The NHWC Transmission

March 2017

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Unique Challenges of Alaska Spur Technology Development and Partnerships

Jessica Cherry, Scott Lindsey, and Crane Johnson
NOAA NWS Alaska-Pacific River Forecast Center

Imagine trying to forecast floods and flow conditions for a quarter of the conterminous United States with only a handful of precipitation and river gages and four isolated radars. Now imagine this large domain has significant spring flooding that routinely inundates whole villages. This place also has changing, complex hazards such as glacial outburst floods, river ice jams, and permafrost sinkholes. This is the situation faced by hydrologists in Alaska. These challenges demand creativity and collaboration to meet the public need for accurate and timely hydrologic information. Technological development and strong partnerships are helping the National Weather Service's Alaska-Pacific River Forecast Center (APRFC) provide decision support to the public.

Several new technologies were developed to give forecasters more information from this sparse and costly observational network. Co-author Crane Johnson developed a low cost acoustic river stage gage, called an iGage when he worked for the Army Corps of Engineers (USACE). The iGage is a compact, low-cost river monitoring package with an ultrasonic distance sensor, a digital temperature sensor, a microcomputer, a solar-panel, a battery, and an Iridium satellite data transmitter. Now a Service Coordination Hydrologist at the APRFC, Johnson works with staff to assemble these units in-house. They provide critical river stage and storm surge information at previously un-gaged sites and extend the reach of real time monitoring, supplementing the high-quality river discharge information provided by the USGS.

Figure 1: Photo of the compact iGage package next to a standard field notebook, for scale.

Photo courtesy of C. Johnson

Prior to joining the APRFC, author Jessica Cherry also applied new technologies for improving situational awareness during the spring river ice breakup period. Cherry was then a Research Associate Professor of Hydro-climatology at the University of Alaska Fairbanks and a commercial pilot, with her own plane. She installed optical and thermal cameras and a survey-grade GPS on her Cessna 182. In coordination with the APRFC, she collected downward looking photos on the upper Yukon River, and

processed those into ortho imagery overnight, using a technique called Structure from Motion (SfM). In addition to flat mosaics of river ice conditions, the processing software generates digital surface maps. Ice ridging and travel time can be calculated from repeat collections and additional processing. Cherry used the same SfM technique to estimate snow loading in mountainous areas of interior Alaska.

Figure 2: Example of rapidly-processed ortho imagery of river ice conditions on the Yukon River near Circle City, AK, collected by Cherry in 2015.

The ability of satellite remote sensing to detect flooding has also recently improved by leaps and bounds thanks to George Mason University researchers Sanmei Li and Donglian Sun and funding from the Joint Polar Satellite System program of NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). Li and Sun have implemented a flood detection algorithm and continue to refine it for the mixed ice and water conditions in Alaska's cold climate rivers. Li traveled to Alaska last year, met with NWS forecasters in Anchorage and Fairbanks and then flew with Cherry to flood-prone Eagle on the upper Yukon River, where an ice jam was just forming. This was Li's first opportunity to see river ice and potential sources of product contamination like snowmelt waters near the river bank. This new product has already shown to be tremendously valuable to forecasters in Alaska and other remote parts of the world.

The technology development described here reflects partnerships between NOAA, USACE, the University of Alaska, and George Mason University. Other successes in Alaska rely on old fashioned face-to-face visits to communities, where forecasters can talk with residents about their own hydrologic observations and concerns. APRFC partners with the State of Alaska's ➡

Division of Homeland Security and Emergency Management on a program called River Watch. River Watch has been in place for more than 40 years and focuses primarily on the spring river ice breakup season. The APRFC, along with Service Hydrologists from the Weather Forecast Offices (WFOs) in Anchorage and Fairbanks, trains pilots with regional air services to file comments on ice conditions in Pireps (pilot weather reports transmitted via aviation radio). The second component of River Watch entails APRFC hydrologists flying on charter aircraft with state

Figure 3: Cherry and Li en route to Eagle to see a developing ice jam. Photo courtesy of J. Cherry

Figure 4: 2013 Ice jam flood in Galena, AK.
Photo by NWS Service Hydrologist Ed Plumb

While it is difficult to do justice to all the myriad partnerships that help hydrologists predict flood hazards and other high impact events in Alaska, we will mention the Interagency Hydrology Committee for Alaska (IHCA), in closing. Twice a year, this committee of hydrologists from the state and Federal government, the research community, and the private sector meet and exchange information about their respective agency's efforts. For as large as Alaska is, this committee plays a critical role in connecting practitioners, enhancing our community readiness, and sharing information from technology old and new.

