Report from "Scoping Workshop on Climate and Weather Information Services and Needs for Flood Emergency Management and Flood Mitigation Planning"

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Sponsored by National Oceanic and Atmospheric Administration Climate Program Office, Iowa State University Extension, Iowa State University Climate Science Initiative, University of Iowa IIHR-Hydroscience and Engineering

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1. Executive Summary

The Scoping Workshop for Climate and Weather Information Services and Needs for Flood Emergency Management and Flood Mitigation Planning included 39 persons that represented three universities, university extension services, community organizations, and numerous federal, state, and local governmental agencies. In particular, workshop attendees represented Iowa State University, Iowa State University Extension, Midwest Regional Climate Center, Oakhill Neighborhood Association, University of Iowa, Iowa Department of Natural Resources, Linn County Emergency Management, United States Geological Survey, Iowa Department of Homeland Security, East Central Iowa Council of Government, University of Northern Iowa, Federal Emergency Management Association, and National Oceanic and Atmospheric Administration.

The workshop agenda contained multiple extended discussion sessions from which there emerged two lists, one that describes findings of the discussion groups and another that contains recommendations for future engagement. Engagement priorities in the short-term are focused on establishing a working group that has as its goal a proposal writing effort to support the generation of maps to estimate financial and infrastructure losses due to flood inundation. It will be proposed that the financial losses information will be incorporated into the state and local hazard mitigation plans, that potential for infrastructure inundation will be communicated to emergency management personnel, and that inundation impacts will be incorporated into National Weather Service products and services. Long-range engagement actions include evaluations of effective communication and educational devices of flood inundation impacts, development of climate literacy materials to describe the impact of climate change on heavy rainfall and floods, workshops that adopt the structure of this scoping workshop to identify needs of stakeholders in relation to other weather extremes such as droughts, and efforts to establish a permanent interface that can support frequent stakeholder-driven and sector-specific workshops.

The list of discussion group findings is as follows:

Information Available and Decisions Made 2-3 Months In Advance

Finding 1: Interagency communication needs improvement.
Finding 2: Public awareness of flood risk outlooks and potential flood impacts needs improvement.
Finding 3: It is unknown whether emergency management response plans can incorporate information with 2-3 month lead times.
Finding 4: The public needs better information about flood insurance.
Finding 5: More frost gauges are needed.
Finding 6: Probabilistic river forecasts and retrospective forecast information are needed.

Information Available and Decisions Made 1-7 days in Advance
Finding 1: Public awareness of potential flood impacts needs improvement.
Finding 2: Broadcasts of flood information need multiple communication pathways, and they need to target specific audiences.
Finding 3: Interagency communication needs improvement.
Finding 4: Short-term probabilistic river forecasts are needed.

Climate Change Information, Information Used in Flood Mitigation Planning, and Information Used in Flood Plain Mapping
Finding 1: State mitigation plan writers need more feedback from public and county/local planners
Finding 2: Mitigation planners need more quantitative information related to hazards.
Finding 3: The public needs better information about flood insurance.
Finding 4: Funding for mitigation planning needs to be preventative in addition to reactionary
Finding 5: Assessments of how climate and land use changes affect flood inundation frequency is needed but requires an integrated modeling approach that has yet to be attempted

2. Introduction

It is timely in light of discussions about the creation of a National Climate Service (NCS) to consider what climate and weather information is in use and what information is needed to adapt to climate variability and climate change in the Midwest. The need to adapt to a change in heavy rainfall frequency is apparent from research that has found that one of the largest climate change signals in the United States is an increase in intensity and frequency of heavy rainfall events in the Midwest. The frequency of floods is one among many potential impacts of this change. Furthermore, a significant role in outreach and education on climate change matters is under consideration for the Department of Agriculture's Cooperative State Research Education and Extension Services (CSREES). With all of this in mind, a dialogue between NOAA, ISU Extension, and climate partners was established with a prototype scoping workshop. The "Scoping Workshop on Climate and Weather Information Services and Needs for Flood Management and Flood Mitigation Planning" was held 2009 February 18-19 at University of Iowa IIHR-Hydroscience and Engineering.

