Local Office Service Assessment

Central Iowa Floods of 2008

Late May through Mid June, 2008

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service
Weather and Forecast Office – Des Moines, Iowa

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Contents

Cover Photo: *A Union Pacific bridge is partially swept away by high floodwaters on the Cedar River in downtown Waterloo, Iowa on Tuesday June 10, 2008. With rivers continuing to rise and more heavy rain on the way, state officials said Tuesday they were trying to help towns already battered by floodwaters while working to protect others. (AP Photo/*The Waterloo Courier*, Morgan Hawthorne)*

Overview

This service assessment focuses on the historic flooding in central Iowa from late May 2008 through June 2008. It is specific only to the National Weather Service Des Moines (DMX) area of responsibility, which includes 51 central Iowa counties and 46 river forecast points on 3 major river basins.

During this time period, the DMX Senior Service Hydrologist (SSH) position was vacant. The SSH vacancy had major impacts on office workload, on staff availability to handle the flood threat, and ready expertise regarding central Iowa's rivers and flood impacts.

In addition to the flooding threat, the DMX staff also tackled numerous severe weather outbreaks during which 362 Severe Thunderstorm and Tornado Warnings were issued, and 483 reports of severe weather were recorded, including 63 reports of tornadoes.

Hydrologists from other National Weather Service (NWS) locations were rotated through the DMX office on a temporary basis during peak flooding, and their efforts were appreciated. Still, heavy workload demands (including 240 hours staffed at the State Emergency Operations Center (SEOC)) caused the flood forecast responsibility to fall upon the entire DMX staff, and not just one or two individuals. Normally this effort would be expertly handled by the DMX Senior Hydrologist, maintaining a focus and a time continuity that was difficult to match during the floods of 2008.

As such, this service assessment summarizes the efforts of the entire DMX staff to provide exemplary flood warning and forecast services, with the attendant positive and negative aspects. Fifty-seven findings and recommendations for improvement were identified by the DMX staff, reflecting their desire to provide better service more efficiently in future events. Most of the recommendations were internal to NWS operations, so they are summarized here for brevity.

Figure 1: Iowa map showing counties in the DMX area of responsibility or County Warning Area (CWA).

Central Iowa Floods of 2008 Service Assessment Team

A service assessment team was formed shortly after the floods began to recede. The team goal was to evaluate the DMX service and operations, plus external response to the event. The Central Iowa Floods of 2008 Service Assessment Team focused on three primary areas: internal operations and forecast process, NWS products and service, and external service and response. This assessment reviews multiple events over a period of weeks, and on time scales from flash flooding to mainstem river flooding.

The service assessment team reviewed the events, met numerous times to discuss best practices and findings, and developed recommendations to the findings to improve DMX operations in future events. It is the team's goal to accurately detail the NWS's role in the event and to improve future operations.

Internal operations and forecast process:	Karl Jungbluth, Ben Moyer, Melinda Albrecht, Rod Donavon, Frank Boksa, Jeff Zogg
NWS products and services:	Ben Moyer, Steve Teachout, Karl Jungbluth
External service and response:	Roger Vachalek, Brenda Brock
Overview of rainfall and flooding:	Ken Podrazik, Miles Schumacher

Acronym Definitions

12Planet – internal NWS chat software used for office forecast collaboration

AL – annual leave

AOP – Annual Operating Plan

ARX – National Weather Service La Crosse, WI

BLESS – an internal NWS procedure for approving river forecasts before they are disseminated

CDT – Central Daylight Time

CFS – Cubic Feet per Second

CO-OP – Cooperative Observer

CRH – Central Region Headquarters

CSI – critical success index

CTA – call-to action

CWA – county warning area

DATAC – Data Acquisition employee

DMOI4 – Des Moines River at 2nd Avenue forecast and observation point

DMX – National Weather Service Des Moines, IA

DVN – National Weather Service Davenport / Quad Cities

EC – event coordinator

EF3, EF5 – Enhanced Fujita Scale tornado damage rating of 3 and 5, respectively

EM – emergency manager

EMChat - Internal chat room used to communicate between DMX personnel and county emergency managers of central Iowa

EOC – Emergency Operations Center

ESF – Hydrologic Outlook

FAR – false alarm ratio

FEMA – Federal Emergency Management Agency

FFA – Flash Flood Watch

FFMP – Flash Flood Monitoring and Prediction software

FFW – Flash Flood Warning

FLW – Flood Warning

GHG – Graphical Hazard Generator

HIC – Hydrologist-In-Charge

HMT – Hydro Meteorological Technician

HSEMD – Iowa Homeland Security Emergency Management Division

HWO – Hazardous Weather Outlook

HydroView – hydrologic data viewing and manipulation software

ICP – Incident Command Post

IDOT – Iowa Department of Transportation

IEM – Iowa Environmental Mesonet

ITO – Information Technology Officer

LP1 – Local Primary Emergency Activation System

MIC – Meteorologist-In-Charge

MICRN – Metro Incident Command Radio Network

MRCC – Midwest Regional Climate Center

NCRFC – North Central River Forecast Center

NOAA – National Oceanic and Atmospheric Administration

NWR – NOAA All Hazards Radio

NWS – National Weather Service

NWSChat – NWS sponsored internet-based chat software used to communicate with various external partners

OAX – National Weather Service Omaha/Valley, NE

PDS – particularly dangerous situation

POD – probability of detection

QPF – quantitative precipitation forecast

RFC – River Forecast Center

RiverPro – river product formatting software

SEOC – State Emergency Operations Center

SEOCChat – Internal chat room used to communicate between NWS representative at the SEOC and NWS offices serving Iowa

SOO – Science and Operations Officer

SSH – Senior Service Hydrologist

SVR – Severe Thunderstorm Warning

USACE – United States Army Corps of Engineers

USGS – United States Geological Survey

WarnGen – warning generation software

WCM – Warning Coordination Meteorologist

WFO – Weather Forecast Office

Summary of Rainfall and Historic Flooding

The Des Moines, Cedar, and Iowa River basins, including their tributaries, were affected in the late spring and early summer by the historical Midwest Flood of 2008. The flooding began with an active 2007-2008 winter season where abundant snowfall and ice accumulations occurred across the state. Below-normal temperatures and above-normal precipitation played a significant role in the record-breaking flooding of May and June 2008.

Iowa Governor Chet Culver confirmed that damage across the state was nearly $10 billion, making it the worst disaster ever to occur in the state of Iowa. The flooding across Iowa and the rest of the Midwest resulted in the governor declaring 86 of the 99 counties in Iowa as state disaster areas. In addition to the state disaster areas, federal disaster declarations were issued by FEMA (Federal Emergency Management Agency), for 80 of Iowa's 99 counties. Within the DMX CWA, 44 of 51 counties were declared a federal disaster and all but three were declared state disaster areas (Figure 2). Property and crop damage across Iowa reached incredible amounts from the Flood of 2008. Estimates on property damage may exceed one billion dollars once all insurance claims are complete, while the statewide crop damage exceeded four billion dollars. At the height of the flooding in mid June, roughly 2.5 to 3 million acres of corn and soybeans were underwater which placed just over 50% of the statewide crop in the categories of fair, poor, or very poor condition for each crop.[1] An estimated 2.3 million acres, or about 10% of Iowa's cropland, had severe soil erosion. Soil erosion is defined as 20 or more tons of soil loss per acre. According to the Iowa Department of Agriculture and Land Stewardship, an estimate of $40 million in damages occurred to water conservation structures.

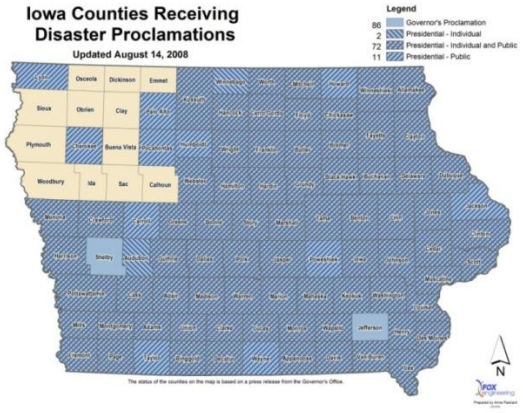


Figure 2: Iowa Counties Receiving Disaster Proclamations from the State of Iowa and the Federal Government.

[1] USDA Iowa Crops & Weather, Vol 08-15.

The Iowa Department of Transportation (IDOT) had major infrastructure damage to primary highways, secondary roads, bridges, and the railroad system. Reports from the state indicated that 125 miles of primary highway in Iowa were washed out completely by the flooding and forced the closure of 464 miles worth of Iowa's primary highway system. Over three hundred bridges and overpasses where damaged or destroyed. Around 1500 miles of road were in need of replacement following the floods. The preliminary damage estimate for road infrastructure was $80 million statewide. The IDOT Office of Rail Transportation reported 17 railroad bridges and over 400 miles of track were damaged or destroyed by the flood waters. Along with the railway itself, replacements of the crossing signals, mile markers, and other related railroad equipment were needed. The statewide damage to the railroad system was estimated between $68 million and $83 million, and was expected to take 6 to 12 months to repair from the time of the disaster. If the loss of revenue due to delays and costs from re-routing of shipments was included, this number would increase dramatically.

The extremely active weather pattern which sparked the historic flooding began during the week prior to Memorial Day, and the bulk of the precipitation continued through the middle of June (Figure 3). From May 22nd through June 15th 2008, Des Moines, Iowa received 13.4 inches of rainfall. Waterloo, Iowa received 12.8 inches of rainfall during this same 25-day span. In sixteen of the twenty-five days, Des Moines and Waterloo received measurable precipitation greater than 0.01 inches. Some of the heaviest daily rainfall totals occurred between June 5th and June 8th. In fact, a record daily rainfall amount of 4.15 inches occurred on June 5th in Des Moines.

On June 7th, Webster City, Iowa, received a record daily amount of 4.40 inches and on June 8th, Mason City, Iowa, received a record 4.90 inches. During the height of the flooding on June 12, 2008, WSR-88D Doppler radar estimated 8 to 15 inches of rainfall accumulated across central to northeastern Iowa over and including the previous 14 days (Figure 4). The statewide average precipitation from January to June 2008 was 24.47 inches which was 8.13 inches above normal. This became the wettest January to June period on record. Statewide records date back to 1873. The Iowa statewide average precipitation for June 2008 totaled 9.01 inches, which ranks as the second wettest June among 136 years of records. Several cooperative observer (CO-OP) stations across Iowa reported record rainfall amounts for the month of June 2008 (Figure 5).

