REVISION TECHNIQUES INCORPORATED IN THE GEORGIA MAP MODERNIZATION PROGRAM

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Abstract. The Georgia Map Modernization program employs several techniques to depict updated analysis of Special Flood Hazard Areas (SFHAs) in a revised Flood Insurance Study (FIS) and Digital Flood Insurance Rate Map (DFIRM). The three principal techniques are the limited detail analysis of unstudied streams, redelineation of detailed flooding sources, and the incorporation of studies completed by others.

Limited detail analysis is performed for flooding sources which are known to have substantial flooding impacts but are either not currently shown on the effective Flood Insurance Rate Map (FIRM), or for which the flooding effects are inadequately depicted. Redelineation revises the currently effective SFHAs based on updated topographic data. Floodplain mapping data made available by others including special flood hazard studies and Federal Emergency Management Agency Letters of Map Change are identified and, upon review and verification, incorporated into the updated FIS and DFIRM.

The paper will discuss the procedures used to incorporate limited detail analyses, redelineated SFHAs, and data submitted by others in the revised FIS and DFIRM. The applications of a GIS environment and the sustainability of the revised information in an adaptable format will be emphasized. The limitations and technical requirements of each approach will be discussed as well.

INTRODUCTION

The Georgia Map Modernization Program is an ongoing effort to revise and update the existing Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies (FISs) used in support of the National Flood Insurance Program (NFIP). These maps and analyses are ultimately used to determine whether or not a homeowner is at risk and required to obtain flooding insurance. Clearly, it is in the best interest of all parties (private citizens, local communities, and state and federal governments) to ensure that the most current and accurate flooding is depicted on the maps and in the supporting studies.

With the ever-increasing prevalence of GIS-based data and applications, it is becoming simpler to perform geographical analyses of varying scope. Specifically, with the availability of up-to-date topographic information and automated hydrologic and hydraulic (H&H) tools, complete watershed and floodplain analyses can be performed in far less time than was previously possible.

In situations where a traditional, in-depth hydrologic and hydraulic study is not feasible, these automated methods are ideal for providing increased detail while minimizing expense and effort. Limited detail analysis and the redelineation of known water surface elevations (WSELs) are two such methods. The incorporation of existing hydrologic and hydraulic studies conducted by others can also greatly increase the detail and accuracy of the modernized FIRMs and FISs.

LIMITED DETAIL ANALYSIS

Quite often, the effective mapping does not capture smaller flooding sources or areas of potential flooding. The mapping may include a depiction of the approximate flooding effects, but observations or anecdotal evidence may show the delineation to be inadequate or outdated. Due to watershed development, natural changes, or projected development, these smaller flooding sources can become increasingly relevant. When a full-scale study is not practical but an increased level of accuracy is required, limited detail analysis can provide that accuracy with a minimum of input.

A limited detail study, like the traditional approximate study, produces a 1% annual chance (100-year) floodplain delineation, but also produces an estimated 1% annual chance flood elevation or Base Flood Elevation (BFE) for use by the community. In a GIS environment, the best available digital topographic data for the subject area is used in conjunction with an automated hydrologic and hydraulic tool to extract the watershed geometry characteristics into a conventional hydraulic modeling platform. For the purposes of this paper, the automated method is assumed to be GeoRAS exporting to/from a current version of HEC-RAS (i.e. version 3.1.3). Using the GeoRAS tool, layers representing the spatial alignment of the stream centerline, bank station locations, flowpaths (for determining the left overbank, right overbank, and channel distances), and cross sections are created. The geometry and spatial attributes are extracted and exported to HEC-RAS.

At this point, the user has a “skeleton” HEC-RAS model which, at a minimum, requires only the entry of Manning’s “n” values and flow data. Discharges can be determined by any of the various FEMA-accepted methods. For instance, for analysis of smaller watersheds, the sub-basins may be manually delineated and the calculated areas can be applied to the appropriate regional regression equation. More sophisticated hydrologic methods can be incorporated as well. Once the flows are calculated, they are then entered at their corresponding flow-change locations in the HEC-RAS model. For the Manning’s “n” values, if aerial photography is available, the roughness coefficients can be inferred from the apparent watershed conditions in the photography. Cursory field investigations can provide adequate support for the estimation of the roughness coefficients as well. Any available structure data should be added to the model geometry as well.

If the general structure dimensions (height from channel invert, width of opening, opening type, etc.) are known, the structure can be added to the model geometry. While not required, the inclusion of even the most basic structure geometry helps ensure that its hydraulics effects are factored into the calculated floodplain and WSELs. This minimal amount of additional input helps provide a much more accurate calculation of the floodplain for the amount of extra effort required. It is important to note that if structure data is to be incorporated, the location of all applicable structures should be identified at the initial stages of the GeoRAS layer creation, such that the appropriate bounding cross sections can be placed. This will ensure that the natural channel geometry is reflected in the HEC-RAS model at the locations where structure data is to be entered. If no structure data is available, the road crossing can be modeled as a weir, which typically results in a more conservative floodplain

After completion of the HEC-RAS model, the output is then exported back to a GIS environment, and the calculated WSELs are compared to the topographic data. At each cross section, areas where the calculated WSEL is higher than the ground elevation are determined to be within the floodplain, and a spatially referenced, polygonal shapefile is created representing the floodplain boundaries which can then be utilized for any number of applications and is easily transferable to other digital formats.