When, where and how deep? How model analysis informs the flood forecasting process before and after the flood

Baxter Vieux, Vieux and Associates, Inc.

Forecasting when and where flooding will occur is difficult given uncertainties in rainfall measurement, and those associated with hydrologic models that are used to transform rainfall into streamflow discharge and stage. However, when a reliable modeling system is established, notification of specific flood information at an intersection, bridge or building is possible. Operationally, modeling and analysis can be performed with a distributed hydrologic model that supports critical information needed for an Emergency Operations Center (EOC). Detailed knowledge of forecast stage helps understand where emergency personnel should be deployed, but also after the flood, in preliminary damage assessment and requests for financial assistance. Figure 1 shows flood depth and flooded extent

Figure 1: Model analysis of flooded extent used to assess the depth of flooding in each structure and preliminary damage assessment

surrounding individual buildings near a flooded stream. Summary information indicates 35 structures were damaged by flooding above the finished floor elevation.

Physics-based distributed hydrologic models are increasingly being used to provide flood forecasting for basins located in regions where flooding is prevalent. Because of steep terrain coupled with abundant tropical moisture from the Gulf of Mexico, central Texas is prone to floods, especially in urban and peri-urban watersheds. An example of a flood forecast produced during a recent flood is shown in Figure 2.

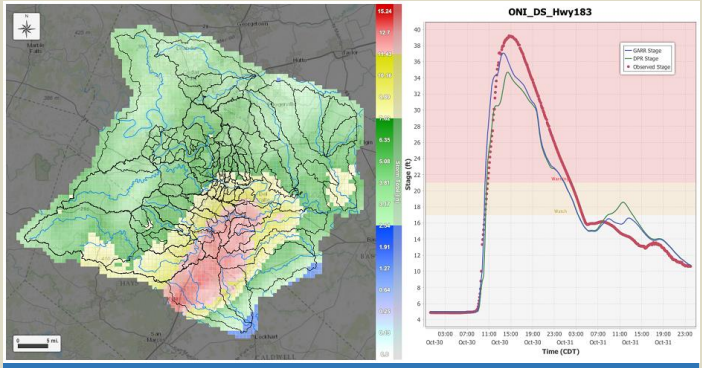


Figure 2: Operational forecasting results during the 2015 'Halloween' flood in Austin, Texas. GARR rainfall accumulation (on left) is used to produce forecast hydrographs (on right. Figure adapted from Distributed Hydrologic Using GIS (2016), 3rd Edition by B.E. Vieux.

In the example, rainfall exceeded 13.98 in during a 6-hr period. In localized areas, rainfall intensity was more than 9.25 in/h in a 15-min period. The watershed response from more than 300 sq. mi. of drainage in the Texas Hill Country caused Onion Creek to rise at rates of more than 2 ft/min, and peaking with nearly 40 ft of depth. These broadly distributed rainfall depths and intensities were measured by Gage Adjusted Radar Rainfall (GARR) and a Digital Precipitation Rate (DPR) radar product. In real-time, these products drive the simulated hydrograph stage with 15 minute updates (see Figure 2 on left). Both the GARR and DPR forecast hydrographs agreed closely with the observed stage without manual adjustment during the flash flood (right).

