GIS Data Sharing and Flood Hazards in Wisconsin

A Wisconsin Land Information Association Emergency Management Task Force White Paper

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Floods are a significant threat to life and property in Wisconsin. In fact, Wisconsin ranked tenth in the nation in 2003, before the spat of recent hurricanes in the Gulf Coast, with over "$1.5 billion in documented flood damages" over the last two decades. Furthermore, flooding has been the principle cause for over half of the Presidential Disaster Declarations in Wisconsin.[1] As with other types of disasters, GIS can serve as a powerful tool for the collection, management and analysis of flood-related spatial information; as a recent WEM GIS Needs Assessment (2005) points out, GIS "can be leveraged for locating critical and vulnerable assets, planning, mitigation activities, assisting in response, and aiding in recovery management."[2] For example:

- GIS can facilitate the identification of flood prone areas within local communities and enable a more effective response to flooding events.
- GIS can be used to map properties that have been flooded repeatedly[3]. For repeatedly damaged properties outside the floodplain boundaries, it can help identify areas that should be mapped as floodplain. For repeatedly damaged properties inside the floodplain, it can help identify areas where mitigation (e.g. buying out or elevating properties) should be pursued as funding becomes available. Information incorporated into GIS includes coordinates, first-floor elevations and lowest adjacent grades, along with structural information and digital photographs. Using handheld mobile GIS devices, which allow for the integration of data from GPS and laser rangefinders (horizontal coordinates and vertical elevations) and from digital cameras, field-based personnel can survey the extent of flooding in real-time.
- With GIS, the user can present flood-related information visually in 2-D or 3-D such that it might be more intuitively understood, particularly by a lay audience. GIS-generated maps, for example, can provide an effective means of informing the public or news media on evacuation routes, on the extent and impact of a flood when it occurs, and on the government's response efforts. [4,5]

Many spatial data sets are needed to address flood planning, response, recovery, and mitigation. The most important of which are the FEMA flood hazard maps, which are required for the Floodplain Zoning, Insurance, Mitigation, and Comprehensive Plans.[6] These maps include:

- **National Flood Insurance Program Maps:** The Federal Emergency Management Agency (FEMA) Flood Insurance Rate maps (FIRM) depict flood risk information and serve as the primary source of for determining the relationship between flood-hazard zones and structures and buildings, streets, jurisdictional boundaries, etc. Their scales range from 1:4,800 to 1:24,000. In the mid nineties, FEMA began digitizing existing FIRMs, which are called Q3s. But, as a federal report concluded, cited by Monmonier (1997, 107), FIRM maps and resulting Q3 data sets

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[1] Lulloff, Alan. 2003. *Flood Map Modernization in Wisconsin*, Wisconsin Department of Natural Resources Floodplain Management Program, published December 17, 2003, accessed January 6, 2006, http://www.dnr.state.wi.us/org/water/wm/dsfm/flood/mapping.htm

[2] GIS Needs Assessment Project Presentation, Wisconsin Emergency Management, published 2005, accessed January 6, 2006, http://emergencymanagement.wi.gov/announcements_detail.asp?annid=18

[3] "A repetitive loss property is a property that has a flood insurance policy with the National Flood Insurance Program (NFIP) and has flooded on two or more occasions within a ten-year period with claims totaling $1000 or more on each loss." "Using GIS for Floodplain Management" , Maryland Dept of Environment, http://www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/floodMgmtGis/index.asp

[4] "City of Hudson, Ohio, Implements Intranet-Based Enterprise GIS", ArcNews Online (ESRI), Fall 2004, http://www.esri.com/news/arcnews/fall04articles/city-of-hudson.html

[5] "Using GIS for Floodplain Management" , Maryland Dept of Environment, http://www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/floodMgmtGis/index.asp

[6] Bellovary, Tony. Bay-Lake Regional Planning Commission, Wisconsin. Private communication, December 14, 2005

frequently are outdated, inaccurate, or difficult to obtain.[7] In Wisconsin, for example, the age of 30% of the effective map panels was 10-15 years old, while 33% was more than 15 years old. Furthermore, these maps do not have an updated road network and in many instances do not include streams that could affect homes during flooding events.[8]

