, as is the shading; suggest 3 dots for each 6 hour time period.
- NOAA background makes it too busy.
- Deterministic forecasting with a confidence level is preferred.

Stream Flow: Departure from Normal



Uses/Decisions to Inform



- USGS is looking where to deploy resources to make measurements. This information could be useful if set up right with an appropriate threshold.
- Maricopa County could consider using this for their smaller dams for a 6 hour forecast.
- Regarding the hourly streamflow fluctuation, participants indicated that this

product could be very useful as it is easy to understand, and allows you to see where streams are still rising at a rapid rate.
- Combine a county ALERT network to be correlated with a given anomaly area of the map.

What else could be useful?
- It would be useful to have the 5-year or 10-year return flow used.
- Add topographic data from USGS StreamStats.
- Add county flood control stream gages in addition to USGS stream gages. County ALERT data is real time.
- A color code for discharge would be most helpful.
- This could be useful in a flood scenario for smaller, less technically savvy communities.
- It would be helpful to have a threshold related to when a bridge or culvert might be overtopped. Maybe much "above normal" is when a bridge is getting overtopped.
- Lakes should be represented in the NWM.
- Regarding output file type: A .kmz file would be very helpful to display such as on a Google map display.
- Add the time that the level will be exceeded (e.g. for 3-hours, 5-hours, etc.).
- Maricopa County Flood Control uses a color-coded system on their web page. Suggested color-coding revisions: blue is not a concern, green is alarm level, and red is exceeding a flood flow.
- Would be useful to see all streamflow lines even if they do not exceed a given threshold.
- The 10-year streamflow return flow from StreamStats could be helpful.
- Provide more temporal context. A slide-bar to display time would be useful.

Concerns
- Small dams within small watersheds are of most concern during a heavy storm event.
- Validation and verification is needed to increase comfort level with these products and to use them in operations.
- Monsoon season would have the shortest duration. Tropical systems have longer scale.
- Opacity slider is not useful in its current form - feedback from Salt River Project (SRP).
- This information is too technical for the general public.
- Related to the time to exceed flow and duration based on NWM 15-hour forecast, with more than 4-colors on the color scale, this is complicated.
- The National hydro dataset from USGS and EPA has many errors in it.
- Local knowledge is key in knowing the thresholds for streamflow anomaly.
- Calibration of the tools is a concern raised.

Voting:

Below is the tally in response to the question "where would you invest your dollars between the products shown in the three rotation stations?"

Rotation Station Voting	Uncertainty	Inundation	Departure from Normal Streamflow
Partners	28	22	32
NWS	13	5	6

Phoenix Stakeholder Forum – April 19, 2017

Large Group Debrief

Thoughts on Services/Products:

- The votes are generally evenly distributed between the 3 stations among non-NOAA participants.
- Streamflow anomaly:
    - This product was highly valued, but ***stakeholders recommend using the term "thresholds" because no flow is typically average***.
    - Suggest changing to streamflow anomaly to make it more useful by using Maricopa gages to recalibrate.
    - Streamflow anomaly thresholds should be tied back to a streamflow annual exceedance threshold. Stakeholders suggested using the USGS StreamStats data for values for each stream reach.
    - ***Need to show underlying blue lines – they appear disconnected.***
- Uncertainty:
    - Learning more about uncertainty is valuable because it can inform probabilistic forecasting.
    - 10 percent is too low for precipitation uncertainty.
    - ***Suggestion to change low end of range to 30 percent uncertainty***.
    - Display streamflow uncertainty differently, not the same accuracy for high and low.
    - Show multiple variables on the vertical axis and overlay the flood stage on the graph.
- Inundation Mapping:
    - Inundation scale is not defined enough/too coarse.
    - Add regulated flow/control structures to inundation mapping component of NWM.
    - Stakeholders can access the NWM data through the NOMADS data service.
    - Data output in .kmz and .kml file formats would be the most helpful.

NWS should issue a special statement for changes in file format/data format changes. There needs to be communication about changes made especially in the way data is broadcasted to users.

- ***Suggested subscription so that users know about changes in format will happen.***

Lunch discussion – The National Water Model (NWM)

Peter Colohan presented some information about the National Water Model, prompting the following discussion:

- How does the NWM calibration work?
    - The NWM is a geophysical model of the streams without calibration.
    - We are using this technique to go from streamflow to inundation in the NWM.
- Where does the geometry in the model come from? How accurate could velocities be?
    - The NHDPlus Catchment Aggregation.
    - To drill down on velocities, we could connect you with one of the modelers.
- Suggested additional to NWM:
    - ***In Arizona channel transmission losses are key – peak flow and volume will be off/double peak, etc. Must get these values right in the NWM.***
    - ***Sub-hourly time steps are needed especially for flash flooding warning.***
- Computational power is obviously a limitation.

  - Need a super computer – example of University of Texas using the NWM code to develop the NWM for the Rio Grande.
- ***We need more automated rain gauges, with wind sensors.***
- Soil moisture – CBRFC has some soil moisture products (new)
  - NWM soil moisture guidance map – http://water.noaa.gov/ - but no information/legend explained the graphic.
  - Suggestion: ***NWS to fix that graphic (soil moisture) and elaborate on output.***

CBRFC information is based on their model and provides information for sub basins; not related to real world measurements. Gridded.

