



Strategies for Flood Disaster Reduction

Subcommittee on Disaster Reduction Meeting
October 7, 2010

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Priority Interagency Flood Implementation Action



The *Grand Challenges for Disaster Reduction* outlines a ten-year strategy crafted by the National Science and Technology Council's Subcommittee 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 require 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.

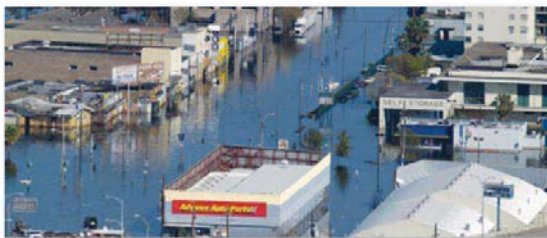
To meet these Challenges, the SDR has identified priority science and technology interagency implementation actions by hazard that build upon ongoing efforts. Addressing these implementation actions will improve America's capacity to prevent and recover from disasters, thus fulfilling our Nation's commitment 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 sdr.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 causes or threatens damage. Floods occur 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, more development in flood-prone areas, an increase in the frequency of heavy-rain events over the last fifty years, and impacts of wildland fire and land use changes have resulted in an increase in flood-related losses. Many of these losses are mainly 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 result of inland flooding in the United States. In 2002 alone, 42 fatalities resulted from severe flooding, a majority of which could have been avoided if the victims had practiced risk-wise behavior.¹ Property damage from all types of flooding, from flash floods to large river floods, averages \$2 billion a year.

The 1993 Mississippi Basin Flood was among the most severe disaster events in recent U.S. history, resulting in an estimated \$12-\$16 billion in damages.² More than 10,000 homes were destroyed during this event, and millions of crop acres were ruined by inundation.³ Thousands of people had to be evacuated, and many of them were never able to return to their homes. The event also severely damaged forests and other



FLOOD

A report of the
Subcommittee
on Disaster
Reduction
www.sdr.gov

An element
of the National
Science and
Technology
Council

Exploit digital elevation data to develop comprehensive mapping of inundation scenarios, referenced to the national stream gage network and river forecast points

Grand Challenges

Grand Challenges *for* Disaster Reduction

National Science and Technology Council
Committee on Environment and Natural Resources



A Report of the
Subcommittee on Disaster Reduction

June 2005
Second Printing January 2008



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

Blanchard River at Findlay, OH (FDY01)

To see all current watches and warnings, [click here](#).

7500 5000 10000 Feet

Data Type

- Inundation Levels
- Flood Categories
- Current/Forecast

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
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Image Type: Standard (Faster Download) Detailed (Slower Download)

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

Transparency Level 100 Year Flood 500 Year N/A (See FAQ) Floodway Data

Flooded underpass, Beaumont, TX (photo courtesy of L. Roll/FEMA)

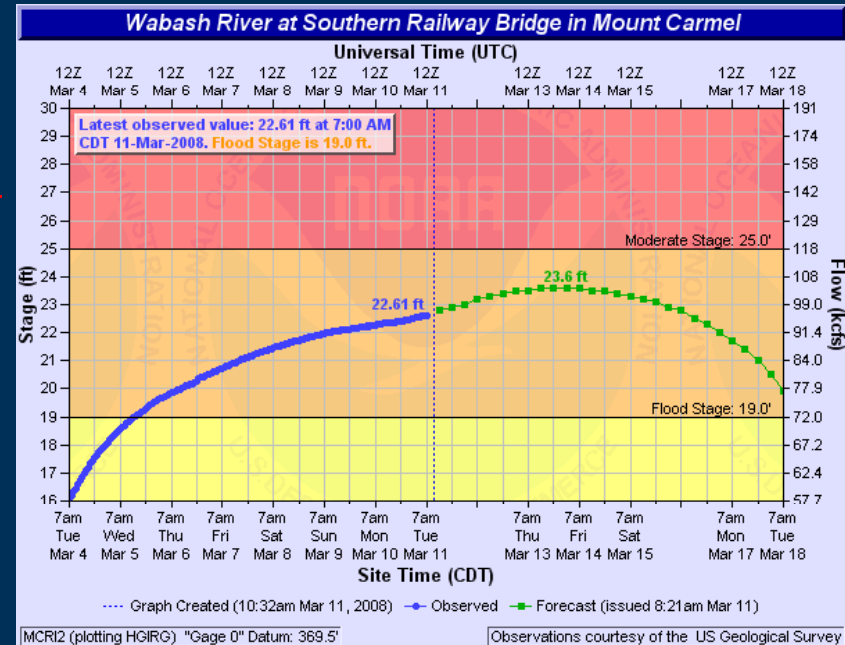


NWS Advanced Hydrologic Prediction Service (AHPS)

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

Flood Safety Awareness Week: March 17-22

Society continues to build homes and businesses in floodplains which are vulnerable to flooding. This increases the need for more accurate and timely hydrologic information including flood and flash flood watches and warnings. See what the National Weather Service is doing to protect lives and property. Details... <http://www.weather.gov/floodsafety/>



