The NHWC Transmission

October 2015

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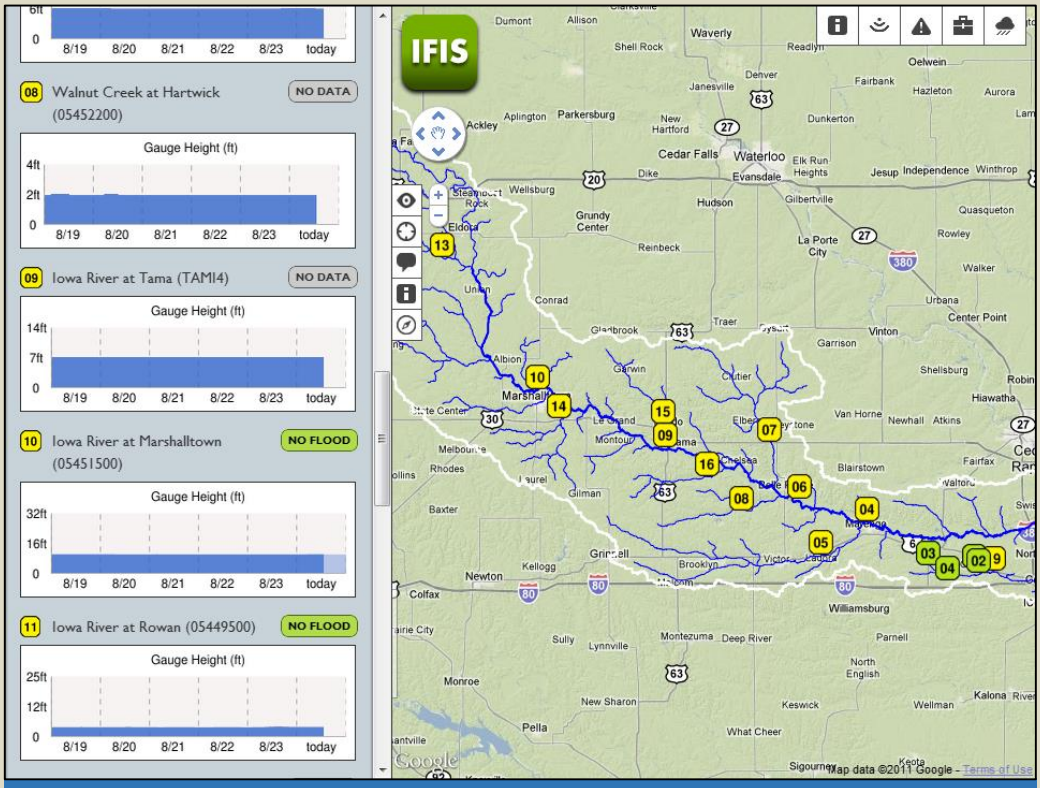
A System for Integrated Data Collection, Dissemination and Sharing via Web Technologies

Ibrahim Demir, PhD, and **Witold F. Krajewski, PhD,**
IIHR Hydroscience & Engineering, University of Iowa