Beyond operational use, analysis of where additional stage gage location and prioritization is supported by the model. This model was employed in a study for the Texas Water Development Board (TWDB) to identify where additional flood forecasting resources would be most beneficial. In response to recent deadly flooding such as in Wimberley Texas, and to improve flood forecasting across the State, TWDB identified new locations for stream and rain gauges that would assist the National Weather Service with flood forecasting. Each stream gauge needs to allow for approximately an hour of lead time for the community it warns. V*flo*® was used to model the lead time, assuming a flood producing rainfall. Terrain, land use, and soils were integrated in the model for the watersheds affecting the entire state at 1x1 km resolution. Historically underserved communities, were identified and prioritized for additional flood forecasting resources. Locations were tested by running with GARR input from the Wimberley storm event (May 23-25, 2015). Modeling was performed to determine if a one-hour lead time could be achieved. From this analysis, stream gages for over 40 communities were prioritized and analyzed. Figure 3 shows the model drainage network above Wimberley, Texas along with a portion of the hydrograph analyzed for lead time. The upper portion shows the Blanco River basin upstream of Wimberley. The lower portion shows a predicted 1.3-hour lead-time gained by installing a gage at the location indicated.

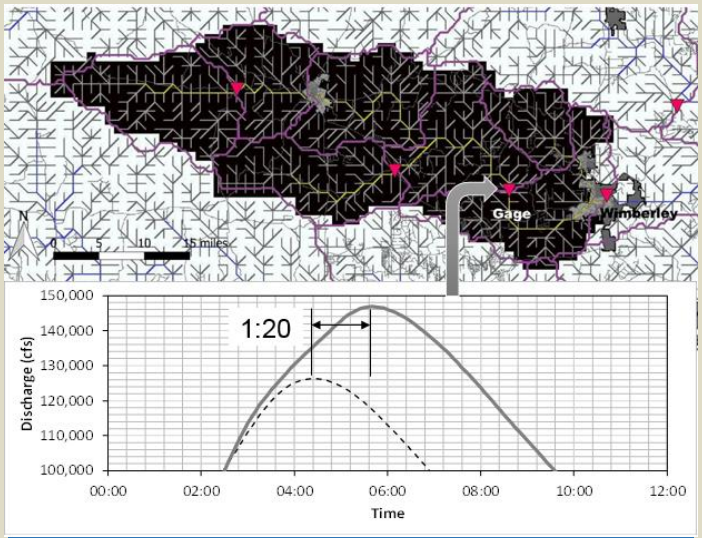


Figure 3: Model Output for the Blanco River above Wimberley Texas used to analyze lead-time at a potential gage location

Distributed forecast models such as V*flo*® can form the basis for a variety of applications before, during and after a flood. Such technology builds on sensor measurements of rainfall and stream stage, integrates radar products and digital terrain data to produce truly useful information for flood emergency management and response, operational forecasting, and analysis of where flood forecasting resources could potentially benefit a community.

12th National Hydrologic Warning Council Training Conference and Exposition

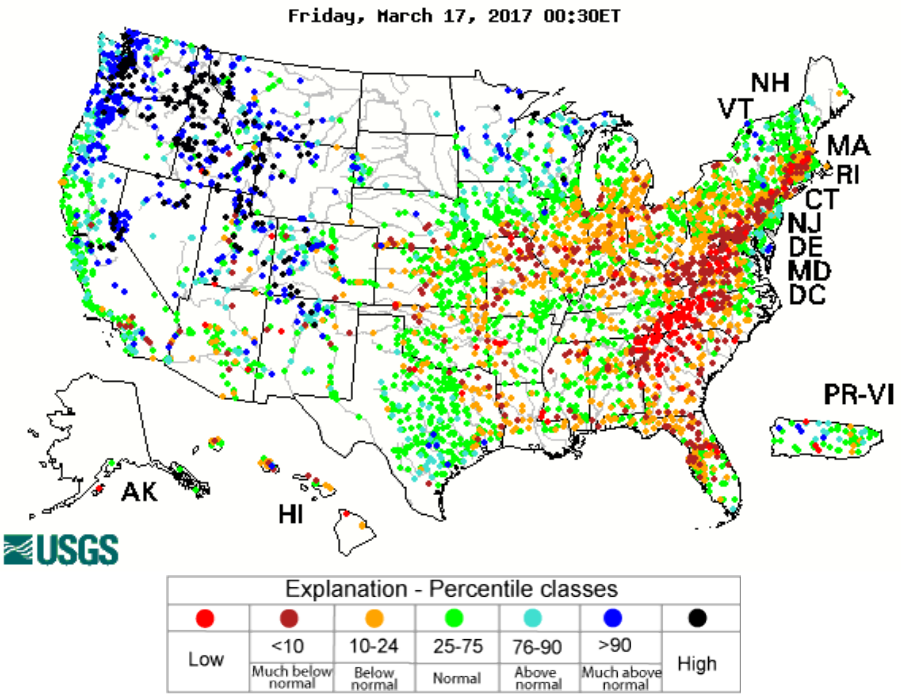
June 6-8, 2017 at Olympic Valley, California