<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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/KINN7.1.ER.010407T1300Z.010412T0100Z.000000T0000Z.NO/
200 PM EDT FRI APR 6 2001

THE NATIONAL WEATHER SERVICE IN NEWPORT HAS ISSUED A

- FLOOD WARNING FOR NEUSE RIVER AT KINSTON
- FROM SATURDAY MORNING UNTIL FURTHER NOTICE
- AT 9 AM EDT FRIDAY THE STAGE WAS... 13.5 FEET
- **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/



Enhancing the Communication of Flood Risk

- 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

October 2004

Evaluation of National Weather Service Flood Severity Categories and Use of Gage Station Flood History Information



Prepared by:



A report of Riverside Technology, Inc. for the National Oceanic and Atmospheric Administration prepared for NOAA Contract No. 570-1004-000-0001, 7-04-0000



National Weather Service Customer Satisfaction Survey

Hydrologic Services Program

Executive Report 2006

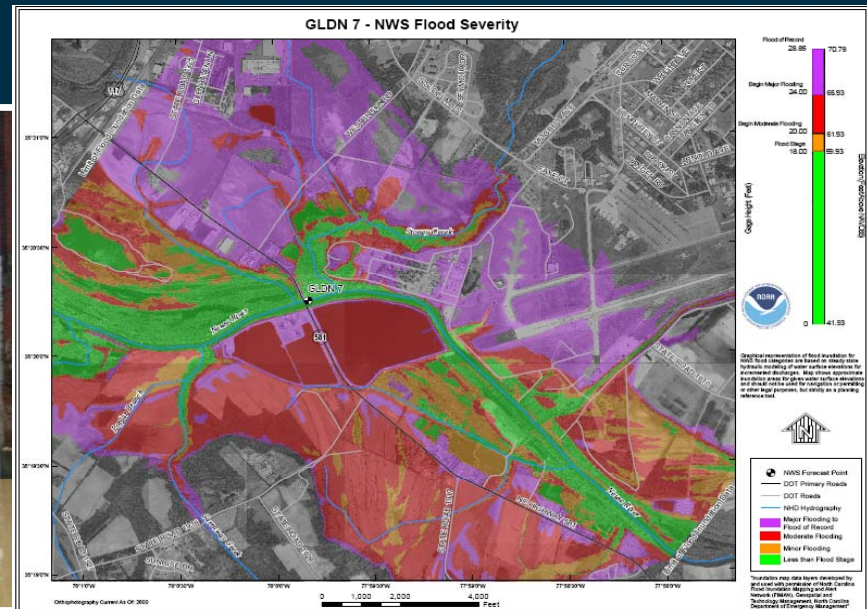




Enhancing the Communication of Flood Risk

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)



RED RIVER BASIN DECISION INFORMATION NETWORK

FFDT Home | **Flood Forecast** | Layers | Overview Map | Zoom to Address | Tools | Help | Exit

Locate Address

Address contains:

 Search

(ex. Rivershore Dr or 3419)

Current Flood Forecast

Deterministic Flood Forecast:
3/16/2010 12:00:00 PM thru 3/23/2010 12:00:00 PM

- Peak Flood Forecast
 - River Flooding
 - Ponding
 - Protected By Levee
 - Not Studied