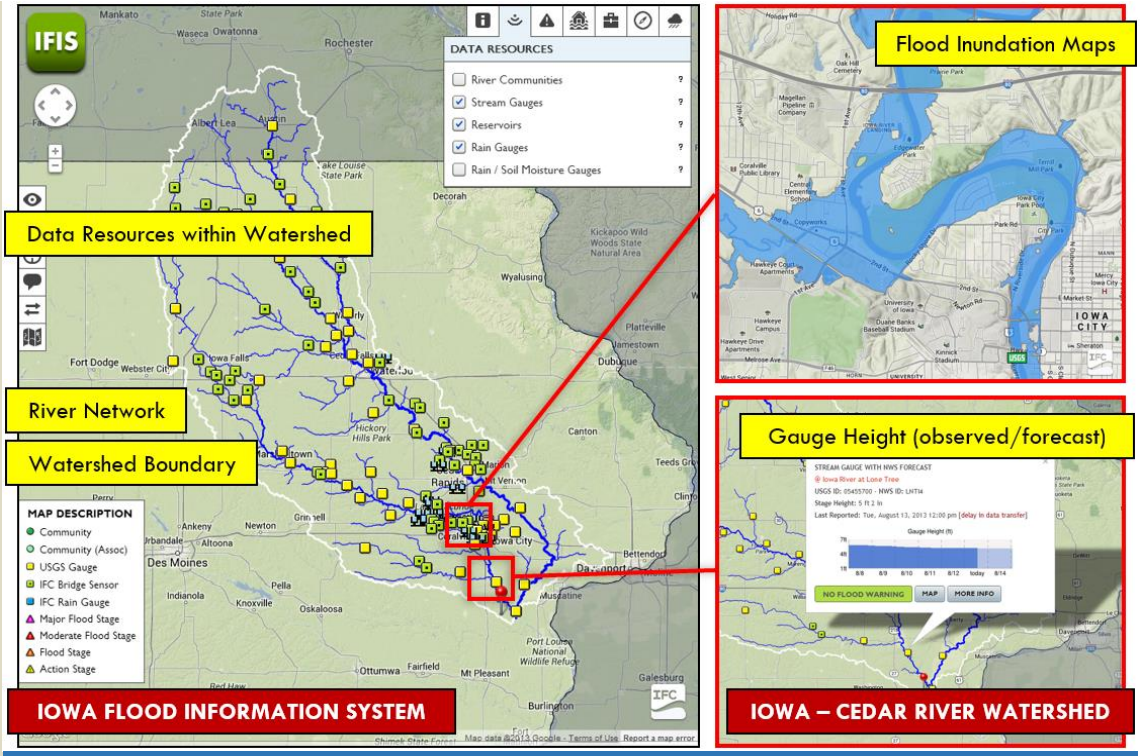
The Iowa floods of 2008 provided the impetus for the Iowa state legislature to create the Iowa Flood Center (IFC), based at IIHR. IFC researchers began collecting time-sensitive data on many aspects of the flood — from high-resolution data to document flood water elevations to contaminated sediments deposited by flood waters. The IFC is actively engaged in flood projects in many Iowa communities and employs several graduate and undergraduate students participating in flood-related research. IFC researchers designed a cost-effective sensor network to better monitor stream flow in the state; they also developed a library of flood-inundation maps (Gilles, et. al., 2012) for several Iowa communities.



IFIS provides visualization of multiple sensors in a river path

When floodwaters rose yet again in the spring of 2013, Iowans had innovative new tools that hadn't even been dreamed of five years ago — thanks to IFC's focused research designed to help all Iowans be better prepared for future flooding. The IFC's Iowa Flood Information System (IFIS, Demir and Krajewski, 2013), is a one-stop hydroinformatics web-platform to access community-based flood conditions, forecasts, visualizations, inundation maps and flood-related data, information, and ➡

applications for more than 1,000 communities in Iowa. The IFIS provides community-centric watershed and river characteristics, rainfall conditions (Seo and Krajewski, 2010), flood information, and stream-flow data and visualization tools for Iowa communities. Basin boundaries and river network depiction provide users with the hydrologic context of the water flow and allow them to better understand the potential flooding conditions in their community. Some of the main features of the IFIS include:



IFIS provides real-time and forecasted river stages on interactive inundation maps

- Real-time stream levels at 398 locations in Iowa
- Current flood warnings and stream forecasts for more than 1,000 communities in Iowa
- Real-time rainfall maps displaying current conditions and past rainfall accumulations
- Flood inundation maps for select communities

Researchers and students at the IFC designed and built a network of affordable electronic stream water-level sensors that are attached to the downstream side of bridges; the sensors provide part of the real-time data that is such an important part of IFIS. The sensors provide Iowans with up-to-the-minute reports on water levels in Iowa's rivers and streams. In a situation where information and preparedness can save lives, the sensors provide a vital service for Iowans. The success of this project led to many partnerships — working with the DNR, the Iowa DOT, and others, the network now totals more than 200 sensors.