The scoping workshop built upon the motivation of many agencies and citizens to better understand floods due to the intense effort within the state to recover from the devastating floods in eastern Iowa in 2008. It was envisioned as a gathering of decision-makers and stakeholders from federal, state, and local agencies and citizenry who were impacted by the 2008 floods, a d who could provide feedback concerning flood information that was available and what types of improvements might be made to flood information. The information gathered and connections made among the attendees are expected to provide guidance for further work that could include more focused workshops on flood information services or adaptation of this workshop format to other sectors.

Workshop attendees represented Iowa State University, Iowa State University Extension, Midwest Regional Climate Center, Oakhill Neighborhood Association, University of Iowa, Iowa Department of Natural Resources, Linn County Emergency Management, United States Geological Survey, Iowa Department of Homeland Security, East Central Iowa Council of Government, University of Northern Iowa, Federal Emergency Management Association, and National Oceanic and Atmospheric Administration. The workshop consisted of five sessions, with each session initiated by an hour of presentations from invited speakers and completed by one-and-a-half hours of facilitated discussion.

Many workshop attendees gave positive reviews of how effectively the workshop generated dialogue. A comment received from Professor Dave May from the University of Iowa expresses nicely the sentiment of many attendees: "… thanks for a well-organized workshop. The discussions were every bit as informative as the talks, and I usually

cannot say that about workshops."

Engagement priorities in the short-term are focused on establishing a working group that has as its goal a proposal writing effort to support the generation of maps to estimate financial and infrastructure losses due to flood inundation. A sub-group of participants was formed with a short-term goal of obtaining grant funds through FEMA mitigation programs for the development of inundation maps. It will be proposed that the financial losses information will be incorporated into the state and local hazard mitigation plans, that potential for infrastructure inundation will be communicated to emergency management personnel, and that inundation impacts will be incorporated into National Weather Service products and services Long-range engagement actions include evaluations of effective communication and educational devices of flood inundation impacts

The success of this workshop points to untapped energy and an interest in climate information that has the potential to generate long-standing engagement in which NOAA can facilitate activities that promote interaction among entities impacted by climate extremes. Activities underway in support of long-term engagement include efforts to adapt the structure of this scoping workshop to identify needs of stakeholders in relation to other weather extremes such as droughts and other sectors such as wind energy, to establish a permanent interface that can support frequent stakeholder-driven and sector-specific workshops, and to identify opportunities for NOAA to brief Iowa State University Extension specialists on information produced and distributed by NOAA.

The remainder of this report summarizes the activities and outcomes of the workshop. Section 2 contains a list of findings and recommendations for engagement and collaboration. Section 3 contains a description of key discussion points in each of the five sections. Appendix A contains the agenda. Appendix B contains a list of attendees.

3. Findings, Recommendations For Engagement/Collaboration

3.a. Information Available and Decisions Made 2-3 Months In Advance

Finding 1: Interagency communication needs improvement.
State and federal agencies are in close communication with NWS River Forecast Centers. There is a false assumption, however, that information from teleconferences between high-level agency representatives and NWS personnel funnels down to lower levels. For example, conference calls with FEMA did not necessarily get communicated to State DHS.

Finding 2: Public awareness of flood risk outlooks and potential flood impacts needs improvement.
Graphics intended to convey forecast information may need to be simpler and may need to show potential impacts for interpretation by the general public. It is equally important to consider the language used (i.e., 100-yr flood language is useless) and the topics addressed within the flood outlook information. For example, the general public may need guidance on the expected agency activities if flood risk continues to increase and may need reminders of what their personal responsibilities include. Community memory of past events may hinder or aid public awareness. Inundation maps could significantly raise public awareness about potential flood impacts.

Finding 3: It is unknown whether emergency management response plans can incorporate information with 2-3 month lead times.

