Newsletter by Subcommittee on Flood Control:

- Analysis of the Levee Certification and Inspection Process
- The Role of Geographic Information Systems in Computer Modeling

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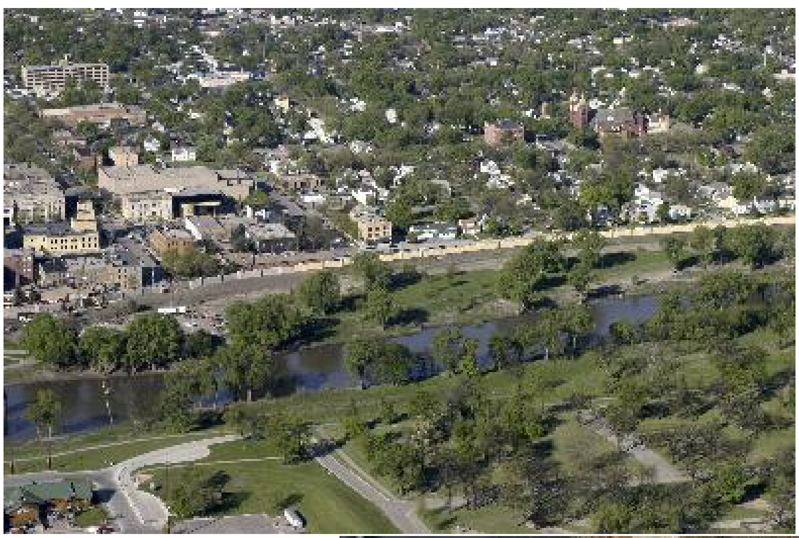

Introduction

For this Newsletter we have selected two topics that, although different, both are quite relevant to flood control issues. The first topic is the certification and inspection of levees and the second is the use of Geographic Information Systems (GIS) technology for development of computerized flood control models.

Hurricane Katrina and its impacts on the City of New Orleans brought to the national attention the safety issues associated with the design and operation of levees. It has been recognized that more attention is needed to determine the level of safety that the thousands of miles of levees that exist throughout the nation provide to the millions of people who live in the flood risk areas behind those structures. However, it is also understood that the levee problem has been in the making for nearly a century and it will take a long time to resolve it, particularly to educate our communities about the true risks associated with levees and levee construction. The issue of national policies associated with levee operation was addressed in a white paper prepared by the Association of State Floodplain Managers (ASFPM, 2007). That paper covers various topics from levee standards to residual risk, insurance, and communication. Because of the relevance of the topic, for this newsletter we elected to re-print the portion of the ASFPM paper dealing with Certification and Inspection, including ASFPM's recommendations.

As indicated above, the other topic selected for this Newsletter addresses the application of GIS technology for flood control computer modeling. Traditionally, the use of GIS has been limited to a *support* role for mapping and related engineering activities – not as a tool that *drives* the analytical process. However, watershed studies conducted using a GIS platform have demonstrated that the spatial analysis capabilities of GIS hold the key to improved computer modeling techniques. The analytical muscle of GIS combined with readily available digital elevation data, can be used to automate the modeling process and provide a visual representation of a watershed's response to existing conditions and proposed improvement scenarios. This article addresses some of the many benefits associated with the incorporation of GIS/geodatabase technology into the modeling process.

Analysis of the Levee Certification and Inspection Process

Adapted from:
Association of State Floodplain Managers Position Paper on National Flood Policy Challenges.
Levees: The Double-Edged Sword

Services provided by State agencies regarding the National Flood Insurance Program (NFIP) related services often include six categories- training, community compliance, technical assistance, agency coordination, disaster response, and strategic planning requirements. Training courses include guides to implementing the NFIP, floodways and the floodplain management regulations, preparation of map amendments and/or elevation certificates, and realtors' workshops.

The United States has in place requirements for inspecting and certifying numerous private and public enterprises that affect human health and safety. However, the nation's sole requirements for operation and maintenance of levees are found either in an agreement between a federal agency and a non-federal sponsor (executed during construction of a levee), or as a requirement imposed by FEMA in the course of mapping flood hazard areas associated with levees. In the latter case, proper inspection and certification is mandated in order for a levee to be recognized as providing 100-year flood protection.

For many of the nation's levees, the federal government planned and built the structure, with a nonfederal "sponsor," often a local government, contributing some share of the cost. Under this arrangement, the local sponsor assumes responsibility for operation and maintenance of the levee after it is built. The certification and inspection of the levee is thus the responsibility of the local party who chooses to use that structure as a mitigation measure. The certification and inspection of levees is not the financial responsibility of the federal government, except in those instances where the federal government is the sole owner and operator of the levee. Although it is clear that the local sponsor is responsible for operation and maintenance, the local entity is not required to demonstrate financial or technical ability to carry out these tasks. Further, both federal and state oversight and enforcement of the adequacy of ongoing operation and maintenance is problematic.