Thus, FEMA initiated a map modernization initiative in 2003 in collaboration with state agencies. As part of this process, the WDNR Floodplain Management Program (http://www.dnr.state.wi.us/org/water/wm/dsfm/flood/title.htm) is generating the updated Digital Flood Insurance Rate Maps (DFIRM) database for every county in Wisconsin. DFIRM are generated from better topographical data, are Quality Assurance/Quality Control tested, and will be available in GIS format. Because of the improved accuracy over the old FIRM and Q3, DFIRM can be used for planning, permitting, and regulatory purposes. To this end, the WDNR is collecting planimetric data, such as roads, hydrography, structures, bench marks, and elevations, etc. and topographic data directly from the counties and communities. This information will be viewable within the WDNR Web Viewer, which is discussed below. The WDNR also is collecting and creating flood hazard boundaries, cross sections, and hydrologic and hydraulic models, which also will be made available via the web when they are finalized. Through the WDNR Web Viewer, all of this data will be viewable and some will be downloadable. In addition, the data will be maintained and be made available via CD, DVDs or external hard drives. [9] This entire process may take up to five years to complete.

Currently, the WDNR Floodplain Management Program enables public access to scanned existing FEMA paper maps that have been geo-registered through their interactive web mapping site (http://www.dnr.state.wi.us/org/water/wm/dsfm/section/mapindex.htm), although these maps are not official and therefore cannot be used for zoning purposes. These maps can be viewed in combination with USGS topographic maps, air photos, and historic flood photos and recorded flood elevations where available. Users also can access the Wisconsin Floodplain Analysis database as well as the Floodplain Insurance Studies and Engineering Input Models, but these would require an engineer or consultant to evaluate properly.[10]

Flood Insurance Claims: The National Flood Insurance Program (NFIP) compiles a database of flood insurance claims (which includes repetitive loss properties), with the property address, the name and address of the property owner, the amount and date of the loss due to flooding, as well as other relevant information; for example, it could include "a summary table of flood-related

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[7] Monmonier, Mark. 1997. Cartographies of Danger: Mapping Hazards in America (Chicago: University of Chicago Press), p. 107; Interagency Floodplain Management Review Committee, *Sharing the Challenge: Floodplain Management into the 21st Century* (Washington, D.C., 1994), 100.

[8] Lulloff, Alan. 2003. *Flood Map Modernization in Wisconsin*, Wisconsin Department of Natural Resources Floodplain Management Program, published December 17, 2003, accessed January 6, 2006, http://www.dnr.state.wi.us/org/water/wm/dsfm/flood/mapping.htm

[9] Schwoegler-Boos, P Amanda L. Map Modernization Project Manager, Floodplain Management Program, Bureau of Watershed Management, WDNR. Private communication, December 21, 2005.

[10] In addition, the Mapping Information Platform (MIP), which is part of FEMA's Federal Insurance and Mitigation Administration's Multihazard Mapping Initiative, supplies multihazard maps over the Internet (http://www.hazards.fema.gov; https://hazards.fema.gov/femaportal/wps/portal). This website is designed to "facilitate the assembly of maps on demand from a variety of online data sources" and to provide a "Data Exchange in which map data can be uploaded or downloaded to foster the exchange and collection of geospatial hazards information." In particular, the FEMA National Flood Map Web Service provides public access to FEMA DFIRM data layers as they become available, and to Q3 Flood Maps nationwide, albeit for a fee. While fees for individual layers are relatively modest at under $50, the total cost and administrative overhead can be significant for groups that need access to data for large geographic areas.

information, a digital photograph, a GIS map showing the location of the structure in relation to the 100-year (or 1% chance) floodplain, and recommendations for mitigation."[11] Due to proprietary and privacy concerns however, access to this database is restricted. This database can be accessed by state agencies, such as Wisconsin Emergency Management (WEM), and by local communities for planning purposes, but other emergency-related organizations such as the Association of State Floodplain Managers, Inc. may have a hard time obtaining access.[12] Needless to say, this information is not available for download over the Internet and would have to be obtained in advance.

- **Flood maps of ongoing events:** These maps could be obtained from aerial or satellite imagery and overlaid with other data sets to determine impacted critical facilities or washed out roads, bridges, and railroads.