Finding 4: The public needs better information about flood insurance.
Most individuals do not understand flood insurance. There is little incentive for real estate agents and insurance agents to explain flood risk and insurance options to their clients. Since flood insurance is purchased for a single year and has a thirty-day period before enactment, it is important to consider the economic condition of persons vulnerable to floods and whether 90-day outlooks might provide useful information for deciding whether to purchase flood insurance in a given year.

Finding 5: More frost gauges are needed.

Finding 6: Probabilistic river forecasts and retrospective forecast information are needed.
River stage outlooks are difficult to apply to management decisions since the reliability of the risk (probability of exceeding a river stage level) is not included in the forecast information. Categorical forecasts for flood, moderate flood, and extreme flood are more desirable to emergency response personnel than the risk of exceedance for all flood stages. There was interest in having tools that allow managers to create scenarios or at the very least to view the range of historical conditions used in the 90-day outlook.

3.b. Information Available and Decisions Made 1-7 days in Advance

Finding 1: Public awareness of potential flood impacts needs improvement.
Inundation maps may be extremely powerful for communicating with general public as well state, county, and local response activities. This is particularly important at un-gauged locations and in rural and unincorporated communities that may not have dedicated emergency response teams or information providers. Community memory of past events may hinder or aid public awareness.

Finding 2: Broadcasts of flood information need multiple communication pathways, and they need to target specific audiences.
It is critical that all communication pathways are used when circumstances may soon become dire. These pathways include neighborhood association captains, television media, radio media, flyers, internet, Extension Services, reverse 911, emergency response personnel, and others. Furthermore, communication must target specific audiences with appropriate language and guidance (e.g., Emergency Management, low-income persons without access to television/internet, elderly, places of business, general public).

Finding 3: Interagency communication needs improvement.
State and federal agencies are in close communication with NWS River Forecast Centers. There is a false assumption, however, that information from teleconferences between high-level agency representatives and NWS personnel funnels down to lower levels. For example, conference calls between NWS RFC and FEMA were not brought to the attention of NWSFO Des Moines or Iowa Department of Homeland Security. Under these circumstances, it is difficult to maintain a common message and creates the possibility of miscommunication between state and federal disaster response agencies.

Finding 4: Short-term probabilistic river forecasts are needed.
A desire was expressed for the development of short-term river forecast products that provide information similar to a hurricane track forecast with a cone of uncertainty. Categorical forecasts for flood, moderate flood, and extreme flood are more desirable to emergency response personnel than the risk of exceedance for all flood stages. Support was widespread for the development of maps of inundation potential consistent with the probabilistic river forecasts.

3.c. Climate Change Information, Information Used in Flood Mitigation Planning, and Information Used in Flood Plain Mapping

Finding 1: State mitigation plan writers need more feedback from public and county/local planners.

Finding 2: Mitigation planners need more quantitative information related to hazards.

Authoritative sources do not readily provide the historical risk of natural hazards, the potential changes to that risk, or the economic and social impact of hazards in a format that mitigation planners can easily incorporate into their plan writing process. Flood inundation maps are an essential piece of information needed for mitigation planning, especially if coupled with estimates of property values.

Finding 3: The public needs better information about flood insurance.
Most individuals do not understand flood insurance. There is little incentive for real estate agents and insurance agents to explain flood risk and insurance options to their clients.

Finding 4: Funding for mitigation planning needs to be preventative in addition to reactionary.

Finding 5: Assessments of how climate and land use changes affect flood inundation frequency are needed but require an integrated modeling approach that has yet to be attempted.

3.d. RECOMMENDATIONS FOR ENGAGEMENT/COLLABORATION

3.d.1 Recommendations for immediate or near term engagement/collaboration

Recommendation #1: Participants should become more aware of the roles and constituents of the respective agencies and institutions represented at the workshop by completing an agency table to be provided via email.

Recommendation #2: A sub-group of participants should develop a proposal to use Hazard Mitigation Grant Program funds to produce inundation maps suitable for mitigation and land use planning and should identify avenues to communicate this information to local government and emergency management personnel.

Recommendation #3: Participants should a form a coalition that can provide a community forum and collective voice for flood information to increase the value and awareness of flood information for mitigation and response.