- Time to Flood Peak
 - N** Arrival Time

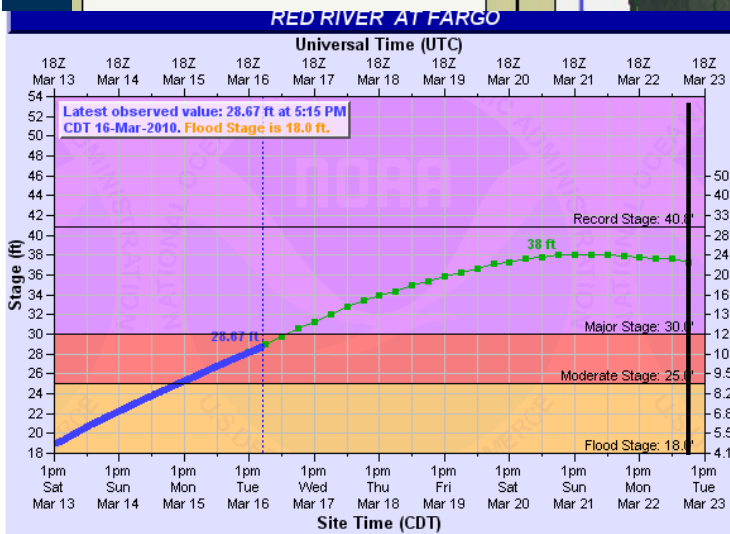
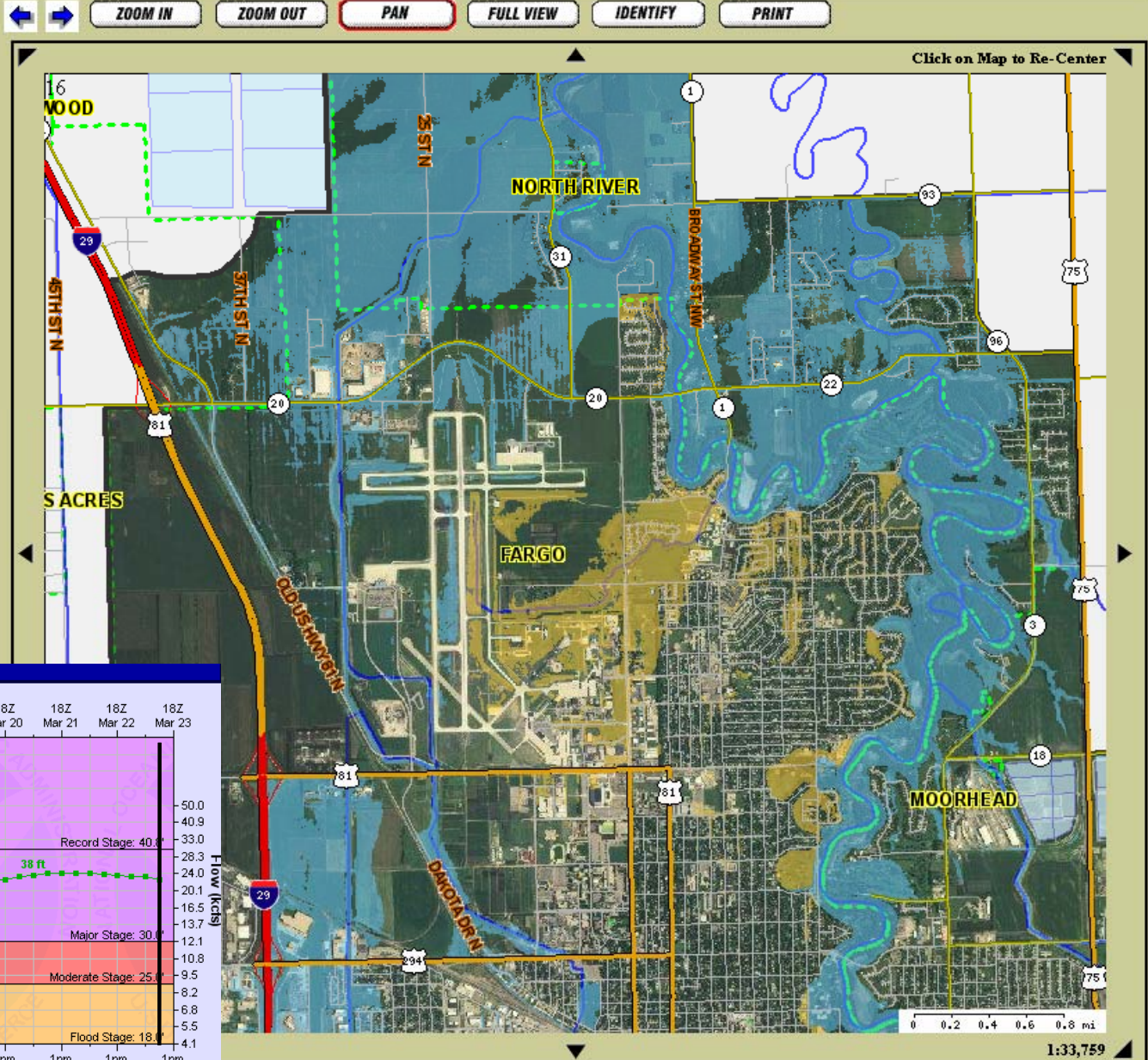
Forecast Animation

Progression:

Forecast Time: 3/23/2010 0hrs



Mar 23 0 H





Flood Mapping Partnerships in North Carolina



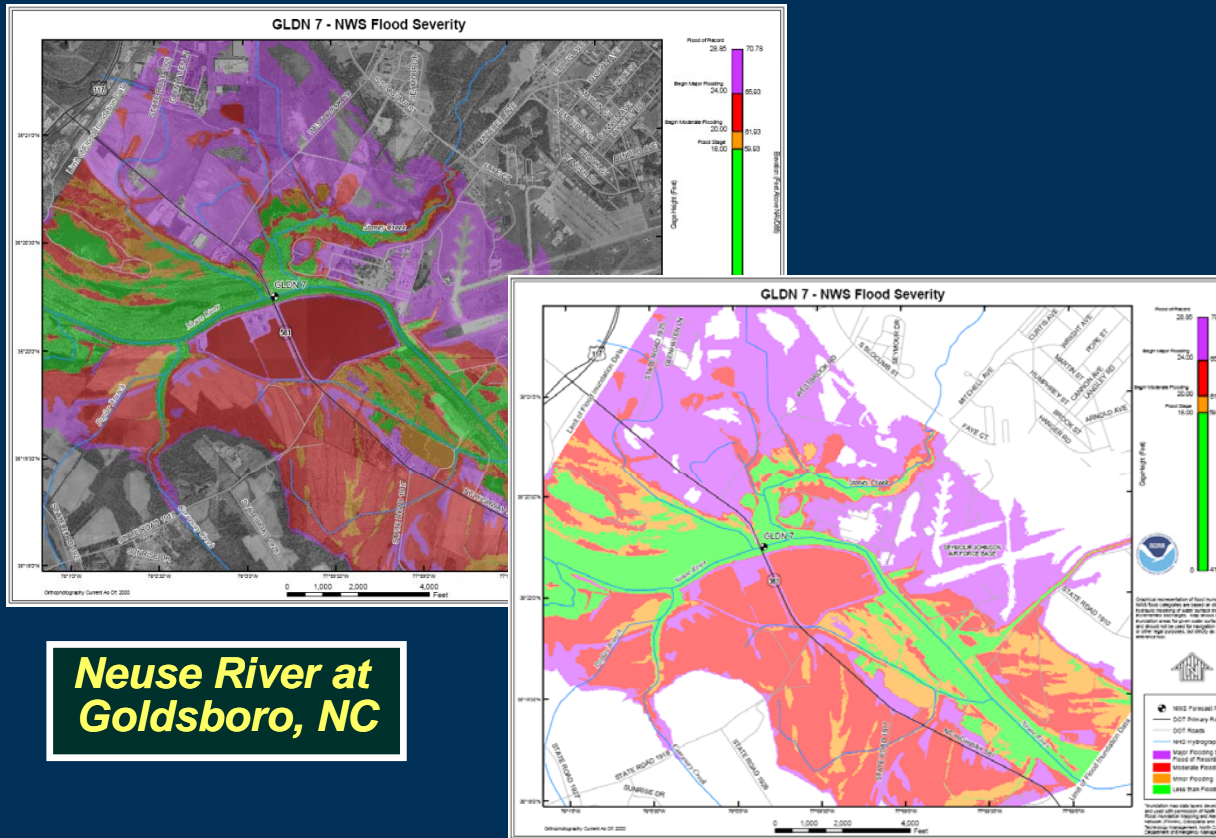
North Carolina Floodplain Mapping Program

LiDAR-Derived Flood-Inundation Maps for Real-Time Flood-Mapping Applications, Tar River Basin, North Carolina