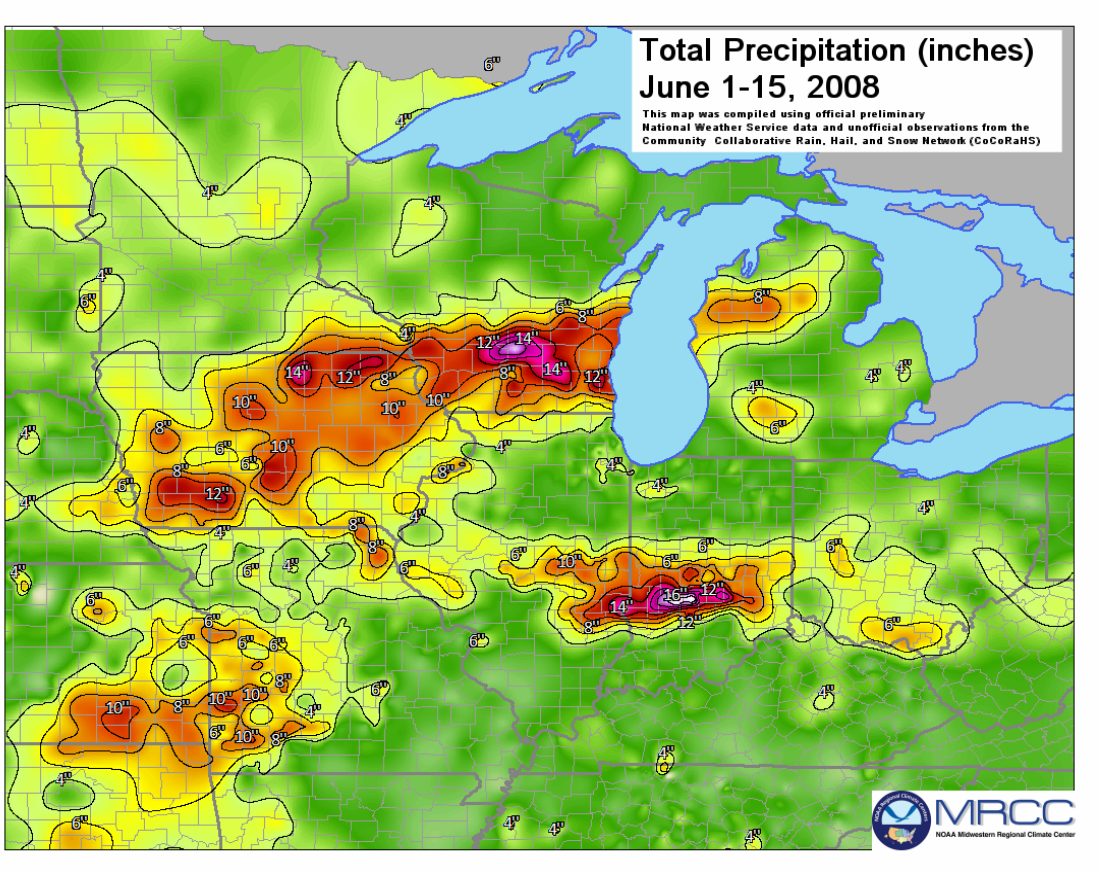


Figure 3: Total precipitation (inches) during the period of June 1-15, 2008. Map courtesy of Midwestern Regional Climate Center (MRCC).

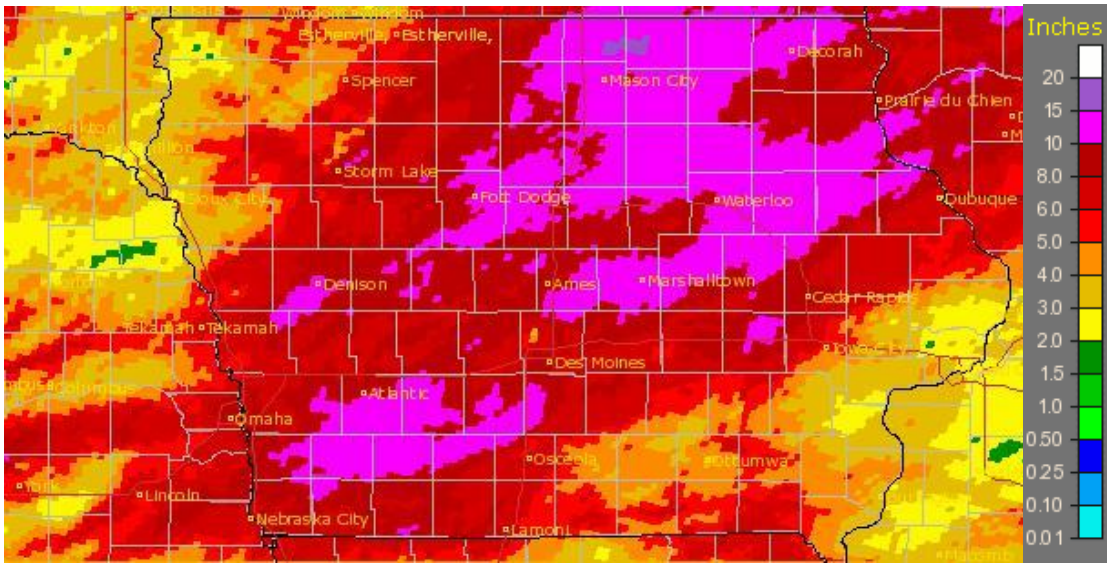


Figure 4: June 12, 2008 radar-estimated total rainfall across Iowa for 14 days ending on the 12th.

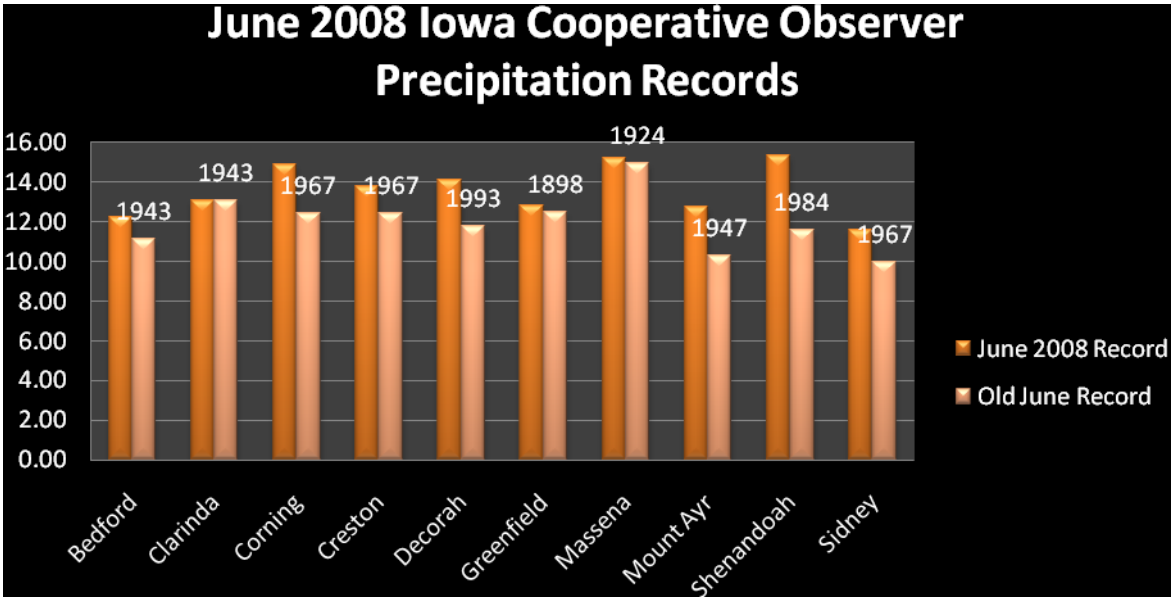


Figure 5: Iowa CO-OPs that broke precipitation records for the month of June.

According to the Iowa Crops & Weather report, provided by Iowa State Climatologist Harry Hillaker, for the week ending June 1, 2008, the statewide average precipitation was 2.32 inches, which more than doubled the weekly normal of 1.04 inches. This week was Iowa's wettest week in 40 weeks. The following week, ending June 8, 2008, the statewide average for precipitation was 5.00 inches which was 575% of normal for the week. The highest report was a 2-day unconfirmed amount of 16.27 inches in Dorchester (northeast). And for the week ending June 15, 2008, the statewide average precipitation was 2.30 inches; once again more than double the normal amount of 1.10 inches.[2]

Out of the 46 river forecast points within the DMX CWA, eleven sites reached record crests during the month of June 2008 (see Table 1 and Figure 6). Twelve other forecast points within the DMX CWA reached major flood stage, as well as Saylorville Reservoir. In fact, Saylorville reached a near record height of 890.87 feet, which was a mere 1.16 feet off the 1993 record level. Water came extremely close to the bottom of the Mile Long Bridge (Highway 415) over Saylorville Lake (Figures 7 and 8). The Des Moines River at 2nd Avenue (DMOI4) crested on June 13th at 31.57 feet with a river flow rate over 50,000 cubic feet per second (CFS). CFS is defined as a volumetric flow rate that is equivalent to a volume of one cubic foot flowing every second through a given surface. In other words, the flow rate is the volume of fluid which passes through a given surface per unit time. A great visual interpretation of CFS is to compare

[2] USDA Iowa Crops & Weather, Vol 08-13

it to a basketball, which is roughly one cubic foot in volume. Hence, 50,000 CFS can also be seen as a wall of 50,000 basketballs per second flowing by a given point.

A levee breech occurred on June 14, 2008 near the Birdland area, close to downtown Des Moines. This prompted Des Moines city officials to issue voluntary and mandatory evacuations to the residents of around 270 homes in the Birdland area. Several other notable areas affected in and around Des Moines were Gray's Lake, Des Moines' North High School (Figure 9), and Principal Park (Figure 10).