3.d.2 Recommendations for long term engagement/collaboration

Recommendation #1: Federal and state agencies should meet periodically to identify ways in which flood inundation maps may undergo improvements in precision, may be updated cost effectively, may be incorporated into state and local hazard mitigation plans, may be used in land use planning, and may be incorporated into real-time flood forecasts including as an aid to generate storylines of flood impacts for targeted audiences.

Recommendation #2: Flood information producers should seek out opportunities to link with University extension, community colleges, and other public information networks to deliver educational materials and real-time flood information. The information delivery should take into consideration the credible agents, conduits for information delivery, and information presentation and content needed for specific audiences, and it should be subjected to assessment and social science methods to evaluate its effectiveness.

Recommendation #3: A rationale for preventative flood mitigation funding should be developed and articulated clearly to Federal and State governmental entities.

Recommendation #4: A permanent entity, such as a NOAA Regional Integrated Science Assessment Team or academic Center, should be created to facilitate the transfer of best available science to response operations and mitigation and land-use planning. The entity should promote the use of scientific research to identify risk, the prioritization of new scientific research questions initiated by members of the emergency response and mitigation and land-use planning communities, the assessment of needs of decision-makers and stakeholders, and the engagement of flood information providers with stakeholders.

Recommendation #5: A sub-group of participants should work together to find opportunities to advance the science and transfer to operations of probabilistic river forecasts, including tools that permit analysis of critical scenarios as defined by emergency responders and mitigation experts.

4. Workshop Sessions

a. Information Available and Decisions Made 2-3 Months Prior

Presentations by **Steve Buan from the National Weather Service (NWS) North Central River Forecast Center** (NCRFC) highlighted five critical factors that are examined when issuing the 90-day Flood Outlook issued in February: (1) fall soil moisture, (2) depth of frozen soil, (3) depth of snow cover, (4) potential for heavy rains during melt period, (5) potential for rapid melt. He noted there is generally high volatility in the outlooks between February and March that is caused by changes in both snow cover and forecasts of spring rainfall.

Presentations by **Ray Wolf (Science Operations Officer) and Donna Dubberke (Warning Coordination Meteorologist) from the NWS Forecast Office in Davenport, Iowa** discussed the critical weather conditions during the fall up through the time of the floods. They noted heavy rainfall occurred on top of saturated soil during the two week period of 2008 June 1-15 with a swath of 8" extending from northeastern Iowa into Wisconsin. The time of the crest was difficult to forecast even 24 hours in advance since it was greatly impacted by 2-3" of rainfall for which it was difficult to forecast the location until 6-12 hours prior to its occurrence. Flood warnings were issued on June 5th, and daily conference calls with emergency managers were initiated June 8th, using the existing emergency management communication systems for hazardous weather.

Allan Bradley, Associate Professor from University of Iowa, provided a presentation on probability forecasts and their reliability. He noted the 90-day outlooks are assessments of flood risk, and they are expressed relative to the historical flood risk as determined by the models in use. For example, the 90-day flood outlook for Marengo, Iowa contained a 63% historical risk of flood and a current flood risk of 97%. He stated the reliability of 90-day outlooks can only be judged by examining the performance of past outlooks, and he defined the skill of outlooks as a demonstrated ability of the outlook to have smaller errors than using a constant outlook, such as the historical risk. In general, fall outlooks have least skill; winter and spring outlooks have higher skill; the outlooks occasionally warn of surprise events and rarely cry wolf. He concluded retrospective outlook information is a gap in flood outlook information that would be useful in providing users with information about the reliability of outlooks and identifying analogous situations.

Rob Middleness-Brown, Director of the United States Geological Survey (USGS) Water Research Center in Iowa, provided an overview of the USGS stream gauge monitoring system. The USGS maintains ~7300 stream gauges with ~97% reporting in real time. Gauges cost ~$20K to install and ~$14K per year to operate and maintain within 5% accuracy. Most gauges are funded by agencies other than the USGS with about 20% funded by the federal government. Other groups that

fund stream gauges include US Army Corps of Engineers, state governments, cities, some powerplants, and 850 cooperators. Some private gauge networks exist, but generally are not maintained by USGS since the USGS may enter a cost share arrangement only with public entities. One way to provide the data to the public is to route data from private gauge networks through universities. He concluded with an overview of recent projects that have created inundation maps that translate the USGS stage measurements into rise of the river and ground being covered.