In numerous other cases, levees were constructed by local or state governments, were private levees built specifically for purposes of compliance with the requirements of the NFIP, or were constructed to protect areas (most notably agricultural lands) from occasional inundation. These non-federal levees have become part of the protection system with varying degrees of ongoing operation and maintenance.

This haphazard approach to levee certification and inspection fails to protect the federal interest in public health, safety, and fiscal responsibility. These requirements for levees are far less stringent than the certification, design, maintenance, and inspection requirements for dams. When flood damage results from levee failure (even if the failure results from the negligence of the levee owner who did not meet the agreed-upon inspection and maintenance duties), federal programs come into the picture to rebuild failed or damaged levees, provide disaster assistance, and sometimes to provide additional financial support to the NFIP—leaving the nation's taxpayers to foot the bill. These policies combine to create a lack of understanding and accountability for levee owners to invest in proper design, construction, inspection, and maintenance of their levees. Reversing this trend will take strong leadership, a sense of shared responsibility, and sharing of the costs and consequences of levee failure.

As with other flood loss reduction programs, a federal-state partnership is the logical avenue for the effective and efficient oversight of the certification and inspection of all levees. The certification process should consider elements of the NFIP but be more aligned with determining whether a levee meets specified design, operation, and maintenance criteria rather than simply whether a professional engineer is willing to attest that the levee will not fail. Over the long term, levee certifications that are provided to FEMA should be delivered by an approved levee safety program, most appropriately housed within state government. Although the private sector may perform much of the engineering work, it should be reviewed and approved by qualified state staff. State capability in this area is critical and must be developed through federal legislation that provides incentives and disincentives that encourage states to undertake effective state levee safety programs, which then will reduce the federal costs described above.

Recommendations

1. Written guidance is needed on what constitutes a "proper" inspection, what is needed for certification to enable the NFIP to recognize the levee, and what the actual consequences are to the levee owner if the levee is not properly maintained to meet these requirements. Both the Corps of Engineers and FEMA have guidance for requirements of programs that come into play with these issues, and the guidance from each agency must be consistent and correlated with the other agency's guidance.

2. A federal policy should be clearly articulated that the periodic certification and inspection of levees, including related operation and maintenance, is the responsibility of the levee owner and that transferring this responsibility to the federal government is inappropriate. Participation in federal programs of

repair, insurance, and disaster relief must be contingent on levee owner compliance with these elements.

3. Non-federal levee owners must be required to demonstrate the long-term financial and technical ability to carry out operation and maintenance tasks. Further, both federal and state oversight and enforcement of the adequacy of periodic inspections and ongoing operation and maintenance must be in place and enforced.

4. A state-administered national levee safety program is needed to protect the federal interest in public health, safety, and fiscal responsibility, as well as to protect public safety and costs related to all levees not in the federal system. Such a program must be fully integrated with state and local programs of flood risk management, especially floodplain management and dam safety, and should use a state delegation model similar to that used to implement the Clean Water Act, rather than function as an independent program like the existing National Dam Safety Program. State capability in this area is critical and can be developed most effectively through federal legislation that provides incentives and disincentives for states to accept delegation for the development and implementation of effective state levee safety programs.

5. FEMA should require that all communities with an NFIP-recognized levee have a multi-hazard mitigation plan that considers how other hazards affect the safety of their levee (e.g., earthquake, subsidence, river sedimentation, erosion, etc.) and appropriate emergency action plans (EAPs) with action steps to account for any of these factors that affect the safety of the levee. FEMA should require that this plan be updated at least every five years, including accounting for any changes in flood flows caused by increased watershed development. The potential for catastrophic consequences of levee failure or overtopping should be included in levee planning, design, regulations, and insurance considerations.