Latest News

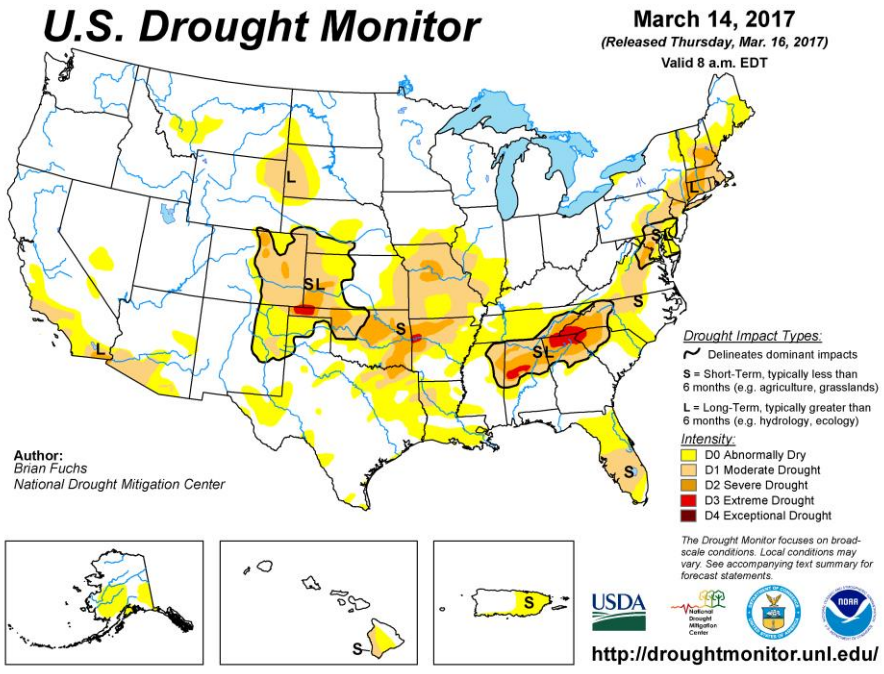
- The full conference program is available now, go to **www.hydrologicwarning.org**
- Registration fees are available at a reduced rate until April 30 (members and speaker $575, non-members $700). Registration fees include an evening social event at High Camp, 8,200 feet above Squaw Valley and the awards banquet on the last night. Start your registration planning now!
- A limited number of exhibit booths and unique sponsorship options are still available, so make your selection now to avoid being shut out.
- Special hotel rates of $189 per night are available at Squaw Creek. Hotel reservations can be made online from the NHWC webpage or by calling (530) 583-6300 and referencing "National Hydrologic Warning Council" to secure the group rate. The hotel will honor this special rate until May 15, 2017.
- Reduced government rates of $119 + taxes are available for government employees. To request the special government passkey, please contact **april@aprilkrieg.com** and **govrooms@hydrologicwarning.org** and provide your government agency information.
- For all the latest information visit **www.hydrologicwarning.org**

For any registration questions contact **april@aprilkrieg.com**

Hydrologic Conditions in the United States
Through March 14, 2017



Latest stream flow conditions in the United States. (courtesy USGS)



Latest drought conditions in the United States.
(courtesy National Drought Mitigation Center)

April Newsletter Articles Focus:

Hazard Communication & Public Awareness

NHWC is requesting articles that focus on getting the word out.