The **discussion session** covered a wide range of topics. Questions were raised about (1) the availability of temperature and precipitation traces that were used as inputs for the seasonal streamflow simulations, (2) the ability to use the streamflow model to simulate scenarios, (3) the presentation of the model data on the NCRFC website and whether it is interpretable by the general public, (4) the definition of flood risk and whether it is interpretable by the general public, (5) the need for probabilistic crest forecasts, (6) the need for skill information in the outlooks, (7) the utility of past observations in a changing climate, (8) the need to speak the language of the user when communicating to specific groups, and (9) the potential for 90-day outlooks to be used in cost-benefit analysis for individuals that may purchase flood insurance. A topic that generated excitement among all participants was inundation maps. Every person in the group agreed that inundation maps had the potential to be informative for a wide range of stakeholders and users.

4.a. Information Available and Decisions made 1-7 Days Prior

Michael Richards, President of the Oakhill Jackson Neighborhood Association, spoke on the impact to small businesses, neighborhoods, and cultural vitality in Cedar Rapids. He noted many of the homes flooded in Cedar Rapids were over 100-yrs old, and many of their residents fall into categories of low-income, fixed-income, and over-60 population. This means very few residents have personal computers, many residents view the evening news as a primary information source, and information about flood impacts is relayed by word of mouth. The best information about potential flood impacts for 2008 was believed to be the inundation levels of the 1993 flood. He noted that 2 of the 30 residents had flood insurance coverage and that many of the residents were either unaware they were eligible or unable to afford insurance. He concluded that flood information must be communicated through multiple channels (neighborhood captains, cell phones, evening news, internet), inundation maps may be a powerful tool in explaining potential impacts, and even a day of lead time with compelling information about potential impacts could allow for residents to move cars and small business equipment to higher ground.

Tom Ulrich, Emergency Manager for Linn County, gave an overview of emergency management activities in Cedar Rapids and surrounding areas that includes Palo (1100 people) and rural Linn County. He received much of the flood information he used in his operations by telephone conversations with NWS office

in Davenport. Once flood stage was hit on June 8th, he gathered city officials to brief them of the forecast, organized an unprecedented effort to deliver over 1,000 fliers, and noted Cedar Rapids emergency response included a flood plan up to 22'. He also noted many small communities do not have local emergency management. In Palo, for example, it was clear a significant flood would occur after the crest affected Vinton, Iowa, which is about two days upstream. He contacted the Palo fire department, who went door to door to ask people to leave. The fire department is considered a credible source of information in that community. Even so, it was difficult to convince Palo residents a flood more severe than 1993 could occur.

Kathy Vance, ISU Extension Director in Louisa County, provided an overview of extension efforts in Louisa County, where the population is predominantly in rural areas or unincorporated towns. She noted the extension director provides a long list of resources including information on how to deal with mold, how to deal with crop losses, how to salvage personal items, how to rebuild at a higher level, how to determine if your basement walls have water in them, among many other topics. During the 2008 floods, she volunteered for the role of public information officer as the communities within the county do not have formal emergency managers, city managers, city councils or county managers. The biggest surprise of the flood was the force of the water in Oakville. Inundation was expected, but the primary impact was believed to be wet and moldy basements rather than the mass movement of well secured structures by fast moving water. She organized community meetings in local churches to keep residents abreast of developments and included representatives from service providers, such as Alliant energy and law enforcement, who gave updates on their status of their services. She noted a credible meteorologist would have been a welcomed addition to the meetings and would have served a role in answering resident's questions on how the floods happened.