The Role of Geographic Information Systems in Computer Modeling

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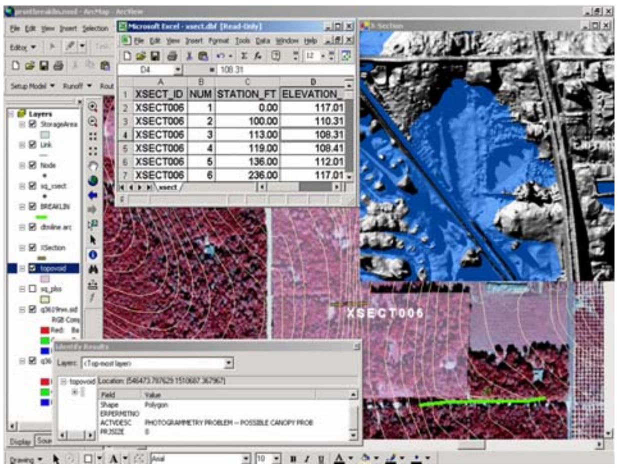
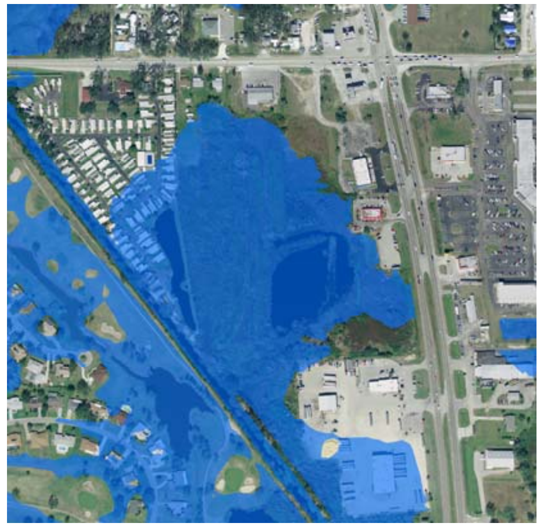
The traditional approach to computerized flood modeling is labor intensive and generally takes significant amounts of time to complete. Often engineers are tasked to manually determine watershed drainage patterns and paths using hard copies of historical contour and aerials maps. Hydrologic watershed parameters are calculated by hand or by spreadsheet, and the computer model setup consists of manually translating structures, bridges, and cross-sectional survey data into usable hydraulic model format. Furthermore, if during model testing and calibration the engineer discovers missing connectivity problems – such as a roadway overtopping or an interconnect between a lake and adjacent depression area – it is quite problematic to integrate the new information into the model, and the solution is often to effectively start much of the calibration process all over again.

In recent years, Geographic Information Systems (GIS) and geodatabases have been successfully integrated into computer model development. Use of a GIS platform has demonstrated that its spatial analysis capabilities hold the key to improved modeling techniques. For example, the analytical muscle of GIS combined with readily available digital elevation data, can be used to automate the modeling process and provide a visual representation of the watershed's response to flooding conditions under current or proposed improvement scenarios.



The GIS-based computer modeling process begins with a digital representation of the ground surface topography or digital elevation model (DEM). Using GIS to analyze DEMs, the engineer can produce a draft watershed delineation and drainage patterns with limited manipulation. Within a relatively short period of time, the engineer is able to have a draft of the modeling framework along with a fairly detailed knowledge of the drainage patterns and a watershed delineation. Today, DEMs are often associated with high-resolution aerial photography and are increasingly available to both public and private organizations. The USGS, for instance, has gathered elevation points for five-foot elevation contours around the U.S. The USGS makes DEM data available at the http://edc.usgs.gov/geodata/ website. Other agencies around the country are building similar digital databases. For instance, the Southwest Florida Water Management District has acquired Laser Imaging Detection and Ranging (LiDAR) data over much of the District's area and has made that information available to those in the computer modeling business. The LiDAR process generates data points spaced as close together as three feet.

We recognize that computer modeling work is not just a desk exercise. It is invaluable to have the engineer in the field infusing reality and context into the process of evaluating and calibrating watershed basin models. The GIS tools first allow a detailed desktop evaluation of the watershed before technical staff even hits the ground for field verification, and later they provide opportunities to maximize the field data collection efforts. For example, rather than sending a survey crew out into the field, the engineer, equipped with GPS and a laser level, can perform field investigations and ground verify



any assumptions made in the desktop evaluation. Then, the same engineer is able to collect model-specific data such as culvert inverts, sizes, and material along with cross-sectional data. Often, the LiDAR data points may be used as benchmarks for field reconnaissance. It should be noted that the GIS derived elevations are generally of sufficient accuracy for computer modeling purposes, but they may not be suitable for design plan development.

Another advantage afforded by the GIS is project visualization. Powerful GIS visualization capabilities are key to improved communication. For example, traditionally a one-dimensional (1D) hydraulic profile was used to present the results of computer models. Using GIS, the 1D hydraulic profile can be easily converted into a two-dimensional (2D) view using automated post processing routines. The 2D view of the system is able to show the paths by which water spreads out beyond the banks of the main channel and into affected areas. In this manner, the 2D approach is capable of more effectively illustrate flooding extents for existing conditions as well as for alternative flood reduction solutions. Using the flood extent plan view as a tool, the benefits of system improvement alternatives can be better presented to decision makers and the public.

In summary, the power and potential of automated GIS techniques is reshaping the way engineers analyze watersheds and develop computer models for assessing expected flood risks. The accessibility and flexibility of the GIS-based computer modeling solutions are key to maintaining the critical balance between water resource needs of current and future users, and protecting the public in times of extreme events. No longer seen as a back office support tool, GIS has moved onto the desktops and laptops of water resources engineers. In effect, the technology has created the opportunity to engineer projects, make better decisions, and share information in a clear, concise format to a broad community of interested, technical and non-technical parties.

References

Association of State Floodplain Managers (ASFPM) (2007). National Flood Policy Challenges. Levees: The Double-edged Sword, http://www.floods.org/PDF/ASFPM_Levee_Policy_Challenges_White_Paper.pdf