Scientific Investigations Report 2007-5032

U.S. Department of the Interior
U.S. Geological Survey



**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

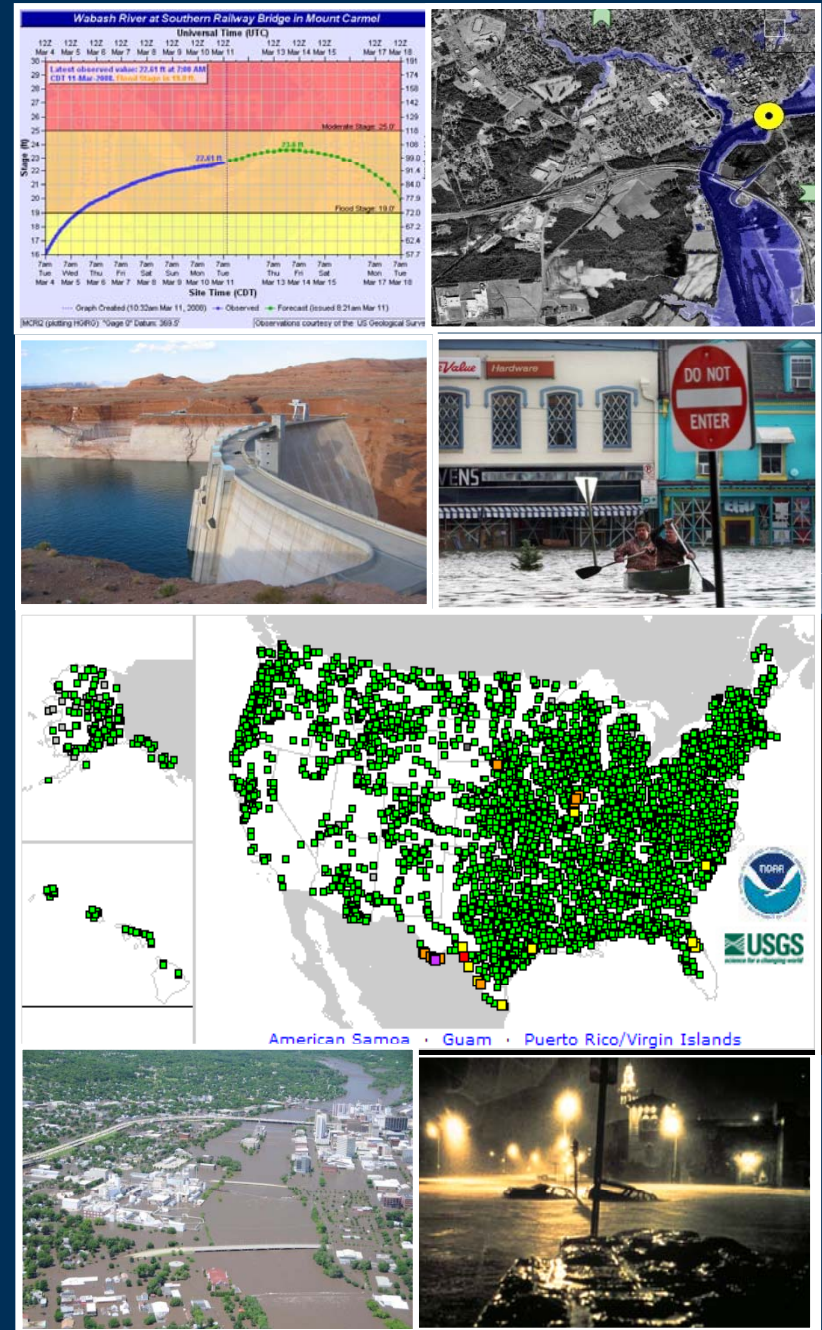
USGS Role in Inundation Mapping



- 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

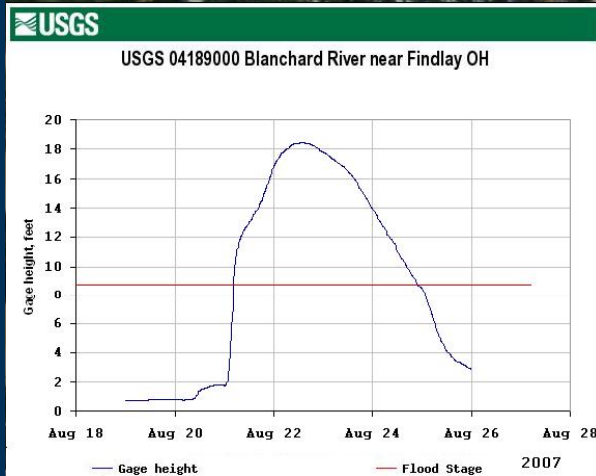
- **USGS Partnering with other agencies to meet multiple missions**
 - NWS Flood Forecasting and Warnings,
 - FEMA Flood Risk Mitigation, USACE Water Management Controls,
 - State, and Local stakeholders.
- **Assist agencies with vexing flood-loss challenges , recurring damages, and repetitive economic losses.**





Collaboration with NWS