Mary Skopec, Research Engineer with USGS, spoke on the unprecedented water quality monitoring activities undertaken during the 2008 floods. When the drinking water facility in Mason City, Iowa was overrun by the flood, she decided to monitor water quality as a case study on Gulf of Mexico hypoxia from this event. Water quality sampling begun June 9th and continued through September 4th, primarily near major urban areas. One exception was Oakville, Iowa, where flooding had breached confined feeding operations and had caused a substantial number of animal deaths. Preliminary results were available within a week from the University of Iowa Hygenic Laboratory. First responders and city planners became highly interested in the water quality information in real-time for securing public safety. This required more targeted sampling, and it was apparent that information could be better used if it became available sooner than one-week after sampling. She pointed out the following information sources that were critical and that performed very well for their purposes: (1) Iowa Department of Transportation web-site showed road closures that could hinder sampling efforts. (2) The coordination of sampling crews between agencies was handled well. (3) The flood forecasts to predict where and when to sample were highly informative, adding "We knew when things were gonna crest." She noted the following lessons learned: (1)

First responders need this information. (2) Much more thought needs to go into how to disseminate the information. (3) Guidelines for clean-up are needed, and they should take into consideration human and environmental health. (4) Some way to estimate the exposure risk in neighborhoods, which could be very different compared to the main river.

Joyce Flinn, Chief of the Iowa Department of Homeland Security Response and Readiness Bureau, presented on the actions of the state emergency operations center. The main objectives of this branch were to coordinate procurement and placement of resources needed for response and to support county emergency managers, though they also kept the Governor's office abreast of implications of some policy decisions that came to light during the flood emergency. The information most used by the Bureau was warning information, river levels, and impacted structures. Often a liaison, such as a staff member of civil air patrol, was used to monitor flood impacts, for example, debris on the bridges that can effectively act as a dam. They had been in contact with the National Weather Service Forecast Office in Des Moines beginning in early February. The flood 90-day flood outlook information was useful for prepositioning resources such as trucks and reminding emergency management personnel to check critical assets such as generators and pumps. The most information most critical to their needs was the 3-4 day forecast of river levels.

Discussion topics focused largely on the language used in communication, targeted communication of warnings and outlooks, multichannel outlets, credibility of information source, and communication of impacts (including the role of community memory of past events). Tom Ulrich pointed out the extraordinary nature of this event might be somewhat misleading when evaluating the activities of all parties affected. Under normal flood conditions, the protective measures in the Cedar Rapids flood response plan are sufficient. Nevertheless, all participants felt inundation maps may be a tool that could provide a more compelling picture of potential impacts, especially if flood levels are expected to exceed past record levels. Inundation maps could serve many purposes: (1) support material for story lines in watches and outlooks issued by the NWS, (2) evidence of expected impacts that neighborhood captains, emergency managers, NWS, and other officials may use in verbal communication to vulnerable populations, (3) identification of water quality sampling locations, (4) identification of vulnerable community resources, emergency response resources, and safe locations to store emergency response resources. The possibility of expanding the role of inundation maps was brought up with the idea of generating maps that represented precipitation scenarios to allow emergency personnel to prepare for a worst-case scenario. Finally, many participants also stated it was equally important to the potential use of inundation maps to identify how the inundation map information could be most effectively communicated to the desired audience. It is critical that social and physical scientists work together to address issues of communicating flood information to the public.

4.b. Climate Change Information

Gene Takle, Professor from Iowa State University, provided an overview of recent climate change in the Midwest. He stated one of the clearest trends in the United States is an increase in the frequency and intensity of heavy precipitation in the Midwest. He provided an overview of projected changes in temperature and precipitation in the Midwest and showed results from work that connects climate projections with hydrological modeling. He discussed a key result from the climate-hydrology model combination that showed the percentage increase in precipitation was less than in surface runoff.

Chris Anderson, Scientist from Iowa State University, provided an overview of event attribution for the 2008 floods. He described work that examined whether the La Niña or saturated soil conditions altered the likelihood of heavy rainfall in the Midwest. The results indicated neither La Niña nor other ocean sea surface temperature patterns created a higher likelihood of heavy rainfall and saturated soil conditions may have contributed to 10-20% of rainfall. He noted the increased frequency and intensity of heavy precipitation is consistent with climate change projections, but research on whether events like the 2008 flood are due to climate change is lacking complementary studies to rule out other factors.