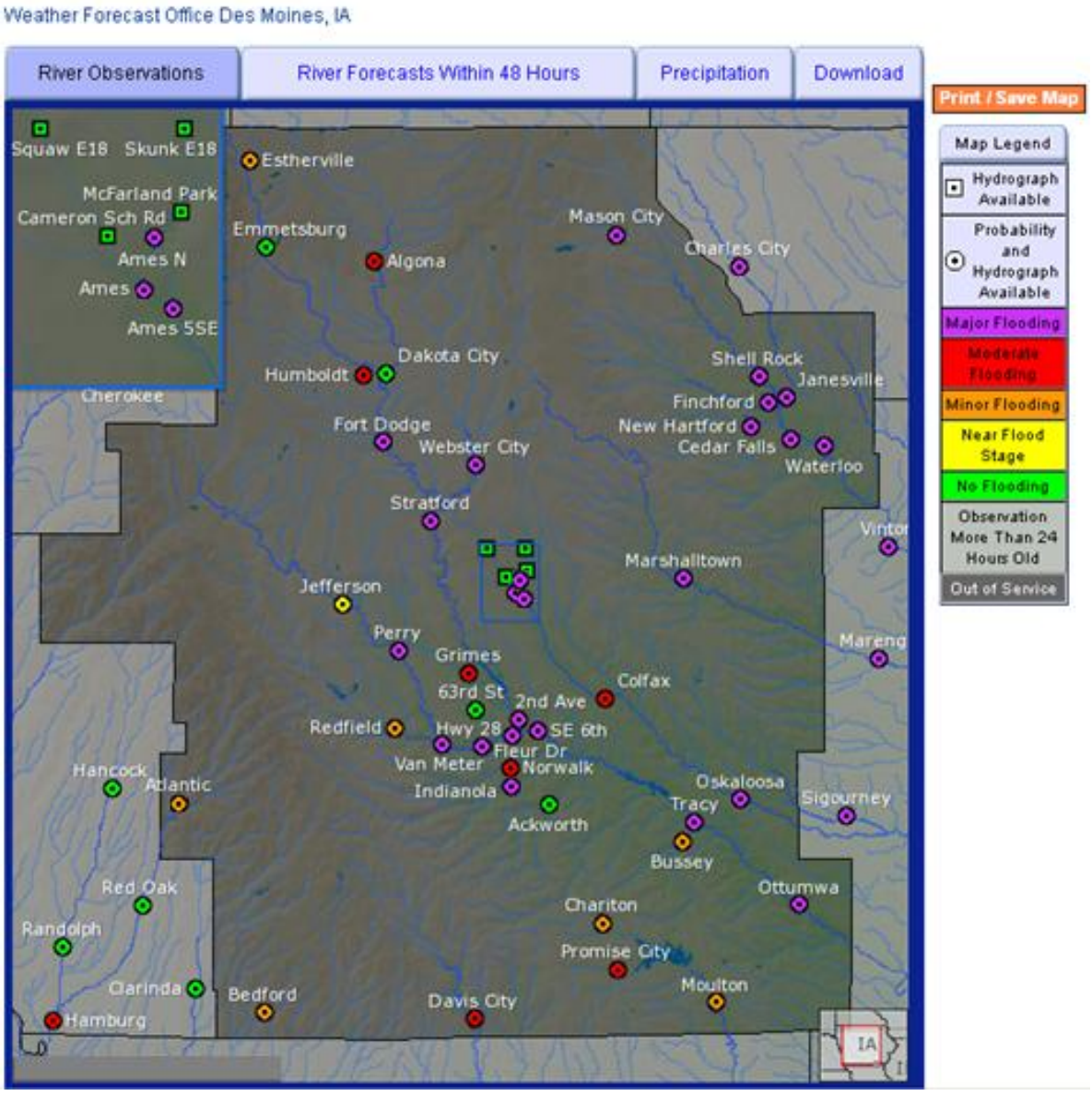


Figure 6: River forecast points within the DMX CWA that reached flood stage from late May through the middle of June 2008. The majority of the crests across central Iowa occurred from June 9th to 13th.

Gage Location	Water Body	Flood Stage	Record Stage	Date	2008 Crests **(Preliminary)**	Date
New Hartford (NHRI4)	Beaver Creek	10 FT	13.50 FT	06/13/1947	***15.71 FT***	***06/09/2008***
Webster City (WBCI4)	Boone River	12 FT	19.10 FT	06/10/1918	17.74 FT	06/10/2008
Janesville (JANI4)	Cedar River	11 FT	17.15 FT	07/22/1999	***19.45 FT***	***06/08/2008***
Waterloo (ALOI4)	Cedar River	12 FT	21.86 FT	03/29/1961	***27.01 FT***	***06/11/2008***
Cedar Falls (CEDI4)	Cedar River	88 FT	96.20 FT	07/23/1999	***102.10 FT***	***06/11/2008***
Fort Dodge (FODI4)	Des Moines River	10 FT	19.62 FT	06/23/1947	15.73 FT	06/08/2008
Saylorville Reservoir (SAYI4)	Des Moines River	NA	892.03 FT	07/11/1993	890.87 FT	06/12/2008
Below Saylorville Reservoir	Des Moines River	NA	24.12 FT	07/11/1993	24.03 FT	06/13/2008
Des Moines Southeast 6th Street (DESI4)	Des Moines River	24 FT	34.29 FT	07/11/1993	***35.55 FT***	***06/13/2008***
Des Moines 2nd Avenue (DMOI4)	Des Moines River	23 FT	31.71 FT	07/11/1993	31.57 FT	06/13/2008
Ottumwa (OTMI4)	Des Moines River	10 FT	22.15 FT	07/12/1993	20.58 FT	06/17/2008
Stratford (STRI4)	Des Moines River	14 FT	25.68 FT	04/02/1993	***27.32 FT***	***06/09/2008***
Tracy (TRCI4)	Des Moines River	14 FT	26.50 FT	06/14/1947	23.70 FT	06/14/2008
Marshalltown (MIWI4)	Iowa River	18 FT	20.77 FT	08/17/1993	***21.79 FT***	***06/13/2008***
Indianola (IDNI4)	Middle River	19 FT	26.90 FT	06/05/1947	25.55 FT	06/06/2008
Perry (PROI4)	North Fork Raccoon River	15 FT	23.00 FT	07/10/1993	21.67 FT	06/10/2008
Van Meter (VNMI4)	Raccoon River	16 FT	26.34 FT	07/10/1993	22.67 FT	06/13/2008
Des Moines Fleur Drive (DEMI4)	Raccoon River	12 FT	26.70 FT	07/11/1993	24.66 FT	06/13/2008
Des Moines Highway 28 (DMWI4)	Raccoon River	32 FT	43.00 FT	07/11/1993	41.31 FT	06/13/2008
Shell Rock (SHRI4)	Shell Rock River	12 FT	17.70 FT	04/01/1856	***20.36 FT***	***06/10/2008***
Ames 3 Miles North (AMEI4)	South Skunk River	14 FT	15.87 FT	06/17/1996	***16.93 FT***	***06/09/2008***
Oskaloosa (OOAI4)	South Skunk River	17 FT	25.80 FT	05/01/1944	24.61 FT	06/13/2008
Finchford (FNHI4)	West Fork Cedar River	12 FT	18.45 FT	07/29/1990	***20.82 FT***	***06/10/2008***
Mason City (MCWI4)	Winnebago River	7 FT	15.70 FT	03/30/1933	***18.74 FT***	***06/09/2008***

TABLE 1: A list of the river forecast points within the DMX CWA that reached record or major flood stage during the Flood of 2008. The shaded light green rows are the river forecast points which set new record stages in 2008. These crests are preliminary. The USGS will provide official crest data later in 2009.

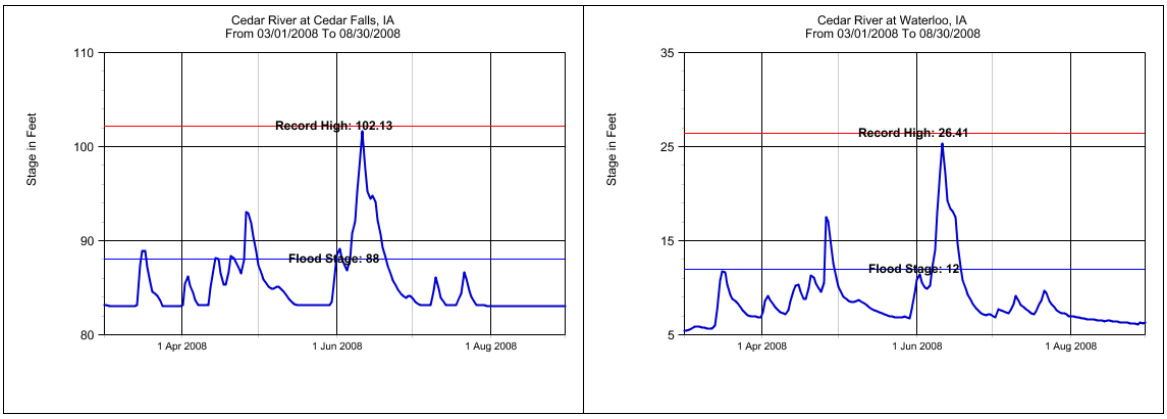
Figures 7 (left) and 8 (right): Saylorville Lake and the Mile-Long Bridge (State Highway 415 to Polk City, IA) during the week of June 12th 2008. Photos are courtesy Iowa Department of Transportation and Boone News Republican.

Figure 9 (left) shows flooding of North High School between 6th Avenue and 2nd Avenue due to a levee breech along the Des Moines River on June 14, 2008. Photo source is unknown.

Figure 10 (right) shows Principal Park in Downtown Des Moines, Iowa at the confluence of the Raccoon and Des Moines Rivers. Photo is courtesy of Roger Riley.

Extensive flooding occurred along the Cedar River in Waterloo and Cedar Falls within the DMX CWA. Some minor and moderate flooding occurred towards the end of March and throughout April before the river fell below flood stage during the second half of May. An abrupt increase in the flow and river levels at Cedar Falls and Waterloo began on or shortly before June 1st,

2008, prior to cresting on June 11th at the record levels of 102.13 feet and 25.39 feet, respectively (Figures 11 and 12). On the Cedar River in Waterloo, the flow rate reached over 105,000 CFS during the crest on June 11th. Relating back to the basketball analogy, during the crest in Waterloo, one could imagine a wall of 105,000 basketballs per second flowing past the forecast point in Waterloo. Near the forecast point in Waterloo, the Union Pacific Railroad Bridge was overtopped and washed out due to the record flood (Figure 13) with the cost to replace the bridge estimated at $5.6 million. The Main Street Bridge and railroad bridge just upstream in Cedar Falls was nearly overtopped (Figure 14).



Figures 11 and 12: Cedar River Hydrograph at the forecast points in Cedar Falls and Waterloo, IA. Graphs are courtesy U.S. Army Corps of Engineers.

Figure 13 (left): Cedar River in Waterloo, IA on June 11, 2008. Photo is taken by Associated Press David K. Purdy.

Figure 14 (right): A railroad bridge used by the Union Pacific Railroad and Iowa Northern in Waterloo, IA was overtopped and washed out. Photo is courtesy of Altered Stars and Weather Underground.

Figure 15: Main Street Bridge and railroad bridge over the Cedar River at Cedar Falls during the week of June 11-15, 2008. Photo is courtesy of Gaylen Isely.

Upstream of Cedar Falls and Waterloo, there are many tributaries which include forecast and data points within the Cedar River basin. The tributaries that feed into the Cedar River include the Beaver Creek, Black Hawk Creek, Shell Rock River, Winnebago River, and the West Fork Cedar River. Forecast and data points along these tributaries are located at New Hartford, Hudson, Shell Rock, Mason City, and Finchford. In addition to the tributaries, on the Cedar River there is a forecast point located at Janesville and a data point at Waverly. Record crests were reached at both sites. A record crest of 19.68 feet occurred along the Cedar River in Janesville, which crested on June 8th and at Waverly where a crest of 19.33 feet was reached on June 10th. With the exception for the Black Hawk Creek at Hudson, every other river forecast and data point (within the DMX CWA) along the stretch of the Cedar River basin reached a record crest from June 8th through June 11th 2008. Major flooding occurred in several cities and towns along the Cedar River and its tributaries. One of the more incredible occurrences was in Mason City as the Winnebago River actually changed course during the flooding and flash flooding events. Water covered vehicles in downtown Mason City and a local quarry filled with water during the crest of the Winnebago River (Figures 16 and 17). The city was

completely inundated and the city water supply was disrupted for several days. Janesville and Finchford gauges stopped reporting the river levels due to the inundation of the water (Figure 18). The record crest at Waverly inundated much of the town and flooded several businesses and homes during the second week of June (Figure 19).

Figure 16 (left) taken on June 8th, 2008 in Mason City, IA at 13th and Elm Drive. Photo is courtesy of Jeff Heinz of the Globe Gazette. Figure 17 (right) shows the Winnebago River flowing in the Holcim Quarry located just north of Mason City. Photo is courtesy of Arian Schuessler of the Globe Gazette.