On the Blanchard River near Findlay, Ohio





WaterAlert

- WaterAlert allows you to receive text 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/>

USGS Collaboration with NWS

On the Blanchard River near Findlay, Ohio

Blanchard River at Findlay, OH (FDYO1)

Data Type

- Inundation Levels
- Flood Categories
- Current/Forecast

Inundation Levels

NAVD88 Stage

772.2 18.4

771.8 18.0

770.8 17.0

770.3 16.5

769.8 16.0

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768.8 15.0

767.8 14.0

766.8 13.0

Major Flooding Begins

765.8 12.0

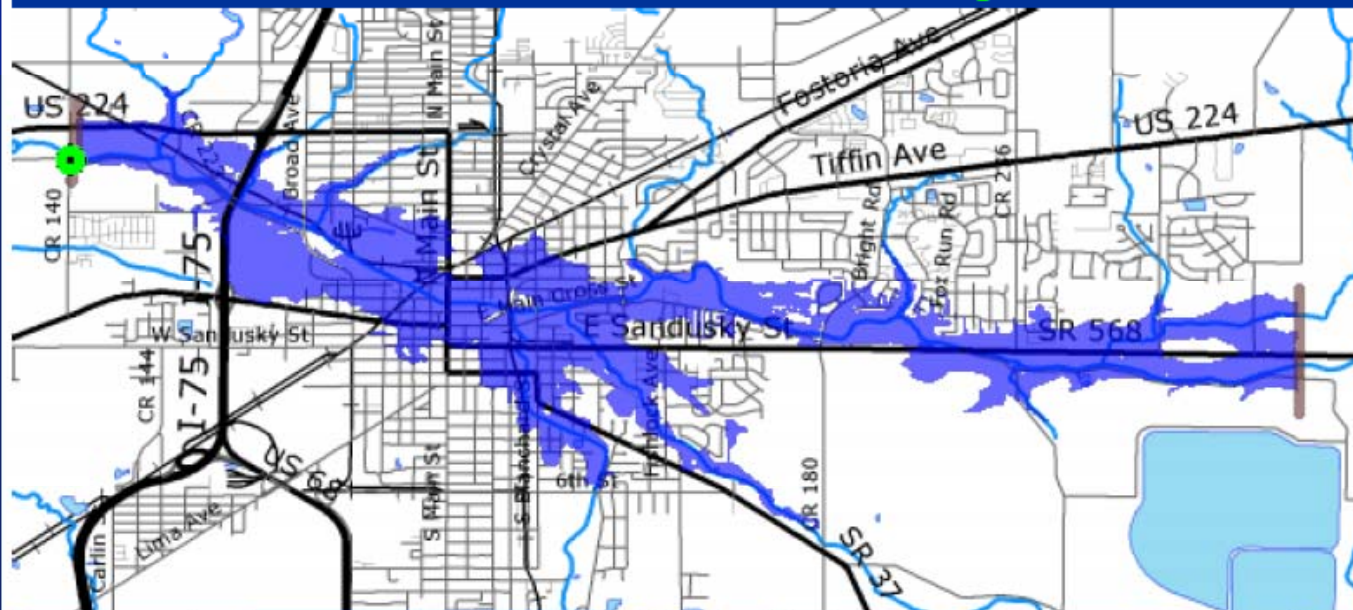
To see all current watches and warnings, [click here](#).