Flood inundation maps of many flood-prone Iowa communities are also available during flood events. These Maps help users visualize the potential extent of flooding at a range of river levels. Homeowners, business owners, and others can see how predicted flood levels might affect their property. This information helps individuals and communities plan and make sound mitigation decisions. Maps for more communities are added to IFIS each year.

IFIS also includes a rainfall-runoff forecast model to provide a five-day flood risk estimate for more than 1,000 communities in Iowa. Multiple view modes provide different user types (general public, researchers, decision-makers, etc.) with varying levels of tools and details. River view mode allows users to visualize data from multiple IFC bridge sensors and USGS stream gauges to follow flooding condition along a river. IFC and IFIS will both continue to help communities make better-informed decisions on the occurrence of floods, and will alert communities in advance to help minimize damage of floods.

To access IFIS, go to: http://ifis.iowafloodcenter.org. From this page, users may launch IFIS, or watch a brief video tutorial on how to use the system.

References

Demir, I., Krajewski, W.F., 2013. Towards an integrated Flood Information System: Centralized data access, analysis, and visualization. Environmental Modelling & Software, 50, 77–84.

Gilles, D., Young, N., Schroeder, H., Piotrowski, J., Chang, Y.J., 2012. Inundation mapping initiatives of the Iowa Flood Center: Statewide coverage and detailed urban flooding analysis. Water, 4, 1, 85-106.

Seo, B.C., Krajewski, W.F., 2010. Scale dependence of radar-rainfall uncertainty: Initial evaluation of NEXRAD's new super-resolution data. J. Hydrometeor., 11, 1191–1198.

Will my marginal ALERT sites come in better if I upgrade to ALERT2?

James Logan, OneRain, Inc.

Will my marginal remote ALERT sites come in better or worse with ALERT2? Great question! The early experiences of agencies implementing ALERT2 suggest it is better. Why is that? With a little research, here are the best answers I could find.

ALERT2 uses several radio transmission and data encoding techniques also used by cellular and deep space communications systems. These techniques reduce data transmission errors, which results in more good messages received.

Three things can cause errors in data transmissions: random noise, burst noise, and collisions with other messages.

First, let's start with some bad news; faster is not necessarily better. ALERT transmits at 300 bits per second while ALERT2 transmits at 4800 bits per second or 16 times faster. However, assuming the same radio transmission power, every bit sent using ALERT2 has only 1/16th of the energy of each bit sent using ALERT. In radio terminology, it results in a -12 dB signal loss using ALERT2 instead of ALERT.

There's a little more bad news. ALERT2 messages have more bits which means more opportunities for error.

With the bad news out of the way, things get better. Next, let's look at the modulation scheme or how the ALERT2 radio waves are shaped to carry data. ALERT uses Audio Frequency Shift Keying (AFSK) while ALERT2 uses the more advanced Frequency Shift Keying (FSK) with Raised Cosine filtering. That's a mouthful but the bottom line is that ALERT2 modulation gains about +6 dB.

Software improvements create additional gain. It's called coding gain and is the reduction in bit transmission energy required to achieve the same bit error rate. ALERT2 uses two techniques for coding gain: convolutional coding and Reed Solomon encoding (R-S).

Convolutional coding converts each bit of payload data to two bits of data transmission. Convolutional coding helps to correct individual bit errors that are from random errors. The net gain from convolutional coding is about +5.7 dB. Now we're nearly back to where we were with legacy ALERT.

Reed Solomon encoding is a Forward Error Correction algorithm that contains information used to detect and correct errors that usually result from burst noise. Enhancements to R-S performance are achieved by shortening certain message components or blocks; in this case from 255 bytes down to 24 for header blocks and 32 for follow on blocks. The net result is a +11 dB gain. And there's more! If there is an uncorrectable error, the algorithm tells you so you won't use a bad message.

The result from all of these ALERT2 improvements is that ALERT2 has a net +10.7 dB gain. Factoring in the negative side of greater message length, the net result of applying the gain from improved bit error rates is that an ALERT2 message is about twice as likely as an ALERT message to get through without an error.