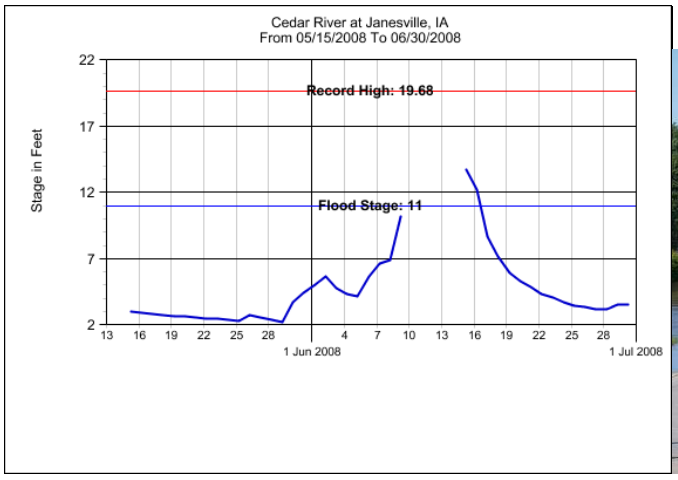


Figure 18 (left) is the hydrograph of the Cedar River at Janesville from May through August 2008. During the height of the flood in the first part of June, the gage stopped reporting. Graphs are courtesy U.S. Army Corps of Engineers. Figure 19 (right) shows major flooding in Waverly, Iowa affecting the Dollar General retail store and several other businesses during the week of June 7-12, 2008. Photo is courtesy of Reynolds Cramer.

Leading up to the historic flood during the summer of 2008, the winter months of December 2007 to February 2008 played a significant role in the foundation for the floods. Temperatures across the region were below normal (Figures 20 and 21), while precipitation remained above normal across the state of Iowa (Figure 22). Heavy amounts of snow accumulated across Iowa during these winter months and remained on the ground into the early part of spring. In fact, March was the only month leading up to the floods that was below normal for statewide precipitation, but any precipitation that fell, generally fell as snow and fell quite regularly (Figure 23). The statewide average snowfall amount for March 2008 was 4.3 inches which was 0.5 inches below normal and the statewide average temperature was 32.0° Fahrenheit, which was 4.0° colder than normal. The precipitation events during March 2008 were frequent, but light in amounts. Overall, about half of the days in March recorded precipitation. For instance, Mason City and Waterloo recorded 20 and 16 days of precipitation of at least a trace, respectively. With the frequent precipitation and below normal temperatures the soil across much of Iowa remained very soggy. It also made for poor driving conditions on many unpaved roadways.[3] Snow remained on the ground over the northeast half of Iowa even towards the end of the month (see Figure 24) as about 4 inches or greater were still on the ground over much of the Iowa and Cedar River basins towards the end of March. In addition, ice on rivers had a difficult time breaking up, and any moisture within the soil likely had a difficult time draining or drying out because of the lack of sunshine and warm temperatures. In fact, some minor flooding occurred due to the snow melt and ice jams in March and April over portions of central Iowa.

Climate statistics from February 1st to mid-June in Mason City, Waterloo, and Des Moines, were further evidence that the below normal temperatures and above normal precipitation played a role in the soil moisture content across Iowa. For instance, the longest stretch of days without precipitation was 7 days (occurred once) at Waterloo, 6 days (occurred once) at Des Moines, and 4 days (occurred 4 times) at Mason City during the aforementioned time frame. Roughly 60 percent of the days or 3 out of every 5 days from February to mid-June recorded precipitation of at least a trace in the three cities. Between Waterloo, Mason City, and Des Moines, seven individual daily precipitation records were set between the months of April to mid-June. Waterloo set a new monthly record in April 2008 with 10.79 inches of precipitation.

[3] Iowa Dept. of Agriculture & Land Stewardship. Iowa Monthly Climate Summary March 2008.

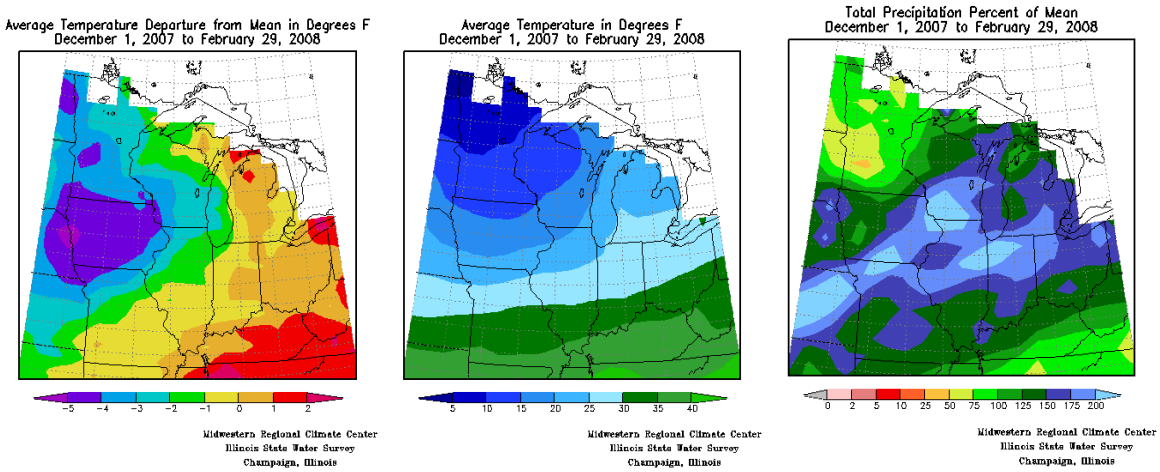


Figure 20 (left) shows average temperature departure from mean for winter 2007-2008.
Figure 21 (center) shows average temperature in degrees F for winter 2007-2008.
Figure 22 (right) shows total precipitation percent of mean winter 2007-2008. All three maps are courtesy of Midwestern Regional Climate Center.

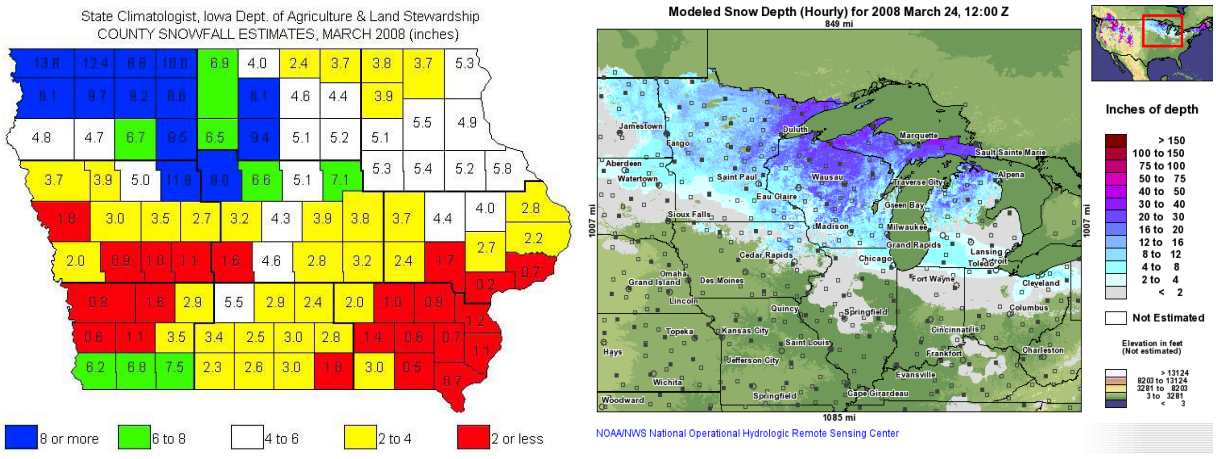


Figure 22 (left) shows total snowfall amounts for March 2008.Map courtesy of Iowa Department of Agriculture & Land Stewardship.
Figure 23 (right) shows modeled snow depth for March 24th, 2008. Map courtesy of Midwestern Regional Climate Center.

The active weather pattern continued right into the spring, which delayed most farmers from planting crops until May. This problem not only occurred across much of Iowa, but throughout the majority of the Midwest and Ohio Valley (Figure 24). With the delay in planting corn and other crops, much of the rain and snow melt drained into the creeks and rivers without being absorbed by growing crops. There were several events where rain mixed with snow across Iowa, even into late April. The last recorded snow in Waterloo and Des Moines was on the 12th of April, and not until April 25th for Mason City. The first half of June averaged 2.1° Fahrenheit warmer than normal and it appeared that Iowa would break its string of six consecutive below normal months. However, the second half of the month averaged 2.2° Fahrenheit cooler than normal, allowing the cold weather streak to extend to seven consecutive months. Waterloo, Mason City, and Des Moines were prime examples of the average temperature remaining below normal for an extended period of time (Figure 26).

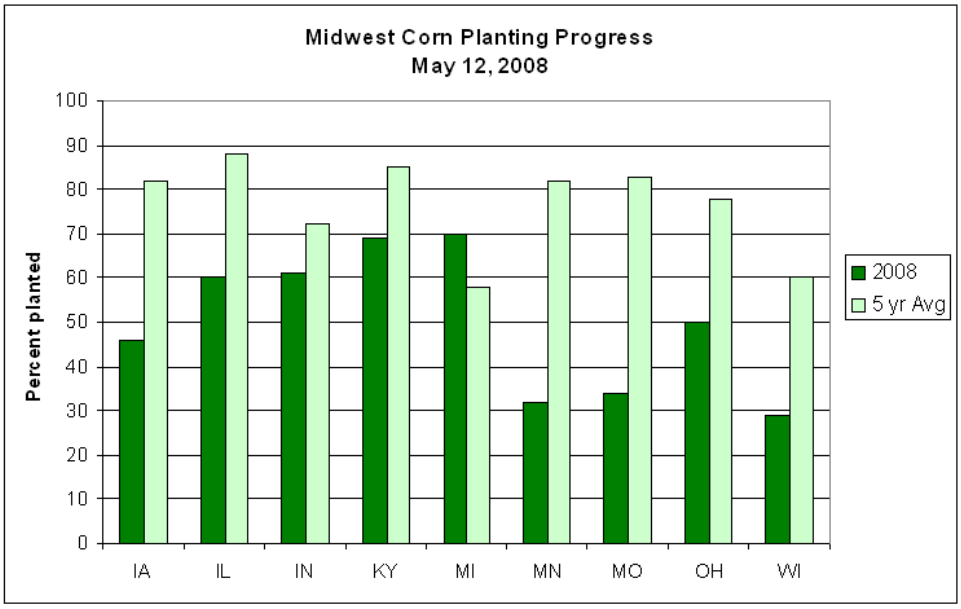


Figure 25: Midwest corn planting progress by mid-May 2008

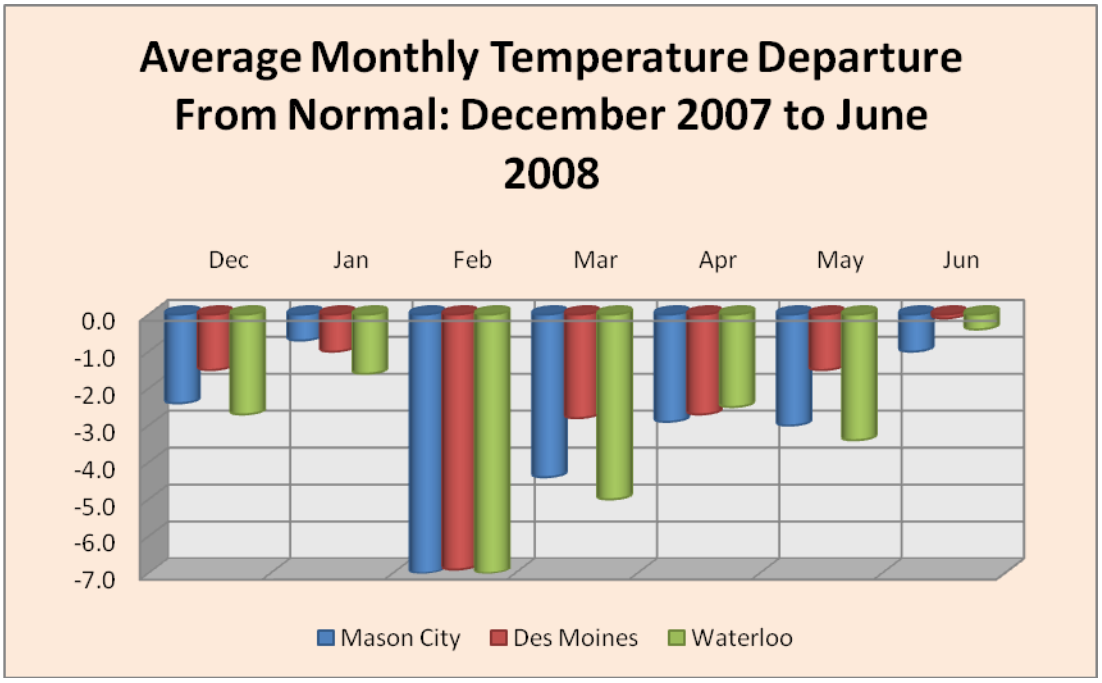


Figure 26: Mason City, Des Moines, and Waterloo, IA average monthly temperature departure from normal. Time frame is from December 2007 to June 2008.

