Strategies for Flood Disaster Reduction

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Bill Guertal, Director
USGS Indiana & Kentucky Water Science Centers

Mary Mullusky, Deputy Chief
National Weather Service Hydrologic Services Division
The Grand Challenges for Disaster Reduction outline a ten-year strategy developed by the National Science and Technology Council’s Subcommittees on Disaster Reduction (SDR). It sets forth six Grand Challenges that, when addressed, will enhance community resilience to disasters and thus create a more disaster-resilient Nation. These Grand Challenges involve sustained Federal investment as well as collaborations with state and local governments, professional societies, and trade associations, the private sector, academia, and the international community to successfully transfer disaster reduction science and technology into common use.

To meet these Challenges, the SDR has identified priority science and technology interagency implementation actions by hazard that build on ongoing efforts. Addressing these implementation actions will improve America’s capacity to prevent and recover from disasters, thus fulfilling one Nation’s commitment to reducing the impacts of all hazards and enhancing the safety and economic well-being of every individual and community. This is the flood-specific implementation plan. See also ndc.gov for other hazard-specific implementation plans.

What is at Stake?

DEFINITION AND BACKGROUND. Floods are an overflow or inundation from a river or other body of water and cause or threaten damage. Flooding occurs in all regions of the United States, at all times of the year. One in three Federal disaster declarations is a result of flooding. An increase in population, new development in flood-prone areas, an increase in the frequency of heavy-rain events over the last fifty years, and impacts of wildfire and land use changes have resulted in an increase in flood-related losses. Many of these losses are multiply caused by inundation but can also be the result of strong currents damaging structures and undermining foundations.

IMPACTS. In the last 100 years more than 9,000 people have died as a result of inland flooding in the United States. In 2002 alone, 47 fatalities resulted from severe flooding, a majority of which could have been avoided if the victims had practiced disaster behaviors. Property damage from all types of flooding, from flash floods to large river floods, averaged $2 billion a year.

The 1993 Mississippi River Flood was among the most severe disaster events in recent U.S. history, resulting in an estimated $12-$16 billion in damages. More than 10,000 homes were destroyed during this event, and millions of crop acres were ruined by inundation. Thousands of people had to be evacuated, and many of them were never able to return to their homes. The event also severely damaged livestock and other
Grand Challenges

1. Provide hazard & disaster information where and when it is needed
2. Understand the natural processes that produce hazards
3. Develop hazard mitigation strategies and technologies
4. Reduce the vulnerability of infrastructure
5. Assess disaster resilience
6. Promote risk-wise behavior
Socioeconomic Impacts

On average, over the past 20 years in the U.S., flooding has claimed over 90 lives and caused damages in excess of $7 billion annually.

- Floods occur in all 50 of the United States
- Threat all months of the year
- More fatalities than any other severe weather related phenomenon
- More than half of all flood-related deaths result from motorists being swept away in their vehicles
Complementary Missions

USGS: minimize loss of life and property from natural disasters

NWS: protection of life and property and the enhancement of the national economy

Collaborative Science Areas
- Water Resources
- Hydrology
- Geospatial Sciences and Data
- Mapping

Complementary Operational Infrastructures
- USGS observations and supporting data
- NOAA GOES DCS and NWS forecast and warning disseminations systems
Inundation Mapping

Benefits

- Provide information on the spatial extent and depth of flood waters in the vicinity of NWS river forecast locations.
- Can display flood inundation maps for various levels ranging from minor flooding through the largest flood on record.
- Better mitigate the impacts of flooding and build more resilient communities.
- Each library includes NWS flood severity categories and regulatory FEMA flood frequency events.
NWS Advanced Hydrologic Prediction Service (AHPS)

- Forecast stage and provide warnings at over 4000 stream locations
- Over 90% co-located at USGS Streamgages

http://www.weather.gov/ahps/
Enhancing the Communication of Flood Risk

- For over 40 years, the NWS has utilized a 3-tier, impact based, flood severity scale with the categories minor, moderate, and major flooding.