2500 5000 10000 Feet

- Hydrograph
- River at a Glance
- Download
- Inundation Mapping
- Weekly Chance of Exceeding Levels
- Chance of Exceeding Levels During Entire Period

Image Type: Standard (Faster Download) Detailed (Slower Download)

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



Transparency Level 100 Year Flood 500 Year N/A (See FAQ) Floodway Data

- **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

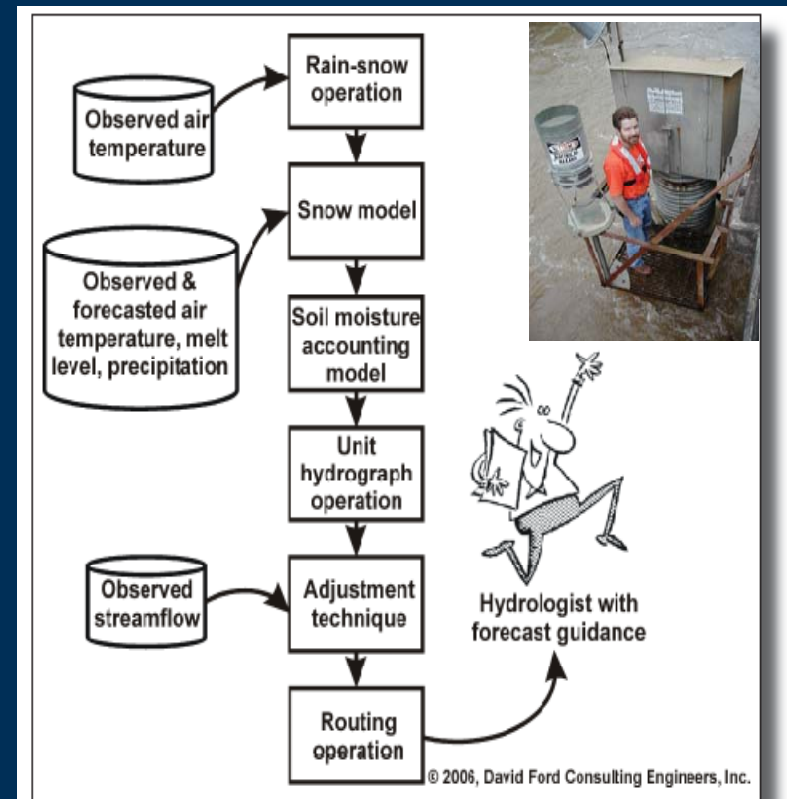
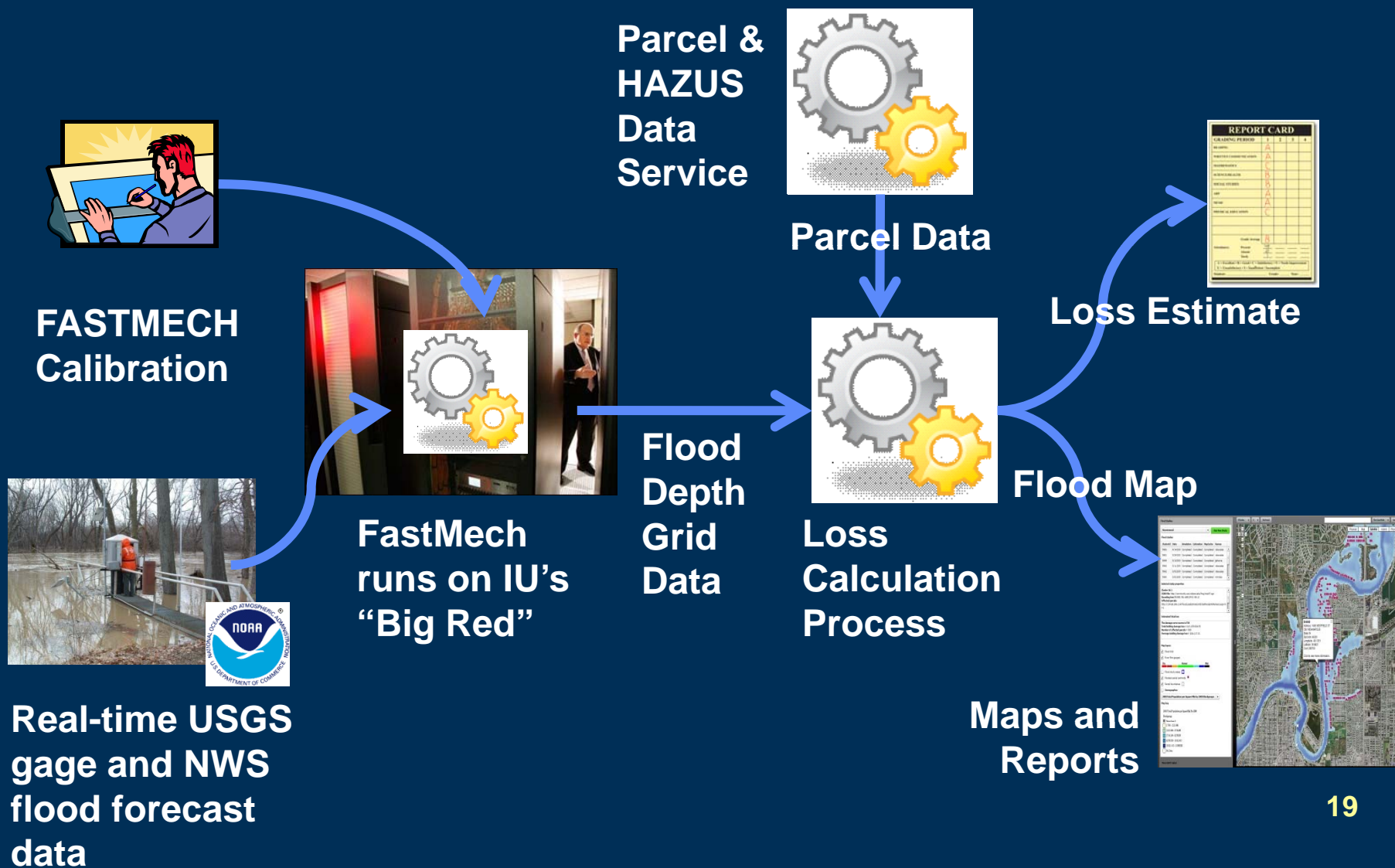


