U.S. Geological Survey Flood Inundation Initiative: Prospectus

Prospectus Summary

A powerful new tool for flood response and mitigation is digital geospatial flood inundation mapping that shows flood-water extent and depth on the land surface. Flood inundation maps that are tied to U. S. Geological Survey (USGS) real-time streamgage data and National Weather Service (NWS) flood forecast sites enable officials to make timely operational and public safety decisions during floods. Because floods are the leading cause of natural-disaster losses, and because disasters associated with flooding can be reduced with proper preventative measures, development of a USGS National flood inundation mapping science initiative is critical to meet USGS science strategy goals for the National Hazards, Risk, and Resilience Assessment Program major science direction. A USGS National flood inundation mapping science initiative would be of great benefit to and foster partnerships with other Federal agencies such as the NWS, U.S. Army Corps of Engineers (USACE), and Federal Emergency Management Agency (FEMA); state USGS cooperators such as departments of natural resources, homeland security, and transportation; and local cooperators such as counties and communities.

This prospectus offers a preliminary view of a comprehensive and partner-based USGS Flood Inundation initiative designed to meet USGS science strategy goals and stakeholder needs. Elements of the program will include the following:

1. The development of technical specifications, standards, and methods for creating and disseminating flood inundation mapping science information, including a consistent visual and electronic file format—that is, appearance and functionality—for all USGS inundation map products. The development of a National USGS Web portal linking to current and future USGS flood inundation data, information, and projects. It is envisioned that the portal will be hosted by the Office of Surface Water (OSW) and that inundation map products will become part of OSW's WaterWatch suite of Web products.
2. The production of static flood inundation map libraries linked to USGS streamgage data and National Weather Service flood forecast data.
3. The development of state-of-the art dynamic, real-time flood inundation applications to meet a host of partner and cooperator needs, from flood response and mitigation to dam- and levee-breach simulations.
4. The development of agency partnerships to foster the development of flood inundation tools that fulfill multiple agency missions and thus provide the most benefit to the Nation's communities and citizens at risk from floods.

Introduction

Floods are the leading cause of natural-disaster losses in the United States. Although loss of life to floods during the past half-century has declined, in part because of improved warning systems, economic losses have continued to rise with increased urbanization in flood-hazard areas throughout the Nation (U.S. Geological Survey, 2006). More than 75 percent of declared Federal disasters are related to floods. From January 1, 2000, through February 2, 2009, there were 48 Federal Disaster Declarations involving flooding in Midwest Area states (Federal Emergency Management Agency, 2009).

Given the severity and wide geographic coverage of Midwest flooding in June 2008, the NWS formed a 10-member, multiagency Service Assessment Team (including USGS) to evaluate NWS products and services during the event. A major finding of the Service Assessment Team was that "flood inundation mapping will help the public, media, emergency managers, and others visualize the spatial extent and depth of flood waters in the vicinity of NWS river forecast locations." Further, the team recommended that the "NWS should expand efforts with state and Federal agencies and other groups to accelerate the implementation of flood inundation mapping across the United States" (National Weather Service, 2009).

The USGS has developed a national science strategy that includes the major science theme titled "A National Hazards, Risk, and Resilience Assessment Program: Ensuring the Long-term Health and Wealth of the Nation." This science theme states: "The USGS will develop a national risk-monitoring program, built on a robust underpinning of hazard assessment and research, to visualize and provide perspectives at multiple scales of vulnerability and resilience to adverse land change and hazards. Accurate observations, targeted research, and timely communications will safeguard people and property and keep natural hazards from becoming natural disasters" (U.S. Geological Survey, 2007). A critical need for addressing flood hazards is development of science products showing flood-inundation depth and extent in a geospatial format that is both accurate and understandable to nontechnical users such community planners, emergency management officials, law enforcement officials, and the general public.

To meet the need for flood inundation mapping science, several USGS water science centers across the Nation have undertaken flood inundation mapping projects, usually in partnership with USGS cooperators (http://water.usgs.gov/osw/flood_inundation/). Most of these projects have involved the creation of static map libraries: collections of maps that have been created in advance of a flood and that are ready to be served through the Internet. Each library consists of a set of flood extent and depth maps at set water-level (stage) intervals (for example, a map for each 1 foot of stage). A user can view real-time stage data from a USGS streamgage or forecast stage for NWS flood forecast point (almost all of which include a USGS streamgage) and quickly access the map corresponding to the stage data. An alternative to static map libraries is creation of dynamic inundation maps, whereby flood simulations are based on forecast information and real-time data for a specific event and maps are created "on the fly." Several water science centers have taken the next step in this important flood science area.