- For each NWS river forecast location, flood stage and the stage associated with each of the NWS flood severity categories are established in cooperation with local public officials.

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**THE NATIONAL WEATHER SERVICE IN NEWPORT HAS ISSUED A**

- **FLOOD WARNING FOR NEUSE RIVER AT KINSTON**
- FROM SATURDAY MORNING UNTIL FURTHER NOTICE
- **MINOR FLOODING IS FORECAST **
- FLOOD STAGE IS...14.0 FEET
- **FORECAST...FLOOD STAGE WILL BE REACHED AT 900 AM SATURDAY. MAXIMUM STAGE WILL BE 15.0 FEET AT 900 PM EDT WEDNESDAY. THE RIVER MAY REMAIN ABOVE FLOOD STAGE FOR SEVERAL WEEKS. THE EXACT FLOOD DURATION IS DIFFICULT TO PREDICT DUE TO THE VERY SLOW RISE AND FALL TIMES FOR THIS RIVER.**
- **AT 14 FEET...WATER WILL BEGIN TO OVERFLOW INTO LOWLANDS ADJACENT TO THE NEUSE RIVER. $$**

water.weather.gov/ahps/
Since 2002, NWS has conducted extensive outreach to objectively evaluate current flood severity index.

- Partnered with Claes Fornell International (CFI) Group to survey users of NOAA’s hydrologic information via the American Customer Satisfaction Index (ACSI).
- Conducted user forums with State and Local Officials in North Carolina.
- Partnered with David Ford Consulting Engineers, Inc. to conduct a national survey of emergency managers.
- Conducted additional local and regional user outreach.
Enhancing the Communication of Flood Risk

Partners and Users are telling us that they….

- are familiar with NWS flood severity categories
- find them useful
- do not want changes to the existing flood severity indices
- need communication of flood risk to be enhanced by use of inundation graphics (maps)
Flood Mapping Partnerships in North Carolina

Neuse River at Goldsboro, NC

Partnered with NC Floodplain Mapping Program Office, FEMA, and USGS to develop prototype user-requested graphics to better convey flood threat
USGS Role in Inundation Mapping

- Expand & modernize hazards technology ... mapping tools.
- Develop models with robust predictive capability to support emergency mgmt ... 1D/2D, 2D Models.
- Develop a core of USGS and partner researchers focusing on vulnerability science
- Develop a national risk-monitoring program
- Develop new ways of communicating hazards and hazard assessments
USGS Role in Flood Mapping

- USGS Partnering with other agencies to meet multiple missions
  - NWS Flood Forecasting and Warnings,
  - FEMA Flood Risk Mitigation, USACE Water Management Controls,
  - State, and Local stakeholders.

- Assist agencies with vexing flood-loss challenges, recurring damages, and repetitive economic losses.
Collaboration with NWS
On the Blanchard River near Findlay, Ohio
WaterAlert allows you to receive test or email alerts
- Subscriber based
- You choose alert thresholds
- Works for any USGS real-time parameter
  - Stage
  - Streamflow
  - Groundwater level
  - Water quality – e.g. temp, DO

http://water.usgs.gov/wateralert/
Collaboration with NWS

On the Blanchard River near Findlay, Ohio

To see all current watches and warnings, click here.

Current Stage: 1.69 ft at 20:00 UTC 04/28

Inundation Levels
NAVD88 Stage

772.2 18.4
771.8 18.0
770.8 17.0
770.3 16.5
769.8 16.0
769.3 15.5
768.8 15.0
767.8 14.0
766.8 13.0

Major Flooding Begins
765.8 12.0
The Next Steps

- **Demonstrate Concept**
  - Dynamic Real-time Application
  - Constant Mining of USGS/NWS Data
  - *On-the-Fly* Hydraulic Model Runs
  - Responds to Changing Gage & Forecast Info
  - Outputs RT & Predicted Maps
Real-time Mapping Pilot Project