4.c. Information Used in Flood Mitigation Planning

Shane Hubbard, Doctoral Student at the University of Iowa, provided and overview of Hazards United States Multi-Hazards (HAZUS-MH) software developed by FEMA to estimate potential costs of hazards. He showed that HAZUS-MH as a GIS tool may contain a wide array of information including population, damage curves for buildings, and potential economic losses. The power of HAZUS-MH lies in connecting it to models of hazards such as flood inundation for which it is possible to estimate losses, numbers of displaced persons, and other potential impacts.

Michael Raes, Mitigation Planner with the Homeland Security and Emergency Management Division, provided an overview of hazard mitigation planning. He described the statutory requirements of hazard mitigation that includes the critical requirement that states must have a mitigation plan in order to qualify for mitigation grants. The state mitigation has a 3-yr cycle with the current process at the 16-month point. Local mitigation plans have a 5-yr cycle. However, mitigation plans must be updated under a Presidential declaration of disaster. Hazard plans must include plans for 16 natural hazards and 24 human caused hazards that are ranked in priority by risks to several sectors including loss of life and economic losses. He listed the following sources of data for natural hazards in use: National Climatic Data Center US Storm Event Database, National Severe Storms Laboratory severe thunderstorm climatology, FEMA disaster and emergency declaration history, and USGS earthquakes hazards program. He noted the following needs: (1) standard methods for estimation potential cost savings and future potential savings, (2) standard methods for estimating probability, severity and geographical extent of future disasters, and (3) methods for overlaying multi-hazard maps.

Joe Chandler, Community Planner for FEMA Region 7, provided an overview of basic terminology in the FEMA mitigation planning. He pointed to FEMA information sources including FEMA 386 series ("blue book"), HAZUS-MH, and how-to guides. He noted most dams do not have a hazard action plan.

4.d. Information Used in Flood Plain Mapping

Bill Cappuccio from the Iowa DNR Flood Plain Programs described the steps in and products resulting from flood plain mapping as it relates to DNR review and National Flood Insurance (NFIP) mapping program. He described the many years that have passed since good intentions to map flood levels were expressed. Iowa currently has 22 counties with some level of detailed study, 31 with no mapping at all, and the remaining 47 counties with mapping based on very coarse data. He noted a recent mapping program called Risk Map may provide some funding for detailed mapping in FY09. He described the steps in determining flood profiles and maps as follows
(1) Obtain topographic information, preferably LIDAR with 1-foot contour, and supplemental data such as channel geometry, and bridge/culvert dimensions.
(2) Develop flood discharge frequency relationships, especially 10, 4, 2, 1 and 0.5 percent exceedence for basins larger than a 10 km^2 and use regional regression equations for ungauged sites.
(3) Develop flood profiles with a calibrated hydraulic model (HEC-RAS).
(4) Prepare flood maps by using use flood profiles within topography maps.

Witold Krajewski, University of Iowa Professor, provided a detailed analysis of difficulties that arise when estimating flood return periods. He demonstrated errors inherent in calculating flood return periods that require assumptions about distributions that are actually unknown. His work uncovered a power law relationship between the sub areas within the basin and their peak flows. He concluded it is the characteristics of the drainage network rather than rainfall that defined the power law relationship, although rainfall characteristics do contribute to scatter.

The **discussion session** covered two topics. The first probed whether the tool built for analysis of the Cedar River basin could be adapted for climate studies. The main concern with that idea was the question of how to emulate the data set (radar rainfall estimates) used to calibrate the hydraulics model. The second topic of discussion centered on the idea of using power law relationships to infer flood frequencies. It was noted that a large number of basins with varying geometries would be needed to build robust relationships between power law curves and channel characteristics.