Although these individual projects have yielded great benefits, a unified USGS program approach is needed, not only to ensure the high level of USGS standards our stakeholders expect but also to ensure these efforts fit within the science strategy framework and meet the Federal interest. A national program approach prevents duplication of effort and results in products that present a uniform USGS face to our stakeholders. A USGS Flood Inundation initiative will bring with it the benefits of a nationally guided effort that fits the USGS science strategy while still meeting the needs of local, regional, and national USGS stakeholders seeking to create more flood-resilient communities.

Benefits

1. A Flood Inundation Initiative will benefit numerous USGS science strategy directions—in particular, the National Hazards, Risk, and Resilience Assessment Program. The initiative supports the following Strategic Actions outlined under this science direction:
    - Expand and modernize USGS monitoring and communications capabilities to take full advantage of technology advances in order to deliver robust and reliable products.
    - Develop models with robust predictive capability to support land and emergency managers in short- and long-term hazard mitigation decisionmaking.
    - Develop a core of USGS and partner researchers focusing on vulnerability science, collocated with USGS hazard program science centers, external agencies, universities and Federal partners.
    - Develop a national risk-monitoring program, built on a robust underpinning of hazard assessment and research that visualizes and provides perspectives at multiple scales of vulnerability and resilience to adverse land change and hazards.
    - Develop communication strategies and decision-support products that focus on understanding societal risk and resilience to natural hazards, and develop new individualized ways of communicating hazards and hazard assessments to local audiences and to targeted audiences with different needs.

2. This initiative will provide a base for partnering with other agencies to meet multiple missions through programs such as Integrated Water Resources Science and Services (IWRSS), National Weather Service flood forecasting programs, FEMA's HAZUS-MH and RiskMap programs, USACE modeling and operations programs, and individual state Silver Jackets hazard mitigation taskforces.

3. Static and dynamic flood inundation mapping will be a tool to assist agencies with vexing flood-loss issues, specifically repetitive flood losses and losses caused by dam and levee breaches.

Initiative Goals and Objectives

1. **Develop a consistent visual and electronic file format for all USGS inundation map products**. Consistent appearance and functionality of all USGS inundation products is crucial not only for ease of navigation and wide utility across a broad range of public and partnering interests but also for ensuring the high technical standard historically afforded by USGS products. Toward that consistent approach, the initiative will develop USGS

technical specifications, standards, and methods for creating and disseminating flood inundation mapping science information. A Technical Steering Committee consisting of USGS flood inundation experts will develop the guidance and standards. The technical issues that need to be addressed to develop the technical side of this initiative include the following:

a. Research into best hydraulic models and techniques
b. Geographic and hydrologic data input needs
c. Quality assurance, standard metadata, and presentation of products
d. Ongoing maintenance of mapping products
e. Policy and guidance issues

2. **Develop a National USGS Web portal linking to current and future flood inundation projects**. The portal will help the USGS maintain a uniform user interface to inundation products for our stakeholders and a single entry point for all USGS flood products.
3. **Produce static flood inundation map libraries linked to USGS streamgage data and National Weather Service flood forecast information**. Creation of state map libraries is within the USGS cross-discipline capabilities and mission. Collection, processing, and dissemination of the land-use, elevation, and bathymetric data; development and application of 1D and 2D inundation models; streamflow data collection; and map maintenance all are required for inundation mapping and are part of the USGS core mission.
4. **Develop state-of-the art dynamic, real-time flood inundation applications** to meet a host of partner and cooperator needs, from flood response and mitigation to dam- and levee-breach simulations. These applications involve a higher level of science and technologies than static maps, and USGS can make significant advances to flood inundation mapping and hazard response through this goal. The National initiative will steer these types of applications to ensure that proper support and standards are devoted to this critical emerging science and technology area.
5. **Develop a core of USGS and partner agencies** to focus on the development of flood inundation tools that fulfill multiple agency missions and thus provide the most benefit to the Nation's communities and citizens at risk from floods.

Proposed Strategy

Three strategies are proposed for carrying out this initiative:

1. Develop minimal technical standards and guidelines for inundation mapping products to maintain a common appearance and functionality for those products; major elements of the guidelines will prescribe flood-map file format, appearance, and metadata standards.

2. Undertake multiple pilot projects to produce a series of flood inundation map libraries for various regions of the United States and develop a Web interface that will allow users to perform risk assessments using the inundation map libraries. The pilot project process

will test the technical standards and guidelines and, through that testing, the standards and guidelines will be refined.

3. Move forward with a large-scale, nationally partnered initiative for flood inundation mapping that brings together the USGS, NWS, USACE, FEMA, and other stakeholders. This scale of partnership can realize the "Vision of 2017" for the USGS National Hazards, Risk, and Resilience Assessment Program: "The Nation is safer from natural disasters thanks to a seamless, integrated disaster reduction/monitoring/warning system maintained and operated by the USGS and its partners."

References

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