Please prepare an article that explains how your organization gets the right real-time data and information to the right people for the right response.

Submit your article to:

editor@hydrologicwarning.org

April 7th is the deadline for inclusion in the April issue.

Future Newsletter Articles Focus

To give you more time to prepare articles, below is the article focus schedule for the next four months:

Apr - Hazard Communication & Public Awareness
May - Modeling/Analysis
Jun - Data Collection
Jul - Hydrology

NHWC Calendar

June 5-8, 2017 - NHWC 2017 Training Conference & Exposition, Squaw Valley, California

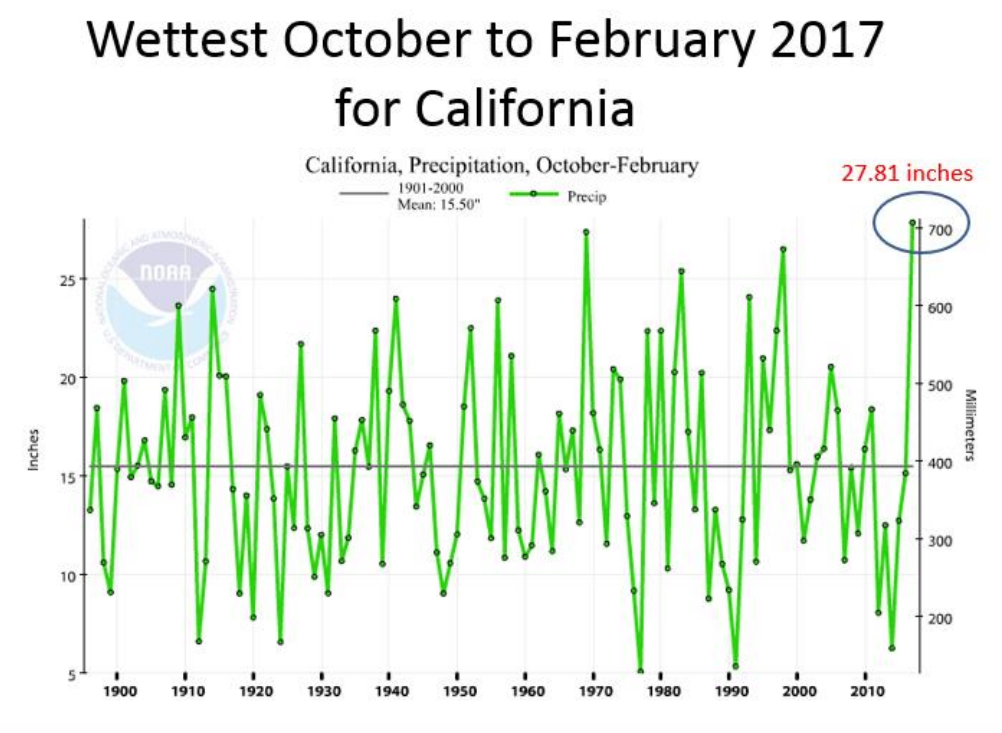
Nominations for Board of Directors

If you are interested in becoming more involved in the National Hydrologic Warning Council (NHWC), please consider becoming a member of its Board of Directors. Nominations from voting members are now being accepted through April 15 after which an election will be held. The Board of Directors manages the activities and affairs of NHWC.

To submit a nomination, please send your name, contact information, and a short background summary to

Steve.Fitzgerald@hcfcd.org

Parting Shot



To see a video of the presentation ***Winter 2016-17 Weather Impacts Review for Southern California*** which includes this graphic, go to https://www.youtube.com/watch?v=AIQ8esu3M0E&feature=youtu.be

Graphic Courtesy **Alex Tardy**, NWS

National Hydrologic Warning Council

Providing Timely, Quality Hydrologic Information to Protect Lives, Property, and the Environment

http://www.hydrologicwarning.org