A **final discussion session** was commenced to permit a dialogue that integrated information from the climate information, mitigation information, and flood plain mapping sessions. It was suggested that NOAA play a lead role in consultation with FEMA, perhaps through the Regional Climate Centers, in developing databases of natural hazards that have a format useful to mitigation planners. One limitation that was discussed is the details of flood reports are very different from other natural hazards, such as tornadoes. The database would contain metadata describing the granularity and source of the reports.

The final discussion session then turned to the topic of stream gauge. It was asked whether mitigation planners could envision a priority list for stream gauge locations that would improve their risk estimates. The answer was 'yes'. However, the discussion soon raised the points that determining which locations were keystones for mitigation planning required careful thinking about how to rate priorities of various communities and agencies that need stream gauges, and how to obtain funding for a gauge network. It was suggested that a consortium of interested individuals could provide a mechanism for moving forward on these issues.

Finally, the question of whether flood mitigation planning might be useful to land use planning was discussed. It was noted that flood mitigation planning is sometimes at odds with land use planning in that flood mitigation usually requires more open space while land use tends to fill-in open space. It was pointed out that unincorporated areas face the opposite problem, namely there is no lack of open space but new mitigation regulations require zoning practices that unincorporated areas have no staff to perform. Regardless of land use decisions, Iowa DNR has encouraged staff to work with communities to increase participation in NFIP. This may be an area of collaboration with ISU Extension services.

4.d.1 Appendix A. Workshop Agenda

Scoping Workshop on Climate and Weather Information Services and Needs for Flood Emergency Management and Flood Mitigation Planning

2009 February 18-19
C. Maxwell Stanley Hydraulics Laboratory
IIHR-Hydroscience and Engineering, University of Iowa, Iowa City, Iowa

Sponsors: NOAA, Iowa State University Extension, Iowa State University Climate Science Initiative, University of Iowa IIHR-Hydroscience and Engineering

Wednesday, February 18 (8:30-5:30)

Welcome (8:30-8:40)

2009 Flood Outlook (8:40-9:00)
Steve Buan, NWS Northcentral River Forecast Center

Information available and decisions made 2-3 months prior (9:00-10:15)
Steve Buan, NWS Northcentral River Forecast Center
Ray Wolf and Donna Dubberke, NWS Quad Cities Weather Forecast Office
Allen Bradley, Associate Professor, University of Iowa
Rob Middleness-Brown, Director, Water Science Center, USGS

Facilitated Discussion (10:30-noon)

Catered Lunch (noon-12:50)

Information available and decisions made 1-7 days prior (1:00-2:30)
Michael Richards, President of the Oakhill Neighborhood Association
Tom Ulrich, Linn County Emergency Manager
Kathy Vance, Louisa County Extension Education Director
Mary Skopec, Research Geologist, Iowa DNR Watershed Monitoring and Assessment
Joyce Flinn, Chief of Operations Readiness and Response, Iowa Homeland Security

Facilitated Discussion (2:45-4:15)

Climate Change Information (4:30-5:30)
Gene Takle, Professor, Director Climate Science Initiative, Iowa State University
Keith Schilling, Research Geologist, Iowa DNR Geological and Water Survey
Christopher J. Anderson, Scientist, Assistant Director Climate Science Initiative, Iowa State University

Adjorn for the day (5:30)

Thursday, February 19 (8:30-5:30)

Day 2 Welcome (8:30-8:40)
Information Used in Flood Mitigation Planning (8:40-9:30)
Michael Raes, Mitigation Planner, HSEMD
Joe Chandler, Community Planner FEMA Region 7

Facilitated Discussion (9:30-10:30)

Information Used in Flood Plain Mapping (10:45-11:45)
Bill Cappuccio, Iowa DNR Flood Plains Program
Witold Krajewski, Professor, University of Iowa

Catered Lunch (11:45-12:50)

Facilitated Discussion (1:00-2:30)

Workshop Wrap-up (2:45-4:00)

Adjorn the Workshop (4:00)

4.d.2 Appendix B. Workshop Participants

Abdelrahim, Sarah, NOAA Climate Program Office, TRACS Program Manager, sarah.abdelrahim@noaa.gov

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