Brief Summary of Flood Inundation Mapping in the Water Discipline

A workshop on the current practices of flood-inundation mapping was help at the National Training Center in Denver, CO on Nov. 27-28, 2001. People from all the Disciplines were invited, but only David Catts from NMD attended from outside WRD. Tom Casadevall, Regional Director, spent the entire first day with the workshop.

Flood inundation mapping is widely done in USGS Water Districts. By far and away the most prevalent use is in flood risk/hazards evaluation. A much smaller number of projects use inundation mapping for habitat or environmental studies. The USGS is pushing the envelope of technology and science in flood inundation mapping, as demonstrated by the use of internet map servers to provide near-real-time inundation maps generated from LIDAR digital elevation data and multidimensional models to route floods through tens of kilometers of river valleys. The National Weather Service is concerned; the USGS needs to meet with them to discuss the relative roles of science and technology research and development versus operational forecasts and flood predictions.

The Georgia District has had a long and successful flood mapping project in the Flint River basin (8,000 sq mi) in central Georgia. They identify a 'statistical' floodplain using regionalized flood-frequency/depth relationships developed for different hydrologic regions in Georgia as described in WRI 77-90 (1977). The District is planning on updating the relationships between flood frequency and depths in the near future. They have been successful in obtaining funding from CINDI to help with information dissemination. The Georgia group believes that the best way to improve communication about floods and flood risks is by careful use of visualizations to portray the flood hazards.

The Kansas District has a modest inundation mapping effort along Cowskin Creek in Witchita, KS. The District has used HEC-RAS to model the flood inundation areas that has not been affected by proposed channel improvements for a reach one mile up and one mile downstream from a streamgaging station. Elevation data were derived from orthophotos, and static flood inundation maps have been pre-processed for 2-ft. increments of stage for the reach. Maps have not yet been completed, nor the flood areas delineated.

The Ohio District has a large flood insurance studies program; about $1.5M a year. A proposal for a flood warning network for the city of Findlay, Ohio was described. In the flood-insurance mapping project for Findlay, 100-year flood profiles were constructed with HEC-RAS using high-quality digital orthophotos with 2-ft. contours for elevation control. A GPS series of measurements were then made to fill in the elevations of areas between cross-sections to more accurately define the flood boundaries. Inundation areas have been pre-processed and outlined on the air photos for 500 cfs increments between the 2 to 100-year flood discharges. The boundaries of inundation are

very clearly marked on the orthophotos; discussion centered on whether there should be error bars associated with the inundation boundaries.

North Carolina is the first Cooperating Technical State in the nation, which means that FEMA has delegated to the State the authority to produce the floodplain maps for the entire State. As part of North Carolina's efforts to update all floodplain maps in the State in 3 years, the entire state is being mapped using LIDAR with 5 meter horizontal resolution. Data sets have been collected for most of the eastern part of the State. Consultants are using HEC-RAS and USGS flood frequency regression equations to delineate floodplains. As part of this effort, the NWS, USGS, and North Carolina are developing a pilot enhanced flood-warning and flood-inundation system for one basin. The project involves installation of about 15 new stage gages (bringing the number of gages in the basin to about 27) from which real-time flood-inundation maps will be produced. The NWS and the USGS also will test application of a distributed rainfall-runoff model to improve flood forecasts.

In Missouri, the District has been working on identifying the 100-year flood hazard area for all streams with drainage areas greater than 1 sq mi. Funding involves about $400K per year, and work is done on a county basis. They use the NED (30 M) data source and Arc/Info amls to automatically compute drainage areas and main channel slopes for hydrology. Profiles for the 100-year flood are determined using HEC-RAS and data from field surveys and NED data. The hazard areas based on HEC-RAS results are produced automatically using Rivercad, a private sector software package. Results are overlain on DOQ's and hard and soft copies are provided to the cooperator. Average cost of modeling a river mile is less than $150.

The Washington District has the most ambitious inundation mapping program, which is a result of 5 years of federal funding under the Urban Hazards Initiative. The project involves a partnership with the Northwest River Forecast Center of the NWS. A forecast flood hydrograph is handed off to the USGS. This hydrograph is then run through a 2-dimensional hydraulic model for about 20 kilometers between two streamgaging stations on the Snolquamie River basin. The model is TRIMR2D, which has proven to be remarkable robust and stable. Results are posted in near-real time with an internet map server with scaleable maps and multiple layers that can be turned on and off. The topography uses a dense coverage of LIDAR elevation data.

Ed Josberger talked about satellite flood mapping. He pointed out that real-time mapping from satellites is unlikely without using classified assets. The most likely use would be in retrospective analyses. Radar seems like the most probably spectral range for identification of water. 30 m resolution with 2-day coverage from commercial systems such as RADARSAT are possible now. It is also possible to task some satellites to look at specific floods, but this would be expensive. Support from CINDI might improve the odds for success.

There are a number of other organizations doing flood-inundation mapping, and we reviewed several of these efforts primarily by looking at web page resources. These

organizations include FEMA, COE, NWS, Danish Hydrologic Institute, ESRI, and several private companies such as the one providing hazard alert warnings for Fort Collins, CO.

Rich McDonald spoke of the generic interface system for hydraulic models developed by the Denver researchers. Several of the widely-used hydraulic models are already in the GUI, and the system is designed for rapid integration of new models. The GUI includes visualizations. Several new 1 and 2-D models are under testing and development. Rick is available to help Districts with their modeling projects, and to train others in use of the generic interface.

SUMMARY

The primary approach to inundation mapping remains the preparation of canned results and maps from model runs determined from flood profiles obtained from either statistical models (regressions) or deterministic models, such as HEC-RAS. The HEC-RAS model seems to be very widely used in the operational program for this purpose. It is important to create a library of inundation maps for critical floodways that have been obtained by the best available practices in the local area. These maps can then be served over the internet as flooding is imminent or underway. In most locations this would be a valuable and important forward step in alerting public officials and lay people about the impending risks of flooding.

The cutting edge is an active, real-time inundation mapping system that produces unique inundation maps from each forecast flood hydrograph, and displays the results in near-real time over the internet. There is a lot to like about an active system such as this. Because every point in a floodplain is not equally dangerous, we need to begin to think in terms of a flood hydrograph, rather than a single 100-year flood. Using dynamic models allows a more comprehensive look at flood hazards beyond simply “is it wet, or is it dry”. It is possible to map depths across floodplains, high-velocity zones, and impact forces of water. Ideally, it is possible to identify specific structures or buildings that are all within the floodplain, but are more likey to be damaged or destroyed because of their position in the floodplain. The USGS has the lead in this thinking and technology, but the opportunity will not be there forever.

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