Several CO-OP stations across Iowa, as well as the rest of the region, received record or near record precipitation during the month of May and June 2008 (Figure 5). The hardest hit rainfall areas were in central to northeast Iowa within the Cedar and Iowa River basins, where the worst flooding occurred. Record flooding occurred with these aforementioned river basins along with their tributaries. The Des Moines and South Skunk River basins received record and major flood within their respective basins. The amount of flood damage was not as extensive as the Cedar and Iowa River basins, but nonetheless, millions of dollars of flood damage occurred from Des Moines to Ottumwa within the Des Moines River basin, and from Ames to Oskaloosa along the South Skunk River. Along with the record and major river flooding, flash flooding posed a significant problem to the DMX CWA from late May through mid June. Flash flooding will be discussed in detail in a specific section. Nearly a year after the historical Flood of 2008, Iowans are still cleaning up and re-building their homes and businesses.

NWS Products and Services

An internal review of all flood-related products was performed. This review concentrated on writing quality, format, and validity of content as it related to the intent of the product and the expected action of users. An external survey of product quality and service was sent to emergency managers, law enforcement and response personnel, media partners, Iowa Homeland Security and Emergency Management, major utility providers, and the Iowa State Fair Authority. The survey focused on the quality of service and products issued by DMX during the Flood of 2008. Respondents provided both positive feedback and constructive criticism. These will be used to continue successful practices and improve practices for future events.

Facts

For the three month period of May, June, and July of 2008 the following numbers of hydrological and local storm products were issued by DMX. Each "product" often contained information for multiple counties or river segments.

- 20 Hydrologic Outlooks (DSMESFDMX)
- 34 Flood Watches (DSMFFADMX)
- 137 Flash Flood Warnings (DSMFFWDMX)
- 470 Flash Flood Statements (DSMFFSDMX)
- 119 Flood Warnings (DSMFLWDMX)
- 583 Flood Statements (DSMFLSDMX)
- 50 Urban/Small Stream Flood Advisories (DSMFLSDMX)
- 1 Hydrologic Statement (DSMRVSDMX)
- 56 County Flood Warnings (DSMFLWDMX)
- 196 County Flood Statements (DSMFLSDMX)
- 428 Local Storm Reports for Flooding, Flash Flooding, and Heavy Rainfall (DSMLSRDMX)

Text Product Formatters for Warnings and Forecasts

Best Practices

- DMX staff added value to the "FORECAST…" section of River Flood Warnings. For example, in the RFC forecast, the river was often predicted to drop below flood stage at a given time because quantitative precipitation forecasts (QPF) are not included at longer time ranges. DMX staff often added, "However, any additional rainfall across central Iowa will prolong the time that the river is above flood stage."

Summary of Findings, Recommendations and Actions

- Finding #1: Due to limitations of River Product Formatter (RiverPro) software and its configuration, written flood warnings and statements often did not contain enough detail or impact information to serve most users. Impact statements save time for dispatchers, emergency managers, law enforcement, city and county engineers, Department of Transportation, and incident command personnel as they try to figure out where threatened areas are located within their community. Impact statements also assist in the response and mitigation phases of the disaster.
  Recommendation/Action #1: DMX will work to fully update impact information over the next year. Software has already been adjusted to include more impact information and flood forecast details into warnings and statements. In addition, DMX will work to decrease the number of redundant call-to-action statements and text errors, which should result in a more concise and understandable text for users.

External Service and Response

Communication with external partners and the media proved very effective in most instances, with many compliments regarding the level of service and professionalism exhibited by DMX during the Flood of 2008. During the height of the flood from June 7th through June 17th, the level of targeted service to severely flooded areas increased dramatically, resulting in a significant increase in communication and coordination workloads.

Examples of typical feedback from external partners follow:

…"there is a continuing trend of very engaged and responsive coordination from DMX"

… "NWS staff worked tirelessly to keep officials updated on forecast predictions as well as actual current events"

Best Practices

- Continue a pro-active stance with communications and forecasts issued to customers at all times, especially when emergency situations arise that need extra and repeated attention.
- Continue to make every warning meaningful by keeping follow-up statements important. Include details of affected roads, areas flooding, and communities currently or forecast to be affected. Keep information timely.
- Keep warning areas as close to the threat area as possible. Continue to pro-actively remove areas no longer flooded after consulting with local law enforcement or emergency management.
- Continue operational staff training in the area of river gage data quality control so they can recognize when gages fail due to clogging, overtopping, or destruction as was the case during the Floods of 2008.
- Continue to utilize all avenues of communication, providing the best service possible. Continue to provide exceptional personal service, when added value is requested. Continue to call on additional staff members for assistance, and redistribute workload to accommodate special requests.
- When issuing or updating areal flood warnings or flash flood warnings, continue to give detail about expected rainfall occurrence, as well as projected additional rainfall at specific points. Rainfall information emphasizes the immediacy and danger of the event, and solidifies the importance of the issued product.

Facts

- Some users stated that impact statements in river flood warnings are important, and should be included in warning products (see Product Formatters section above).

  "Impacts are critical…flood stage and river level are ok, but it provides minimal value unless I know what the river impacts are"

  "Just like the NWS, we have limited resources and can't get out to all of the locations, nor do we have easy access to information from local officials about what they are seeing"

- Though different users had differing positive and negative experiences as for accuracy and usefulness of river flood forecasts and warnings, along with different preferences during the event, a number of common themes emerged from responses by our partners. These included the desire to have a longer lead time than 24 hours for river flood warnings.

- Users expressed the following comments regarding our river flood forecasts and warnings:

  "more frequent updates – hourly – would have been helpful…more complete picture of what is going on upstream…earlier predictions of the maximum flood elevation at crest…crest predictions kept going up as the flood progressed, compounding the difficulty of flood fighting efforts"

  "you did not have much information of what was coming down the river toward us…besides agricultural lands…as the flood levels increase and there are additional impacts, especially to critical infrastructure, this is when flooding that is occurring is critical as we respond"

  "One thing that would be helpful would be more discussion of the downstream effects of rain events…I think the concept of uncertainty needs to be addressed…we need to know exactly what of the future forecasted rain events are being included in that prediction (river level forecast)…that way we can add a caveat to our presentations for example… the river is forecasted to crest at 10pm tomorrow if we receive ¼ to ½ inch of rain this afternoon"

- The effectiveness of areal flood warnings varied depending on the size and duration of the warning. Specific information is generally favored over generically worded warnings. Detail adds to the effectiveness and urgency of the warning. Frequency of some product updates can become burdensome for some users, especially in a prolonged event.

- Users expressed the following comments regarding our areal flood warnings:

  "Information about the expected elevation levels on river and impact on small streams needs more emphasis"

  "the new, detailed statements are a vast improvement over generalized messages in any given area…these messages when scrolled on TV…help our public safety dispatchers as they reduce the number of calls by concerned residents wanting specific information to smaller rivers and creeks near their homes"

  "At times the updates seemed excessive, especially when there was no change in the situation"

  "the more specific you can be…the more serious the impacted areas/residents take (the warning)"

  "product frequency is a difficult issue to address…many of the flood statements are repeated many, many times due to the long term flood…and some areas a very short time frame (rapid rise/fall)… feel the long term situations have the product on the air too frequently"

- Flash flood warning response and effectiveness also varied with timeliness and duration of overall event. There were times when a warning may have been left in effect longer than was necessary. Other times the warning may not have been issued quickly enough. Some of the challenge in timeliness is a result of cooperation of reporting partners, their staff availability to maintain a useful weather watch, and willingness to alert our office when flooding is occurring or has ended.

- Users expressed these comments regarding DMX flash flood warnings:

  "Flash flood warnings were pretty good…I would like to see the likely roads to flood be added to the text, though"

"In some of our flash flooding events, the warnings have been after the fact…this happened several times…people were already being advised to evacuate prior to the release of the warning, (April 25 and June 8)."

"In this event, I'm not sure the flash flood warnings were especially effective…there had been so much rain for so long, that it was all a flash flood, it seemed."

- Overall, users again commended the office on the service and support provided during the Flood of 2008. Some concerns were voiced over the lack of face-to-face contact at the Polk County Incident Command Post (ICP). Other users requested the updated Hazardous Weather Outlook (HWO) be issued between 3 and 3:30 pm to use for staff briefings prior to shift release at 4 pm in the afternoon. Some users felt there was not enough lead time during some high-impact situations which left them unprepared for the unfolding event.

- Users expressed these comments regarding information dissemination and text products:

"The information was useful and appropriate for this event. This type of information should be generated from the Command Post and not the State EOC. There should be an assigned person at the I.C.P. for each event. This puts a face to face dissemination of information and questions, interpretations and forecasting which can be evaluated onsite by the Command Staff for each event. This is a vital format when developing a plan to act upon a disaster event or potential event. The assignment of a weather person to the Command Staff should become mandatory for the implementation of IMT units and ERGs"

"I would forward the DSM NWS HWO and Flood Forecasts to all members of the Department of Public Safety, via E-mail, every morning. I received many thanks from Department members statewide for sharing that information with everyone that I would obtain off your website….It helped to plan and prepare for potential adverse conditions or worsening of conditions in a given area"

"The forecasting is an area of excellence. The use of the MICRN is impressive and directly impacts our operations and employee safety. Recently, there have been more reports on MICRN of storms outside the immediate area, giving a warning to the MICRN area. This is a great trend that should continue… The flooding forecasts could always be faster. A number of evacuations seemed to be forced by flash flooding, but in the more general rise of waterways, the forecasting was accurate"

- There were several instances of equipment failure or malfunction during the prolonged event. The most notable – NWR transmitter failures in Carroll and in Marshalltown caused some service challenges for our partners and public. During the flood, equipment malfunctions at river gages resulted in bad data – leading to delays in some decisions while the gage was checked by NWS or other agency personnel. In the case of several overtopped gages, no useful gage reading was possible which resulted in a very difficult prediction and coordination process for DMX and the River Forecast Center (RFC), and for users of our products.