- FASTMECH Calibration
- FastMech runs on IU’s “Big Red”
- Real-time USGS gage and NWS flood forecast data
- Parcel & HAZUS Data Service
- Flood Depth Grid Data
- Loss Calculation Process
- Loss Estimate
- Flood Map
- Maps and Reports

USGS
Real-time Mapping Pilot Project

- **Indiana Silver Jackets Project**
  - 11-mile reach of White River, Indianapolis
  - Tied to streamgage/ flood forecast point

- **Resources**
  - **Funding:** City of Indianapolis, IDHS, USGS, Indianapolis Museum of Art
  - **In-Kind Support:** NOAA NWS, USACE, INDOT
Real-time Mapping
Pilot Project

Map showing flood studies and related information with a pop-up showing details of a property at 1400 Westfield Ct, Indianapolis, IN 46220, with coordinates 46.1351, 86.1821.
U.S. Geological Survey Flood Inundation Mapping Science

A powerful new tool for flood response and mitigation are digital geospatial flood inundation maps that show flood water extent and depth on the land surface. Because floods are the leading cause of natural-disaster losses, the U.S. Geological Survey (USGS) is actively involved in the development of flood inundation mapping across the Nation pursuant to its major science strategy goal of reducing the vulnerability of the people and areas most at risk from natural hazards. Working with partners including the National Weather Service (NWS), U.S. Army Corps of Engineers (USACE), the Federal Emergency Management Agency (FEMA), state agencies, local agencies, and universities, the USGS is providing flood inundation mapping science resources to help build more resilient communities.

The USGS Flood Inundation Mapping Prospectus
Read the prospectus—Digital geospatial flood-inundation maps are a powerful new tool for flood response and mitigation that show flood water extent and depth on the land surface. (PDF version is also available.)

USGS Flood Inundation Mapping Science Projects, by State

http://water.usgs.gov/osw/flood_inundation/
Importance of Federal Partnerships

- Complimentary missions to reduce risks and mitigate losses
  - FEMA ... to prepare for, protect against, respond to, recover from, and mitigate all hazards
  - USACE ... to strengthen our Nation's security, energize the economy, and reduce risks from disasters.
  - USGS ... minimize loss of life and property from natural disasters.
  - NOAA/NWS ... protection of life and property and the enhancement of the national economy

- Opportunity for enhanced collaboration

- Decision-makers need integrated information to more effectively mitigate the impacts of floods
Partnering to Reduce Costs and Improve Efficiency

- Additional cost to complete one inundation map library as part of a FEMA FIS or local Flood Study: 5 – 10 K (~3 to 6% cost increase)

- Cost doubles and time increases if inundation map library is created after the study is completed: 10 – 20 K

- Developing inundation libraries in conjunction with Flood Study yields significant user benefit for small incremental cost
Integrated Water Resources Science and Services (IWRSS)

- Integrate information and streamline access
  - Share technology, information, models, best practices
  - Develop system interoperability and data synchronization
  - Create a Common Operating Picture

- Increase Accuracy and Timeliness of Water Information

- Provide new Summit-to-Sea High Resolution Water Resources Information and Forecasts
Integrated Water Resources Science and Services (IWRSS)

- Status and Current Activities
  - Memorandum of Understanding (MOU)
    - being drafted
    - NOAA NWS is lead author
  - Charter One
    - Team on System Interoperability and Synchronization
    - USGS is lead author
  - Charter Two
    - Team on National Inundation Mapping Services
    - USACE is the lead author
Summary and Conclusions

- Inundation Maps + Real Time Observations + Forecast = Powerful New Tool for Flood Loss Reduction
  - Partnerships make it possible
  - Partnering Reduces Costs and Improves Efficiency
  - Process is Highly expandable in scope and scale

- A multi-agency effort will be required to develop and improve
  - numerical models,
  - inundation mapping,
  - visualization, and
  - decision-support tools

that will help meet the Grand Challenges.

USGS and NWS believe current Flood Inundation Mapping collaborations and IWRSS are steps in the right direction.