Four other priority data layers for flood hazard management include:

- **Digital Elevation Models.** Historically, the USGS has maintained nationwide elevation data sets, but the USGS 30-meter statewide DEM is not sufficient at the county level for the creation the creation of FEMA maps.[13] Rather, topographic data sets adequate for floodplain mapping are being generated by local governments, often in collaboration with the WDNR Floodplain Management Program for the FEMA remapping effort (e.g., high-accuracy LIDAR with bare earth points and surface models, derived contours and break lines).[14] Redistribution agreements with individual counties may limit access to a statewide compilation of these datasets.

- **Road Centerlines and Bridges** are needed to evaluate evacuation routes and carrying capacity and to assess potential for submersion. Local roads data can be obtained through the WDOT Wisconsin Information System for Local Roads (WISLR) (http://www.dot.wisconsin.gov/localgov/wislr/); however, only authorized representatives of local government are eligible to obtain access privileges and access requests may require a few days to process and to confirm registration. Similarly, bridge information can be accessed through a restricted WDOT website. Counties also maintain this information.
- **Critical Facilities**, including locations of fire stations, police stations, hospitals, nursing homes, day care facilities, schools, immediate care clinics, refugee shelters, airports, bus stations, and so forth; and

- **Building footprints**, which are used in combination with the floodplain boundaries to determine the total number of structures and buildings that may be at risk. Critical facilities and building footprints largely come from local GIS offices, and in some instances, from regional planning commissions. In Wisconsin, critical facilities, for example, must be identified for county All Hazards Mitigation Plans.

Additional flood-relevant GIS data layers include:

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[11] *Using GIS for Floodplain Management* , Maryland Dept of Environment, http://www.mde.state.md.us/Programs/WaterPrograms/Flood_Hazard_Mitigation/floodMgmtGis/index.asp

[12] Alan Lulloff, Project Manager, Association of State Floodplain Managers, Inc., personal communication, December 13, 2005.

[13] Bellovary, Tony. Bay-Lake Regional Planning Commission, Wisconsin. Private communication, December 14, 2005.

[14] Schwoegler-Boos, P Amanda L. Map Modernization Project Manager, Floodplain Management Program, Bureau of Watershed Management, WDNR. Private communication, December 21, 2005.

- **Railroad centerlines** (WDOT)

- **Stream centerlines** (Local government; WDNR Flood Management Program; WDOT, USGS[15]). The WDNR is mapping the sinuosity of stream channels at scales of 1:1000 and 1:6000 as part of the modernization effort.

- **Utility lines** (Private companies)

- **Pipelines** (Wisconsin Public Service Commission, Pipeline Safety Program; and, U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety (OPS), http://www.npms.phmsa.dot.gov/). There are roughly 68,631 miles of hazardous liquid and natural gas pipelines in Wisconsin, according to OPS' website. "Prior to 9/11, OPS made pipeline maps universally accessible through an online mapping application. At this time [however], OPS is providing detailed pipeline data [including GIS data] to pipeline operators, and local, state, and federal government officials only [including emergency responders]."[16] All applicants are screened in advance and so access may take time. Data is proprietary.

- **Culverts and smaller structures** (WDNR Flood Management Program)

- **Dam inventory and failure inundation zones** (WDNR Dam Safety Program, http://www.dnr.state.wi.us/org/water/wm/dsfm/dams/datacentral.html; also Public Safety Commission). A statewide dam GIS dataset is available for download over the Internet but is nearly two years out of date; on the other hand, requests for current data sets may be made, but may take time to process and a fee may be assessed.

- **Levies** (Local government; WDNR Flood Management Program). With few exceptions, levies are monitored by local communities without state oversight. Thus, a statewide levies inventory does not exist; information regarding levies is largely in hardcopy format and maintained by the local communities. Ideally, a statewide or nationwide inventory of levies should be compiled, including maps depicting "residual risk" for adjacent areas that may be affected by levy failure. Homeowners may not have insurance as they are not in the official floodplain, but if their community is participating in the FEMA Flood Program, they can purchase flood insurance. Furthermore, residual risk and inundation maps could be used to target residents for educational programs.

- **Property parcel points or parcel boundaries, building footprints and lowest adjacent grades/elevations above water** (County LIO or Emergency Management). This data may not exist or may not be complete for all counties.

- **Locations of hazardous materials and bulk storage facilities** (County LIO or Emergency Management). This includes location address, location within building, and owner address. In most communities, these locations exist only in hardcopy tabular format.

- **Coastal erosion susceptibility** (UW SeaGrant, WDNR, RPCs).