- Users expressed these comments regarding the equipment and malfunctions:

  "The only problems we experienced were related to inaccurate data created because of debris at/near gage sites. Many locations do not have survey markings for stages marked on bridge supports or other structural references. This would be helpful and was suggested by many communities along Beaver and Four Mile Creeks."

  "Our local NOAA weather radio was out for a time because of flooding in the area of the tower. The DMX NWS office took this project on and relocated the tower temporarily to a building within Marshalltown. The only work we needed to do was to talk to the local business (RACOM Critical Communications) to get the permission for the temporary placement and then inform the public about what was going on and how to reprogram their weather radios. The rest of the hard work was done by the NWS office. Great job!"

- There were numerous positive comments regarding service during the bulk of the flooding event. However, there were two instances when during the overnight hours and after normal business hours, assistance to one of our partners was less than expected.

- Users expressed these comments regarding some service issues and response:

  "Yes, they were easily reached. However, after your full time hydrologist left and during the night when your 'loaner' was not on duty. I called several times to ask questions...the only answer I got was 'all the information they had was on the internet.' I had already looked at the internet...and the forecast was for the river level to drop … it was apparent that was not going to happen as the river basin was getting 5 inches of rain and my area was getting 5 inches of rain. There was no one that could answer my questions of what the 5 inches of addition rain in both areas MIGHT affect the highways I had that was about to go under water. I was a little concerned about that. It was the first time I had encountered that issues and was a little disappointed in the answers."

"Yes. Always. We would like a hydrologist on staff there at all times, but we still received good information in a reasonable amount of time. Local hydrologists know the rivers & conditions much better than the River Forecast Centers do. That personal attention is so very helpful during flood & severe weather events. DM NWS was very accessible at ALL times."

"Yes. The NWS DSM Office is staffed with some of the most capable and easily approachable professionals I have ever dealt with. They all exhibit a deep knowledge of the weather, its effects on people and infrastructure, and they all portray a very vested interest in what they do and the important role they have in community service. I am always impressed with the Des Moines NWS Office."

Findings, Recommendations and Actions

- Finding #2: Emergency managers expressed a need for more upstream information and eventual downstream impacts to their community and property. Users expressed an interest in knowing the quantitative precipitation basis for the river forecasts, giving them a better understanding of the forecasted crest. There appears to be a growing need for probabilistic flooding forecasts – not only for crest timing but for crest height as well. The most severely impacted locations felt that our forecasts sometimes chased the river downstream.
- Recommendation #2(a): DMX should consider issuing river flood warnings with lead times longer than 24 hours when forecaster confidence exists. Partners and users need much more time to prepare for "significant to record" flooding in populated areas compared to "minor or moderate" agricultural flooding.
- Recommendation #2(b): Determine the future availability of probabilistic flooding forecasts and the need for any outreach and training to utilize those forecasts.

- Finding #3: More detailed products are favored by emergency managers and law enforcement over those with less detail. Detailed information causes people to act and take the warning more seriously. Specifically naming affected roads, communities, rivers, and basins greatly assists in this challenge. Statements lacking updated information, even if issued at high frequency, appear to send a message of less urgency to agencies and the public.

- Recommendation #3: DMX should consider increasing the amount of detail placed in warnings and statements, and consider decreasing statement frequency for long-duration events where conditions have not changed or no new information is available.

- Finding #4: Some partners questioned value of additional FFWs after extensive episodes of flooding had already taken place. The public was inundated with flood-related information due to the extended floods of 2008.
- Recommendation #4: DMX should consider developing criteria/guidelines for a "particularly dangerous situation (PDS)" product suite specific to hydrologic products, such as PDS Flood and Flash Flood Watches to heighten awareness of an impending significant flood event. Extra media outreach could emphasize yet another heightened threat.

- Finding #5: All DMX users found that candid discussions about future impacts, and greater accessibility to our forecasts and data, helped them to make the best decisions possible for their response. Communication during high-impact events like the Flood of 2008 – whether scheduled at the request of a partner, or via unscheduled updates, proved valuable.
- Recommendation #5: Investigate the feasibility of using GoTo Meetings, or other web-based image sharing software, to facilitate briefings for several users at the same time during emergency or near-record conditions over a wide area. This type of targeted communication might be implemented for events that require multiple, daily, targeted briefings to several partners. (See Finding #6 for other recommendations)

- Finding #6: The Incident Command Post (ICP) at the Polk County Emergency Operations Center (EOC) wishes to have a DMX meteorologist dedicated to them, in addition to an NWS representative at the SEOC, for future events. This could facilitate Polk County's planning and allow for continual access to meteorological assistance.
- Recommendation #6(a): Investigate methods to provide all county EOCs with enhanced briefings, including graphical information, via computer from the DMX office, instead of personally staffing individual county EOCs. This would allow DMX to utilize all of their information gathering and prediction systems, and to deliver the most up to date and comprehensive information to Polk County as well as *all* impacted jurisdictions.
- Recommendation #6(b): Investigate the use of DMX staff at the SEOC, and SEOC briefings, to enhance the service provided to the local ICP at the county level EOCs.

- Recommendation #6(c): Should the situation and staffing allow, investigate the feasibility of providing an NWS meteorologist, even one from outside of the DMX staff, at the Polk County ICP during high-impact events. This person would directly support the ICP staff and would be in addition to the support already provided to the SEOC. Preparedness activities with the EMs should emphasize the need for EMs to voice their expectations and needs when county EOCs are activated.
- Recommendation #6(d): Determine if the solution to staffing the Polk County ICP is applicable to all of the fifty-one counties that DMX serves, potentially several at the same time, and not just to Polk County (although it is understood that Polk County is the largest population center in Iowa).

- Finding #7: Two NWR transmitters went down during the event. In one instance (see Figure 27), the notification of local authorities was quickly completed while during the second event, the local emergency manager was not notified in a timely fashion. This emergency manager was not prepared for an alternative method of emergency message dissemination and monitoring, had there been an additional need following the transmitter failure.
- Recommendation #7: Make certain to contact the local warning point Local Primary Emergency Activation System (LP1) station and notify appropriate local county officials as soon as it is confirmed that an NWR transmitter is inoperable. Adjust DMX policy to ensure completion and logging of these actions.

Figure 27: Dave Reese, DMX Electronic Systems Analyst, wades to the red NWR transmitter building at Marshalltown, Iowa (left) and DMX Intern Ken Podrazik (right) inside the water-logged transmitter building on June 9 , 2008.

- Finding #8: An update to the HWO later than 4 pm is too late for some county engineers to effectively use, prior to the end of their normal day shift. The HWO is used to brief road crews of upcoming weather during the night. It was suggested that if the HWO could be updated prior to 3:30 pm, the information could be used in their end-of-day meetings.
- Recommendation #8: If possible, update the HWO closer to 3 pm so partners are better able to incorporate any updated information.

National Weather Service Internet Service

- Finding #9: DMX staff wanted to provide enhanced information and visibility for the flood threat on the DMX internet page, but time was not available to implement this during the floods.
- Recommendation #9: The SSH at DMX has already upgraded the DMX Rivers and Lakes webpage to display more river observation points, and include more unique local data resources. The SSH at DMX should also work with the Information Technology Officer (ITO) and the DMX Hydro Team to identify and implement a template "Top News of the Day" page to be used on the DMX internet page in conjunction with flood events.

State Emergency Operations Center (SEOC)

The SEOC was activated several days prior to the flooding, due to the May 25th EF5 tornado in Parkersburg and New Hartford on the Memorial Day weekend. DMX staffed the SEOC briefly during that time. Weather briefings (conference calls) were also conducted on Friday, June 6th with an updated conference call at noon on Sunday, June 8th, covering the hazardous weather outlook, including flooding.

Following the May 25th tornado, NWS staffing resumed for an additional 240 hours beginning on Sunday afternoon, June 8th, 2008. This included two 8-hour shifts the 8th and 9th. Twenty-four-hour NWS staffing began at the SEOC Tuesday, June 10th and continued until Tuesday, June 17th, 5 pm. The NWS also staffed the SEOC from June 18th to June 20th between 7 am and 5 pm. DMX staff included: Brenda Brock (Meteorologist in Charge (MIC)), Jeff Johnson (Warning

Coordination Meteorologist (WCM)), and meteorologists Ben Moyer, Roger Vachalek, Jim Lee, and Ken Podrazik. NWS Davenport/Quad Cities (DVN) staff included: Stephan Kuhl, MIC.

Numerous briefings, including national press coverage, were conducted for Governor Culver, Lieutenant Governor Judge, Adjutant General Ron Dardis, Iowa National Guard, Homeland Security, IDOT and Iowa Law Enforcement in the Executive Quarters. Separately, numerous briefings per shift were also conducted for over forty agencies present within the SEOC, since agency representatives often changed and new personnel were on board. Concerns included the safety of flood fighters during sandbagging, including the National Guard, law enforcement and volunteers during rescues of people and animals.

During the SEOC operations, the threat of severe weather continued with tornadoes and high winds. In addition to current and forecasted river levels, weather briefings included outlooks for potential severe weather. After the Little Sioux Boy Scout Ranch EF3 tornado, briefings in the Executive Quarters also required focus on severe weather safety while the SEOC briefings concurrently focused on Midwest flooding.

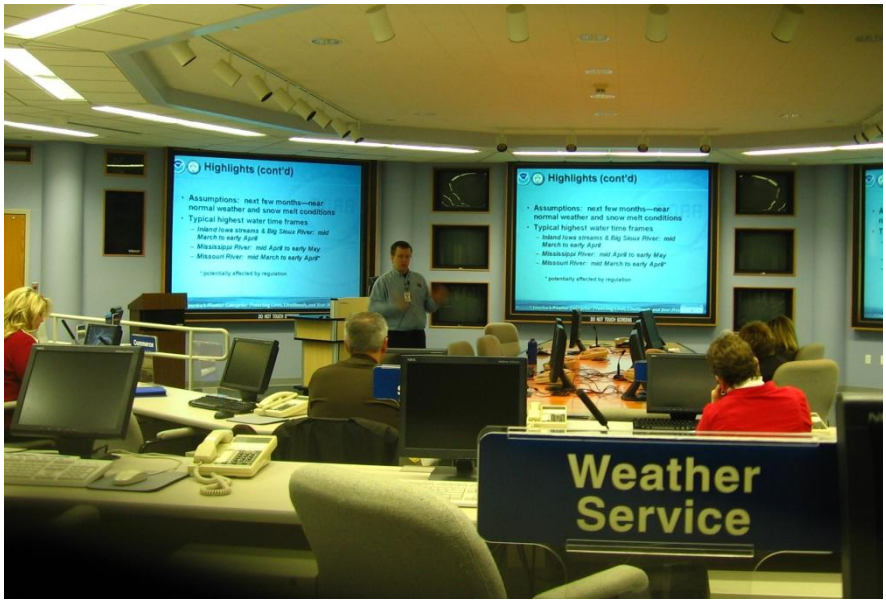


Figure 28: Example of a briefing at the SEOC, taken after the Flood of 2008 by Brenda Brock, NWS DMX.