The previous analysis covers random noise and burst noise, but there is another major difference between ALERT and ALERT2 implementations. Legacy ALERT messages are transmitted using ALOHA, a protocol where each gauge transmits randomly with respect to the others. The most common form of ALERT message failures during storm events are random radio message collisions with other ALERT transmissions. The more ALERT transmissions in a given time period, the more likely data will be lost due to collisions. Unfortunately, that will likely occur during a big event when you need data the most.

ALERT2 uses Time Division Multiple Access (TDMA) as the preferred network configuration. TDMA design gives each transmitter its own GPS-regulated time slot so that no two sites will transmit at the same time. For ALERT2, this eliminates any data loss due to collisions.

When you put everything together, it is clear why ALERT2 should perform better than ALERT. Looking at interference from either random or burst noise, ALERT2 messages are twice as likely to arrive unscathed. In addition, the potential for high numbers of ALERT data message collisions is eliminated. ALERT2 TDMA results in zero message collisions.

In theory and now in practice, ALERT2 messages are more likely to arrive error free. Isn't that what we wanted to know in the first place?

References

ALERT2 TWG (2012), ALERT2 AirLink Layer Specification Version 1.1, National Hydrologic Warning Council ALERT2 Technical Working Group Public Interest Documents.

Roark, R. C. and Van Wie, D. G. (2003), Feasibility Study of a New Air Interface and Physical Layer Packet Definition for the ALERT User Community, Feb. 2003, contract deliverable to ALERT Users Group (AUG).

7th Annual NHWC Texas Workshop

Spring 2015 Floods

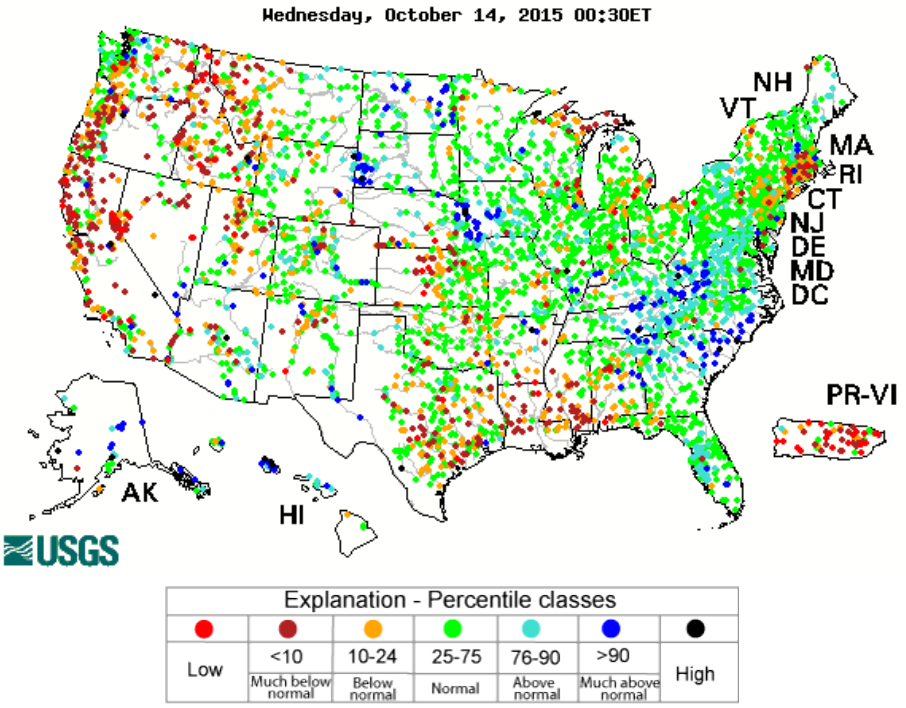
October 28 - 29, 2015 the NHWC will be hosting the 7th Annual Texas Workshop in Austin, TX at the Lower Colorado River Authority. This 2-day interactive workshop will focus on the spring floods across Texas including flood warning systems performance, flood forecasting and warnings, flood impacts, reservoir operations, and post flood activities. Other topics include radio frequency encroachment, NOAA Atlas 14, and ALERT2 rollout. For more information and to register, follow this link.