- ***Could NWM produce an automated integration of QPF and soil moisture (hourly/sub hourly)? Used to assess flash flood potential.***
  - NWS staff will take that information back to the modelers.
- ***Single QPF that drives the NWM (GFS, CFS, etc. depending on the run) - are these the same setting for the entire country? Are there any thoughts to calibrate this locally and regionalize it?***
  - NWC is trying to correct the model in a variety of ways. RFCs and researchers looking at NWM to fix it. Modelers also testing in eco regions and making adjustments (e.g., losses based on soil moisture).
- ***Could the model be used to identify where gages should be added?***
  - Yes, in principal.
- Water resource evaluations
  - The NWS is evaluating how the model performs in different eco regions/geographies.

Uncertainty raw notes

Poster 1

- Range is too wide; concerned that media and others may focus too much on the 90% exceedance.
    - Suggested using example with less spread with different thresholds: maybe 30, 50, 70%.
- Makes sense from the best case/worse case perspective. Good to see the range visually
- Geo-locate to basins of interest: use data to render to own basins.
- Needs more details to the time periods offered
- Use for reservoir operations, flash flood watches/warnings, guide to deploy staff for measurements (USGS),
- Time Steps: Use 6 instead of 24 hours
- Understandable by scientists, but would not be interpreted by media and public. Too confusing.
- It allows you to see all the possibilities but needs be explained.
- People tend to gravitate to worse case scenario.
- More detail: zoom in, more detailed precipitation resolution plus 6 hour time step option. Color bar is not intuitive.

Poster 2

- Is this a Water supply product only?
- From a flooding standpoint, a 30-day forecast does not do any good.
    - 5-10 days window would be better.
- Good for giving an idea of when the flood stage would be exceeded.
- Not understandable.
- Not sure how it would be used.
    - May not be usable in the southwest.
    - Maybe for reservoir inflows?
    - Shorter time frame would be more useful.
    - Would use to see which tributaries would be more affected.
- Can this provide information on when this would occur?
- Why only at certain locations?
- Mouse over capability? (already have it)
- Only useful for larger rivers.
- Shorter duration would be better.

Poster 3

- The double peak in the 95% line is very confusing.
    - Shading also confusing.
- Suggest 3 dots for each 6-hour time period.
- NOAA background makes it too busy.
- People want deterministic, and a confidence level.
- Range is so wide! Need more accuracy for flood forecasting.
- Would be hard to use.
- Takes a while to understand.

- Add bank-full and flood stage.
- How is precipitation treated (what QPF went into the model)?
- Hard to explain to responders and managers. Need more certainty.
- 5 days out does not lead to a response yet, just a heads up.
- Understandable. Straightforward – can be used to deploy people for measurements, alert stakeholders. More useful than what they saw in "next door".

List of Meeting Participants

First Name	Last Name	Organization Name
Kate	Abshire	National Weather Service
Courtney	Bear	Pima County Office of Emergency Management
Menberu	Bitew	USDA ARS
Erin	Boyle	National Weather Service
Jerry	Brown	Tohono O'odham Nation
Peter	Colohan	National Weather Service
Brian	Cosson	Arizona Department of Water Resources
Anthony	Cox	Arizona Department of Emergency & Military Affairs
Eleonora	Demaria	USDA-ARS
Jeral	Estupinan	Phoenix WFO, NWS
Brandon	Forbes	USGS
Stephanie	Gerlach	Flood Control District of Maricopa County
David	Gordner	Flood Control District of Maricopa County
Cory	Helton	JE Fuller Hydrology
Daniel	Henz	Flood Control District of Maricopa County
Brian	Iserman	JE Fuller/Hydrology & Geomorphology, Inc.
Brian	Klimowski	National Weather Service
Thomas	Loomis	Flood Control District of Maricopa County
Justin	Manual	Tohono O'odham Nation
Mark	Massis	Yavapai County Flood Control District
Kathleen	McAllister	Horsley Witten
Tony	Merriman	NWS Flagstaff
Laurie	Miller	LTM Engineering, Inc.
Mary	Mullusky	National Weather Service
Arleen	O'Donnell	ERG
Lynn	Orchard	Pima County Regional Flood Control District
Rudy	Perez	Maricopa County Dept. of Emergency Management
Robert	Rowley	Maricopa County Dept. of Emergency Management
Lonnie	Sanders	Pinal County
Mike	Schaffner	Phoenix WFO, NWS
Jon	Skindlov	Salt River Project
Chris	Smith	USGS

Michelle	Stokes	National Weather Service
Carl	Unkrich	Agricultural Research Service
Christopher	Wanamaker	Pinal County
Stephen	Waters	Flood Control District of Maricopa County
Dave	Waters	NOAA
Bill	Wiley	Flood Control District of Maricopa County
Ann	Youberg	AZGS/UA
Jeff	Zimmerman	National Weather Service