Figure 4. Typical NWSRFS configuration



Real-time Mapping Pilot Project





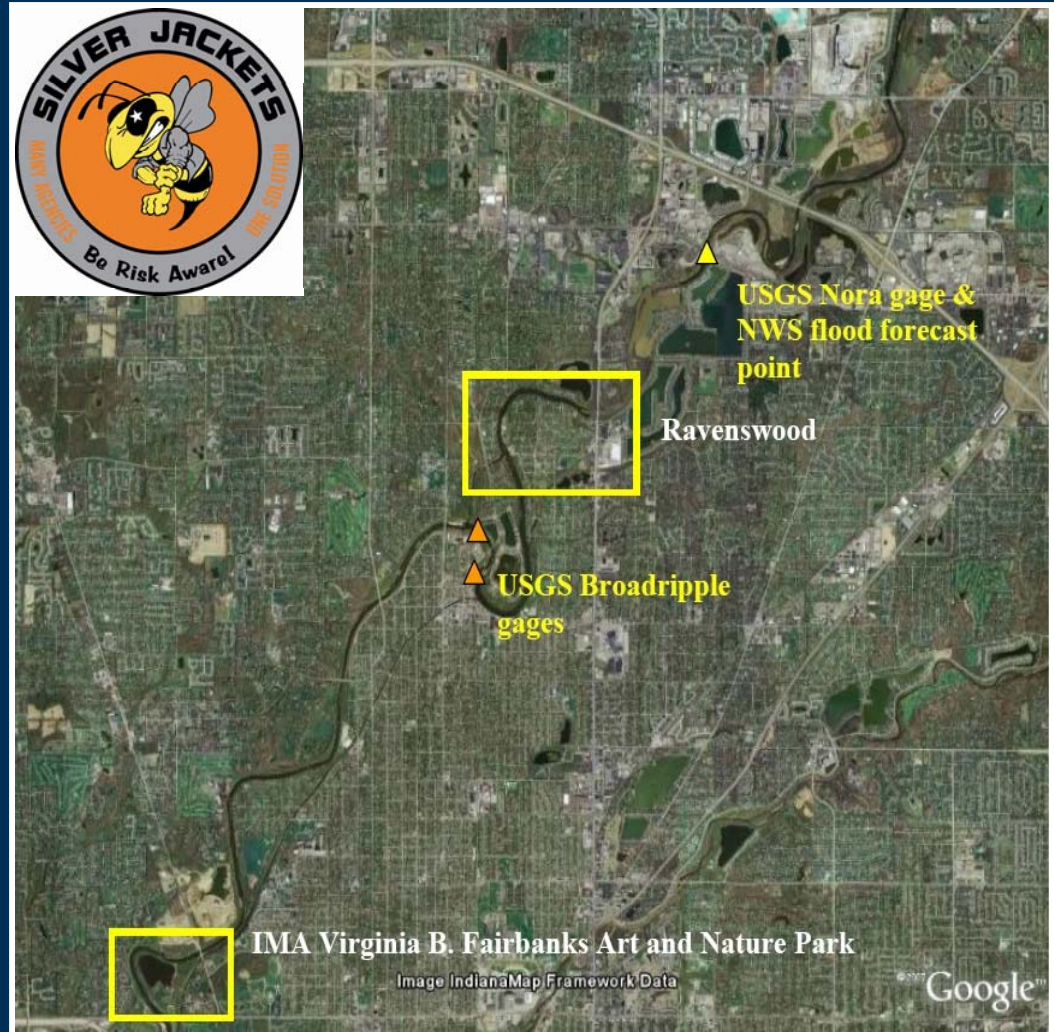
Real-time Mapping Pilot Project

■ 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

Flood Studies

Ravenswood Run New Study

ClusterId	Date	Simulation	Estimation	MapCache	Runner
5952	4/14/200	Completed	Completed	Completed	ndevadas
5951	3/24/200	Completed	Completed	Completed	ndevadas
5949	3/13/200	Completed	Completed	Completed	jjbhome
5943	3/11/200	Completed	Completed	Completed	ndevadas
5942	3/9/2009	Completed	Completed	Completed	ndevadas
5940	3/8/2009	Completed	Completed	Completed	kmickey

Selected study properties

Cluster Id: 1
 CGMS file: <http://community.ucs.indiana.edu/fmg/mar07.cgm>
 Bounding box: 39.868,-86.1466,39.9,-86.12
 Affected parcels: <http://134.68.246.114/FloodLossEstimator/WS/GetParcelsWMarkers.aspx?ci=1>

Estimated Total loss

The damage curve source is FIA
 Total building damage loss = \$10,159,634.93
 Number of affected parcels = 389
 Average building damage loss = \$26,117.31

Map layers

Flood Grid
 River flow gauges

Dry Normal Wet

Flood study areas
 Flooded parcel centroids
 Parcel boundaries
 Demographics

2000 Total Population per Square Mile by 2000 Blockgroups

Map key

2000 Total Population per Square Mile For 2000 Blockgroups

Blockgroups	Color
Fewer than 0	Gray
3,798 - 1,521,486	Yellow
1,521,486 - 3,716,249	Light Green
3,716,249 - 6,278,039	Green
6,278,039 - 10,121,413	Dark Green
10,121,413 - 21,588,302	Blue
No Data	White

[More SAVI data?](#)

YIGnBu 5 Refresh The GeoWeb Search

Physical Map Satellite Hybrid Physical

8046068

Address: 1400 WESTFIELD CT
 City: INDIANAPOLIS
 State: IN
 ZipCode: 46220
 Longitude: -86.1351
 Latitude: 39.8821
 Cost: 289700

[Click to view more information...](#)

Web Portal



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USGS Flood Inundation Mapping Science

[home](#) [focus areas](#) [links](#) [contact](#) [internal](#)



FLOOD-INUNDATION INITIATIVE PILOT PROJECTS

Indiana

- ◆ [Flood of Sept. 2008, Indiana](#)

FLOOD-INUNDATION PROJECTS

Georgia

- ◆ [Flint River at Albany](#)

Illinois

- ◆ [Du Page County](#)
- ◆ [Lake County](#)

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.

USGS Flood Inundation Mapping Science Focus Areas

The USGS is working in the following focus areas for flood inundation mapping science:

- ◆ [Flood documentation studies](#)
- ◆ [Static flood-inundation map libraries](#)
- ◆ [Real-time dynamic flood inundation mapping](#)

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



Costs go down

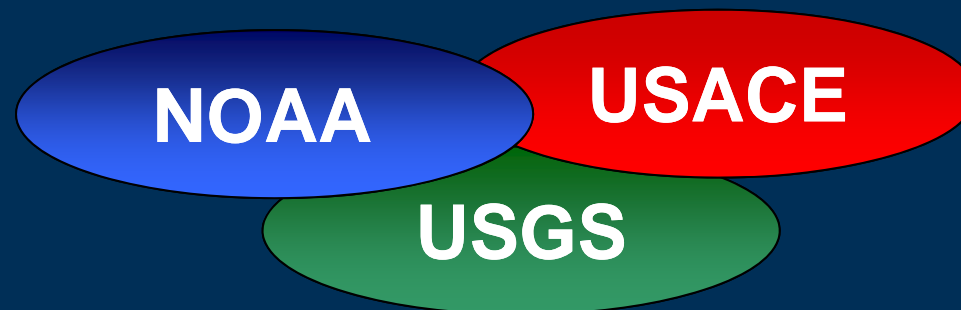


Efficiency goes up

- **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.



Questions?