Best Practices

- Coordination between the SEOC and DMX via SEOCChat is a best practice. SEOCChat should continue to be used at all times when there is an NWS representative at the SEOC, which is current DMX policy.
- SEOCChat, a chat room including emergency managers and NWS offices, was a great enhancement to coordination for all NWS offices involved. It was frequently used by the RFCs and NWS offices, DMX and DVN. NWS La Crosse, Wisconsin (ARX) added comments when they were occasionally in the chat room. Coordination with DVN (mainly Jeff Zogg, Service Hydrologist) was exceptional, especially on June 12th. All affected NWS offices should be informed when their chat participation is needed, since it proved to be such a valuable communication tool.
- DMX maintained a high level of coordination with DVN. Collaboration with Jeff Zogg, DVN Service Hydrologist at the time, resulted in excellent NWS communication for the media and weather briefings, and prevented conflicting coverage.
- The NWS's SEOC representative notified DMX and DVN of critical information, such as levee breaches.
- Using the internet at the SEOC, including heavy use of graphical information, is a best practice**.**
- Executive briefings at the SEOC were precise and keep short.
- On numerous occasions, the NWS SEOC representative helped agencies make critical decisions by adding value to NWS forecasts.

Facts

- The SEOC was activated for the EF5 tornado and remained activated up to and including the Midwest Floods of 2008.
- NWS employees were deployed to the SEOC and kept an "event log" to document all activities.
- Many separate "county" EOCs were activated in numerous Iowa counties, including metropolitan Des Moines in Polk County.
- At the height of the flooding, Des Moines Public Works held daily 10 am meetings for flood preparedness and public safety. The initial NWS representative was Brenda Brock, MIC from DMX, on June 18th to 20th. However, since she was also working the SEOC 6 pm-6 am shifts, this produced a conflict. Shane Searcy, ITO and former staff

meteorologist, assumed the meeting attendance and conducted the weather briefings from June 12th to 14th.

- Major non-hydrologic events during the Midwest Floods of 2008 also required attention of the NWS SEOC representative. This included:
    - June 11, Wednesday, 635 pm (Tornado Warning, 623 pm, NWS Omaha/Valley, NE (OAX)) - Tornado in western Iowa, Monona County, that killed four boy scouts and injured over forty people. There were 93 scouts and 25 leaders at the remote camp. Information was relayed from the SEOC to OAX. Brenda Brock, MIC was at the SEOC when the tornado occurred. Iowa Homeland Security Emergency Management Division (HSEMD) Administrator David Miller requested an actual copy of the tornado warning. Brenda phoned OAX and an on duty meteorologist, Barbara Mayes, faxed the tornado warning copy to the SEOC. This was handed to Governor Culver, HSEMD and the Iowa National Guard. Brenda briefed the National Guard on aviation and ongoing severe weather conditions for their immediate travel to the camp. Based on aviation safety concerns, the Iowa National Guard drove the Governor to the Little Sioux Boy Scout Camp that evening. Federal Emergency Management Agency's (FEMA) Secretary Michael Chertoff also planned to arrive at the camp on Thursday morning, so this information was also sent to NWS Central Region Headquarters, OAX and DMX.
- Both DVN and DMX staffs did an outstanding job helping answer questions and prepare briefs for those stationed at the SEOC.

Findings, Recommendations and Actions

- Finding #10: On Sunday, June 8th, at the SEOC, there were several conference call weather briefings provided to the governor's office, HSEMD, emergency managers (EM) and state officials. EM participants during the noon briefing included all 99 counties in Iowa. The NWS found this to be an overload of weather information for one call, and possibly made the call less effective for participants.
- Recommendation #10: Conduct separate SEOC and EM conference calls.

- Finding #11(a): Two NWS SEOC representatives were often needed at the same time, especially during critical periods, usually on the day and evening shifts. The duties required an NWS representative be on the SEOC floor at all times, but the NWS representative was frequently in the Executive Quarters or other locations within the

SEOC to provide updates. There was also a need for time to prepare updated analysis, while the NWS representative was occupied with media briefings or Executive Quarters briefings.

- Finding #11(b): The SEOC representative from DMX may not have the knowledge needed to cover the entire state. Better customer service would include NWS representatives at the SEOC from all impacted areas.
- Recommendation #11: The NWS should provide additional, trained SEOC representatives from other NWS offices when DMX does not have the additional staffing available, or when non-DMX portions of Iowa are impacted. The DMX MIC should inform NWS Central Region of the need for added SEOC staffing assistance (action completed, but still needs reinforcing).

- Finding #12: There was no initial communication between the Polk County EOC and DMX for the Birdland levee failure. The Birdland levee failure in Des Moines was reported to the SEOC around 3 am, on June 14th, but not to DMX by Polk County. MIC Brock, while at the SEOC, called DMX within a few minutes to provide details on the width of the levee breech, only to find out that they had not been notified.
- Recommendation #12(a): DMX encourages emergency management officials to directly inform DMX when levees fail, or major changes in the flood situation occur. This communication is necessary so that FFWs can rapidly activate the NWR and the Emergency Alert System, and provide the law enforcement officials the water levels expected downstream of the failures.
- Recommendation #12(b): The NWS has an excellent rapport with Polk County Emergency Management and DMX will find out why the direct communication failed. Communication platforms and protocols are in place, including Metro Incident Command Radio Network (MICRN) and EMChat.

- Finding #13: The United States Geological Survey (USGS) is to be commended for their excellent service. Although no additional staffing was available, USGS staffing at the SEOC would provide the NWS a direct contact for quick information exchange.
- Recommendation #13: DMX should make a recommendation to the USGS and HSEMD for USGS representation at the SEOC.

- Finding #14: Crest forecasts for the Cedar basin, from Charles city downstream, were considerably below the observed crests. This caused major issues at the SEOC, credibility problems for the NWS, and the SEOC NWS representative had to explain the discrepancy. The low forecasts also caused inadequate flood protection measures to be taken, had a negative impact on flood-fighting operations, and were difficult to explain at the SEOC.
- Recommendation #14: Extreme rainfall events and record floods are challenging to forecast, and they also produce the highest impacts to our users. Both DMX and NCRFC should continue to explore methods to meet this challenge in future events.

- Finding #15: In one instance, when multiple DMX employees were involved with briefings, some conflicting and outdated information was presented.
- Recommendation #15: Continue the frequent collaboration, and the DMX Senior Meteorologists should assign a dedicated briefing and media contact person, when possible.

- Finding #16: Coordination with the United States Army Corps of Engineers (USACE) was much improved with USACE representatives present at the SEOC.
- Recommendation #16: DMX should thank the USACE for their participation, and reinforce the value of this practice for future events.

Internal Operations and Forecast Process

Flash Flood Operations

DMX performed well in flash flood operations, with a probability of detection (POD) of 0.90 meeting national GPRA performance goals, and surpassing the NWS national average POD of 0.79 for 2008. A mean lead time of nearly 1.5 hours exceeded the 2008 national GPRA goals by over 50 minutes, and bested the 2008 NWS national average by nearly half an hour. Nearly one-third of DMX warnings went unverified, however, with a false alarm ratio (FAR) of 0.31. The FAR was highest during the peak of the flooding, but this still bettered the NWS national average FAR of 0.45. Recommendations for improvement will be included in this section of the assessment. The new storm-based warning approach reduced total warned area by 57%, when compared to the old county-based warning method.

Storm-based flash flood statistics throughout the height of the flooding from 05/24/2008 through 06/15/2008

Group	Total Warning Count	Verified Warnings	Unverified Warnings	Total Event Count	Warned Events	Unwarned Events	POD	FAR	CSI	Mean Lead Time (min)	Percent County Reduction warning area
DMX	**98**	**68**	**30**	**145**	**140**	**5**	**0.90**	**0.31**	**0.64**	**99.83**	**57%**

Facts

Seventy-one percent of all 137 FFWs issued during May, June, and July 2008 were issued during the 3-week period from May 24th through June 15th.

Sixty-seven percent of all 137 FFWs issued during May, June, and July 2008 occurred within the first 2 weeks of June.

Although heavy rain occurred on many days through the first few weeks of June, there were three main flash flood events that had the greatest impacts throughout the DMX CWA (Figure 1), and ultimately led to the record river flooding. The following will examine these events in greater detail. The first event occurred during the evening of Wednesday, June 4th into the early morning hours of June 5th, with flash flooding occurring across much of the southern CWA and a portion of the northern CWA. Two large, slow-moving supercells moved through the area Wednesday evening, with additional development farther west moving through overnight, continuing to bring additional rainfall through early Thursday morning. The greatest impact from the heavy rainfall was felt in Union and Adams Counties. Flooding occurred near the town of Creston, and much of the town of Corning flooded due to rising water from the nearby Nodaway River. Several houses and businesses on the northeast side of Corning were reported to have been inundated with water (Figures 29 and 30).

Figure 29: Flooding in the city of Corning. Photos courtesy of the official NWS storm survey.

Figure 30: Flooding near the Adams County Speedway in the city of Corning. Photo Courtesy of Bob Simon.

The second event occurred the following evening, Thursday, June 5th into the early morning hours of Friday, June 6th. This event covered a larger area with flash flooding reported across much of the central CWA. The greatest impacts from this event were felt throughout the Des Moines metro area, and in the town of Cambridge in Story County. An area of thunderstorms moved northward through the area Thursday evening with additional development to the south which allowed for the heavy rainfall to continue across the area into the early morning hours Friday. The town of Cambridge flooded from the rising water of Ballard Creek on the northwest side of town. Significant flooding of streets, homes, and basements was reported in Cambridge with twelve people evacuated from their homes. Some streets were closed due to the flooding, and over four inches of rainfall was reported.

The third event was even more widespread than the previous two, with flash flooding occurring across much of the entire CWA. This event began the evening of Saturday, June 7th and continued into the evening hours of Sunday, June 8th. Thunderstorms continued to track across northern Iowa through the evening hours of Saturday, and the thunderstorm line extended back into central Nebraska. The line slowly migrated southward through the overnight hours Saturday, and into the daytime hours Sunday. The line finally moved out of the area by Sunday evening. Several inches of rain fell across the northern portions of Cerro Gordo County and

southern Worth County, with the runoff flowing into the Winnebago River. The rising water of the Winnebago River flooded the city of Mason City on June 8th. A detailed analysis of the DMX operations leading up to the events and during the events has been provided below.

On May 31st, HWOs mentioned aggravation to the ongoing flooding 5 to 6 days ahead of the events. There was specific mention of flash flooding already on June 2nd for the Corning flash flood that occurred on the evening of June 4th into the morning of June 5th, and for the Cambridge flash flood event that occurred in the early morning hours of June 6th. An FFA was issued at 416 am CDT on Wednesday, June 4th in effect from noon CDT that day through that evening. At 341 pm CDT that afternoon the FFA was extended in time through 7 am CDT Thursday morning and expanded northward to encompass portions of central Iowa in addition to south-central Iowa. An EM conference call was held at 1 pm the afternoon of June 4th to further discuss the severe/flash flood event expected that evening. Adams and Union County EMs were both on the conference call. The first FFW was issued at 825 pm CDT with the first report of heavy rain coming in at 1040 pm CDT in Union County. Flooding of Corning in Adams County began at 1049 am CDT June 5th.