NHWC Northeast Regional Workshop

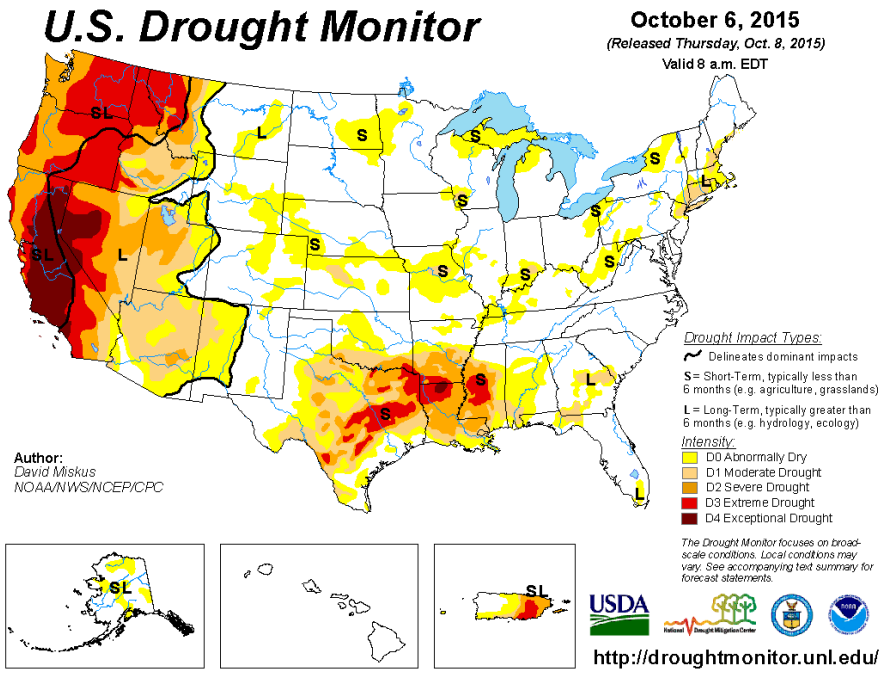
Advancing Community Resilience through Enhanced Emergency Management Systems

It has been more than 10 years since the last workshop was held in the northeast region. On November 4-5, 2015 the NHWC will be hosting this workshop in Albany, New York. This workshop is designed to bring together flood warning professionals from around the region to promote community resilience through advanced flood warning systems. Covering a range of topics related to flood warning, from case studies and use of social media in flood warning to the National Flood Insurance Program, attendees will learn from experts in the field. Plan to come for the meeting and stay for the weekend to enjoy the many recreational opportunities the region provides! For more information and to register, follow this link.

Hydrologic Conditions in the United States
Through October 6, 2015



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



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

November Newsletter Articles Focus: Hydrology

The NHWC is requesting articles that focus on hydrology - the science behind the work we do.

Please consider preparing a short article about new methods, research, or discoveries in hydrology or a recent significant hydrologic event.

Submit your article to:

editor@hydrologicwarning.org

November 6th is the deadline for inclusion in the November issue.

Future Newsletter Articles Focus

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

Nov - Hydrology
Dec - Hazard Communication & Public Awareness
Jan - Modeling/Analysis
Feb - Data Collection

NHWC Calendar

October 28-29, 2015 - 7th Annual Texas Workshop Spring 2015 Floods, Austin, Texas

November 4-5, 2015 - NHWC Advanced Flood Warning Workshop, Albany, New York

General Interest Calendar

November 4-6, 2015 – Arizona Floodplain Management Association Fall 2015 Conference, Safford, Arizona

April 18-22, 2016 - ALERT Users Group Training Symposium and Preparedness Workshop, Tenaya Lodge at Yosemite National Park, California

August 21-26, 2016 – HIC 2016, 12th International Conference on Hydroinformatics, Incheon, Korea

(see the event calendar on the NHWC website for more information)

Parting Shot

ALERT Users Group Fall Training & Meeting

Over 50 people attended the ALERT Users Group Annual Fall Training and Meeting on September 24th in Sacramento, California.

Photo by Ron Marotto, Ventura County Watershed President, ALERT Users Group

National Hydrologic Warning Council

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

http://www.hydrologicwarning.org