[15] Walker, J.F. and W.R. King. 2005. *Water-Resources Investigations Report 03–4250: Flood-Frequency Characteristics of Wisconsin Streams*. USGS and WDOT. Published September 1, 2005, accessed January 6, 2006, http://pubs.usgs.gov/wri/wri034250/

[16] Office of Pipeline Safety, accessed January 6, 2006, http://primis.phmsa.dot.gov/comm/Security.htm

- **Aerial imagery, digital orthophotography, satellite imagery, or LIDAR** (e.g., WDNR; USACE).

- **Driveways or access points for E-911** (County LIO or Emergency Management). This data may not exist or be complete for all counties.

While the above data sets may be available upon request in local communities, frequently they have not been used spatially to identify hazardous conditions or floodplain evacuation routes. Rather, communities often depend on in-depth local knowledge; but, if that person is not available during a crisis or if that person leaves his position, the information cannot be utilized to protect lives and property.

Moreover, data access and sharing between departments or jurisdictions (via email, phone, CD, etc.) is often dependent upon partnerships developed over time based on trust, common goals, and in some instances negotiated license agreements. Again, if a key data expert is unavailable due to unforeseen circumstances during an emergency or due to staff turnover, that institutional knowledge and partnership may be lost. This highlights the need for metadata, for a "who to call" guidebook, and potentially for statewide standards and systematic processes.

Under some circumstances, staff may be reluctant to share their GIS data for a variety of reasons (e.g., proprietary, cost recovery, privacy, security and sensitivity). This often depends on staff preferences and on individual county policies, which are often informal, as there is no consistent statewide policy that addresses what data sets should be made accessible and what should be restricted. Some government agencies regularly charge for copies of their digital orthophotos, DEMs, and parcel maps, which can be burdensome to some emergency-related organizations, both monetarily and administratively. But, at the same time, communities may be willing to share this information for emergency purposes free of charge, albeit with restrictions on redistribution, especially if they will benefit in return (e.g., more accurate floodplain layers).[17]

The provision of Internet access to these data sets depends on local capacity and policies, although the number of local government interactive mapping websites in Wisconsin is growing steadily.[18] For instance, Bay-Lake Regional Planning Commission works with eight different counties and with municipalities to deliver GIS data such as land use, zoning information, and future development over the Internet via ArcIMS; according to Tony Bellovary (Bay-Lake Regional Planning Commission), web access to spatial data sets significantly reduces the amount of time he would have to spend on the phone. Furthermore, if he had to make a data request by phone, the wait times can take 2-3 days or longer, which is not fast enough during an emergency.

However, even if data is available via a website, it may be out of date. Yearly updates are not sufficient to be useful during emergencies; rather, quarterly updates are needed. Furthermore, web mapping sites do not always provide the needed functionality or allow the user to combine local data sets with information from other sources. The data may be viewable via the website, but for proprietary reasons is not downloadable. Or, because of security restrictions, access to the data may be limited to certain organizations, through a pre-approval process, and may not be available to all who need the data. In addition, the local department or federal agency responsible may not offer any metadata or technical support with regards to appropriate use of the data. Finally, technical specifications also may affect how

[17] Bellovary, Tony. Bay-Lake Regional Planning Commission. Private communication, December 14, 2005
[18] *Internet Map Servers in Wisconsin,* WI Department of Administration, accessed January 9, 2006, http://www.doa.state.wi.us/pagesubtext_detail.asp?linksubcatid=392

well data can be accessed via Internet mapping sites, including download speeds, browser version, power supply, etc.

Ultimately, if these flood management systems are operated in isolation, their full benefit might not be realized. For example, if a disaster occurred that involved multiple jurisdictions, data acquisition and integration would not be easy or quick. Parcel data, for example, may not match at the boundaries; some counties use COGO and others do not; associated coordinate systems may differ or be nonexistent; attributes for the same objects may be coded differently; assessors data may be joined in some instances and not others; not all communities will have complete data sets. On the other hand, a Department of Justice data set may have statewide coverage, but it may not integrate easily with local data, again due to differing data models. Ideally, given the time-sensitivity, regional nature, and life-threatening potential of floods, flood-related geographic information and spatial analysis tools should be made accessible to a large number of users for emergency management through a standardized and centralized system. A statewide parcel map, critical facilities map, and levee inventory are especially needed.