At 417 am CDT June 5th, an FFA was issued for the Cambridge flash flood event that included most of central Iowa for that afternoon through 7 am CDT June 6th. The FFA specifically mentioned additional heavy rainfall across areas that had received 4 to 6 inches of rainfall earlier that night during the evening hours on June 4th. Another EM Conference Call was held on June 5th for the severe weather/flash flooding expected that evening. The first FFW was issued at 740 pm CDT the evening of June 5th for western Adams and Cass Counties. The first report of heavy rain came at 1155 pm CDT in Polk County. The significant flooding in Cambridge occurred at 330 am CDT June 6th.

For flash flooding that occurred over the weekend of June 7-8th, the HWO emphasized the possibility for more flooding beginning the with the morning issuance on June 4th. The FFA was issued at 432 am CDT June 7th for nearly the entire CWA. The FFA specifically mentioned thunderstorms potentially training over the same area, and widespread rainfall amounts of 1 to 2 inches, with locally higher amounts in excess of 3 inches. At 354 pm CDT June 7th the FFA was expanded to the southeast to include a few more counties across south-central Iowa. The first FFW was issued at 432 pm CDT for Winnebago and Worth Counties. The first flash flood report came at 635 pm CDT that evening in Winnebago County. The Mason City levee failure occurred at 730 am CDT June 8th. At 445 am CDT June 8th, the FFA was extended until 7 pm CDT that evening. At 353 pm CDT June 8th the FFA was expanded to include the remaining six southeastern counties of the CWA that had not been in the previous FFAs. It was also extended in time through 7 am CDT Monday June 9th. An EM conference call was also conducted for this event highlighting the significant severe/flash flood event expected Saturday evening into

Sunday. This 2-day period alone accounted for much of the record flooding that occurred, and included 26% of all FFWs issued during May, June, and July 2008. An average of 3 to 6 inches of rainfall accumulated across a broad swath of the state extending from west-central through north-central, and into parts of central and northeastern Iowa.

Best Practices

- Two warning meteorologists created a "work" file, which allowed the text of reports to be easily copied and pasted into the WarnGen statement when updates were needed.

- Completion of hourly statements to update each FFW, as required, and included any new reports and updates to existing reports.

- Initiated hourly calls to dispatch centers located in the counties under FFWs to gather new reports and updates existing reports.

- Updated Areal Flood Warnings to include any new reports and update existing reports.

- Conducted EM conference calls for moderate/significant events, highlighting the expected threats of upcoming significant weather.

Findings, Recommendations and Actions

- During May, June, and July, DMX issued storm-based FFWs that decreased the area warned by 57% from the old county-based warning system. Therefore, DMX will continue to implement this storm-based FFW concept. Additional staff training, with a focus toward only warning affected basins, should continue to improve and focus warning service.
- A variety of flood warning products were issued to keep responders and the public informed of flood threats. In this effort, it was determined that the DMX staff need to be more consistent in use of each specific warning "product" (areal flood warning, flash flood warning, for example), so that users always know where to look for a specific type of information.
- Due to the widespread nature of the heavy rainfall, staffing levels needed to be increased to account for the massive workload of issuing FFWs, calling county dispatch centers, and updating FFW statements. Increased staffing would allow the hydrologic warning team to maintain situational awareness, and better anticipate new flood threats.

River Flood and Small Basin Operations

Best Practices

- DMX staff was very proactive issuing Flood Warnings (FLW) for small basins, areal flood warnings and river FLWs, along with appropriate updates.
- DMX staff members were also very proactive in gathering fresh information and reports to support the warnings and statements, and to provide service to our partners and the public.
- DMX coordinated numerous times per day with the North Central River Forecast Center (NCRFC). The NCRFC was open 24 hours per day and made many unscheduled forecast updates.
- Internal communication between forecasters and Hydrometeorological Technicians (HMT) was said to be excellent, and senior meteorologists did a good job recognizing events.
- Site-Specific model (internal NWS forecast model designed for use with smaller, fast-responding basins) and RFC forecasts were both used for the Ames event, in addition to spotter information and precipitation information from radar and mesonet sources.

Findings, Recommendations and Actions

Overall, as noted elsewhere in this assessment, flood warnings and forecasts were timely and provided useful information to external users. Still, the DMX staff noted many items within our *internal* operation that could be streamlined or improved to provide better and faster service in the future. This section briefly summarizes those items.

- Finding #17: In the case of *quick-responding* river forecast points, the unprecedented Floods of 2008 produced many challenges. Forecast crests with customer-useable lead time were often underestimated.
- Recommendation #17: DMX will continue to explore methods, including the best use of all precipitation measurements and estimates, to ensure that the forecast process responds as quickly as the rivers during major events. The goal is to arrive at the best forecast as early as possible, especially in record flood situations. DMX will also explore the utility of RFC QPF contingency forecasts, and how this information would be communicated to our customers in tandem with official crest forecasts.

Finding #18: For locations that were not river forecast points, DMX staff struggled to provide specific crest and impact information that users needed. Example: Belmond and Waverly, Iowa.

- Recommendation/Action #18: DMX should embark on in-office training to include river behavior, river cross sections and routing from the USGS and USACE, and time-to-crest between forecast points, all in an attempt to fill the information gap for users who are not near a forecast point. Since the floods of 2008, Waverly was made an official forecast point.

- Finding #19: Updated USGS flow measurements were extremely useful during the flood.
- Recommendation #19: DMX should make every effort to include the USGS in NWSChat rooms. This would facilitate quick exchange of information, and to make that information available for all external users.

- Finding #20: The DMX SSH position was vacant during the *entire* major flood event. The challenges associated with a record flood event, and at times a lack of staff experience (almost all staff members were rotated into and out of flood duties) exposed weaknesses in staff knowledge of the details of flood forecasting. Higher level awareness was at times clouded by heavy workload and the mechanics of updating warnings and statements. Temporary duty hydrologists were deployed from other offices to help fill the gap, but basically it took very time-consuming hard work by the DMX staff to allow delivery of good information to our users.
- Recommendation #20: The level of DMX staff training will be elevated in 2009 and 2010, to ensure that the entire staff is knowledgeable and has practiced with high impact river forecasting.

- Finding #21: The City of Ames runs its own flood forecast model, and there were differences between the City of Ames forecast and the NWS crest forecast. This resulted in a delayed response to the flood threat in Ames.
- Recommendation #21: It is a recommended practice to communicate frequently with cities and counties, especially with Ames, where DMX has a special partnership arrangement for flooding. All staff needs to be fully aware of the intent of this arrangement with the City of Ames.

DMX Operational Staffing

In general, operational staffing during the Central Iowa Floods of 2008 was handled well and most of the staff made themselves available for multiple days of long work hours. However, an unplanned vacancy of the DMX SSH position, and a requirement to staff the SEOC 24 hours-a-day for 7 days, did mean that less than the normal numbers of employees were available to work forecast and warning operations. Advanced staffing plans were complicated by successive days and nights of significant severe weather episodes concurrent with or followed by significant flooding. The hydrology warning meteorologist or HMT(s) often bore the brunt of the flood workload, because other staff members were needed to cover the severe convective weather operations. There were times when important aspects of DMX operations (like product quality control and external communications) were limited due to not having the personnel or time to complete the tasks.

Facts

- Out of the 7 days of extensive river flooding, there were only two full operational shifts *dedicated* to river flooding and associated workload. There were three instances when a forecaster was held beyond his/her normal shift to work dedicated river flooding issues (2 to 4 hours). The rest of the time, river flooding operations were handled as part of the HMT/Data Acquisition (DATAC) shift.
- DMX forecasters understood the magnitude of the flooding, the consequent high level of service needed, and what needed to be accomplished.
- Lack of detailed training left some of the staff unprepared and uncomfortable when using FFMP or Site Specific software, and narrowed the talent pool of those that could perform these tasks proficiently.
- It was very busy at the SEOC and there were times when two people were needed at the same time. Double coverage was provided on the one day when it was absolutely needed and that seemed to benefit the decision-making by agencies at the SEOC.

Best Practices

- When the Cedar Falls, Waterloo and Des Moines River forecast points were nearing major/record crest, DMX divided the daytime personnel into focal points for a given area. This allowed consistent communication between experts in the local community and a DMX person whom was well versed with what was going on in their area.

- On one occasion, two DMX forecasters were shifted to focus exclusively on the high-end flooding on the Des Moines metro area creeks. This allowed them to stay on top of the situation and keep the city officials informed. One of those forecasters had a high level of experience dealing with these metro flash points.

Findings, Recommendations and Actions

Finding #22: Most of the DMX staff made themselves available (service above self) to work multiple days of long hours. Still, it was challenging to implement advance staffing, due to the repeated and prolonged nature of severe weather and flooding.

Recommendation #22: Even more advanced staff planning is recommended. In addition, since the flooding and flash flooding is often the most high impact weather, even at times when thunderstorms may still be producing high winds and hail, it is recommended that the DMX Event Coordinator direct more fresh personnel to flood forecasting, flood warning and flood communications. During high-end flood events, Event Coordinators should consider assigning the role of a "Public Information Officer" to answer requests for information and media interviews.

Appendix A - Testimonials

Mahala Cox, Emergency Manager – Warren County

Overall, my working relationship with NWS is highly efficient and vastly improved from the last several years. Communications are frequent, brief and also advantageous to response and recovery in my county. Thank you for all you do to serve the citizens of Iowa and especially helping me serve my citizens in Warren County.

Joyce Flinn, Readiness Response Bureau Chief – Iowa Homeland Security and Emergency Management Division

…Conversations always met or exceeded my expectations in terms of helpfulness. NWS reps in the EOC received questions from any response partners in the facility. I never heard of an instance where information was requested and not received in a timely, professional manner. NWS reps were also asked to brief the Lt Governor and often the Governor either in person or on conference calls. There was not one instance where I wished for better assistance.

Iowa State Patrol Communications – Des Moines/Atlantic

..Once again, in time of need, the Des Moines NWS Office performed above expected standards in a severe weather event and prolonged severe weather season in Iowa. Kudos to all of you!

Lori Morrissey, County Emergency Management Coordinator – Story County

NWS has been extremely helpful & cooperative with any requests we have given them. Warnings were coordinated with emergency managers & our comments were requested & added as needed. This information was also provided to local media which also assisted in getting emergency information to the public.

Chris Maiers, Broadcast Meteorologist – ABC5-TV

As always DMX fit the bill of what a WFO is supposed to be. I'm glad that I'm in a viewing area under their jurisdiction. Having a great WFO makes life a lot easier especially when you can count on their warning decision process to be timely, accurate and reliable.

Peter Grandgeoerge, Business Continuity Manager – Mid American Energy

The forecasting is an area of excellence. The use of the MICRN is impressive and directly impacts our operations and employee safety. Recently, there have been more reports on MICRN of storms outside the immediate area, giving a warning to the MICRN area. This is a great trend that should continue. I'd personally like to hear when severe weather is hitting the edges of the MICRN area (Fort Dodge, Ottumwa) because that seems to have a ripple in the Metro area on occasion. This is great situational awareness information that allows us to put together a better picture.

Roxanne Warnell, County Emergency Management Coordinator – Tama County

Again, I have worked with the staff at the Des Moines office for several years, they are always willing to go the extra mile to satisfy and protect lives and property.