While the limited detail analysis method is an excellent alternative to an outdated approximate floodplain, or no floodplain at all, it does have some shortcomings. The convenience of the method stems from the elimination of extensive field surveys for cross sectional geometry, site conditions, and detailed structure surveys. While in-depth field surveys can be time- and cost-intensive, they do provide a level of detail and precision which isn’t typically matched by even the most advanced large scale topographic collections (i.e. LiDAR,etc.). Another boundary of the limited detail analysis method is that although a hydraulic model is generated for community use, no effective BFEs are published on the FIRM. A WSEL profile is generated, but is not published in the revised FIS. Also, it bears repeating that the applicability of a limited detail study is contingent upon the availability of digital topographic data of equal or better quality than that used for the effective study.

REDELINEATION OF FLOODING SOURCES WITH KNOWN WATER SURFACE ELEVATIONS

The limited detail analysis method is applicable for flooding sources with no existing analysis, or an outdated delineation of an approximate floodplain. When a flooding source has already been the subject of a detailed study, and effective WSELs have already been established, the redelineation technique is a simple method for updating the floodplain depiction to reflect more current topographic data.

On a typical FIRM, there are several components which provide a spatial reference for the known WSEL. These are the stream centerline (or profile baseline), the BFE line, and for flooding sources with an effective floodway established, the effective lettered cross section. By using the published stream profile in conjunction with the FIRM, the WSEL at any point along the flooding source can be determined by simply measuring the distance along the stream from any available benchmark (typically the confluence with a parent stream, or a roadway crossing for intermediate reaches). In a relatively simple tracing process, the stream centerline and known WSELs are digitized in a GIS environment and applied to the best available topographic data. The result is a floodplain with the same elevations as the effective study, but with a delineation updated to match the more current topography. It is important to note that any effective FEMA-approved Letters of Map Revision (LOMRs) issued after the publishing date of the effective FIS should be identified and incorporated at this point. Any changes in WSEL resulting from the approved LOMR will supersede those shown in the published FIS.

The first step is to geo-reference digital copies of the effective FIRMs to their appropriate locations. Since natural channels tend to change over time and the locations/alignments of roadways are not variable, the effective mapping should be spatially referenced to the road alignments and not natural stream features (i.e. confluences). This is typically done based on the most current aerial photography or any available GIS-based road data.

Once the FIRM is accurately referenced, the stream line, BFE locations, and effective lettered cross sections (if applicable) are digitized. The BFE lines and lettered cross sections are then attributed with the known WSELs from the effective profile and/or the floodway data table (FDT).

It should be noted that all new FEMA maps are to be referenced to NAVD 88. If the effective map is referenced to NGVD 29 a datum conversion is necessary. The datum conversion should follow the procedures described in the *Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix B Guidance for Conversion to North American Vertical Datum of 1988*.

Once the features and locations of known WSELs are digitized, there a several approaches which can be used to determine the new floodplain. One such method involves the creation of two separate three dimensional (3D) data sets, such as a Triangulated Irregular Network (TIN) or raster, using common GIS tools such as 3D Analyst. One 3D dataset is created based on the attributed WSELs, and one is created based on the topographic coverage of the same area. The 3D dataset based on the topography is then subtracted from the dataset created from the known WSEL. The resulting 3D dataset can then be converted to a shapefile which represents the positive area of difference between the WSELs and the ground (i.e. the floodplain). The end product of this relatively straightforward process is a floodplain defined by the updated topographic data, but based on the same WSELs calculated in the effective study.

As with the limited detail method, the redelineation technique does have certain limitations or shortcomings. Drastic changes in topography (natural or otherwise), specifically in the channel alignment, can cause significant discrepancies in the cumulative channel distances, when compared to the effective profile. This can lead to the application of the incorrect elevations along a stream, with the potential for the discrepancies to compound as the lengths increase. Another limitation of the redelineation technique is that updated models are not produced, and the effects of any errors or inconsistencies in the original study are transferred to the new mapping. Corollary to this is the inability to adjust/update floodways. In order to adjust the width/location of a floodway, changes to the encroachment stations within the effective model would be required. Due to the NFIP regulations governing the revision of effective floodways (i.e. the requirement of a (C)LOMR), adjustments to the floodways are outside of the scope of the redelineation technique.

INCORPORATION OF EXISTING DATA/STUDIES BY OTHERS

Often times a third party will conduct a hydrologic and hydraulic study intended for various applications. While the studies may not have originally been intended for flood insurance purposes they are frequently found to be adequate for inclusion as the best available data, or at least more current data.

When a study is identified, the first step is to review it and establish its level of completeness, as well as to confirm the engineering methodologies incorporated. This involves a full technical review of the hydrologic and hydraulic analysis and floodplain mapping. A thorough technical review is conducted based on the procedures set forth in *Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix C: Guidance for Riverine Flooding Analyses and Mapping – Federal Emergency Management Agency – February 2002.* At a minimum, complete hydrologic calculations, along with supporting documentation and data, and hydraulic modeling in a FEMA approved format are required, as well as the supporting mapping. Depending on the completeness of the study and the engineering methods used, a study can be incorporated as a Zone A approximate delineation, or as a detailed Zone AE area with BFEs established. Certain requirements for inclusion as a Zone AE area include, but are not limited to, certification by a registered professional engineer, adequate tie-ins to the effective WSELs, and general compliance with the engineering standards and methods set forth in *Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix C: Guidance for Riverine Flooding Analyses and Mapping – Federal Emergency Management Agency – February 2002.*

SUMMARY

In support of the Georgia Map Modernization program, several techniques have been incorporated and refined in order to provide increased accuracy. Approximate floodplains can be calculated with much greater accuracy, and existing data can be updated and applied to the best available data with relative ease. The processes for validating and incorporating existing data have been greatly streamlined as well.

While there are certain limitations, the techniques described above have helped ease the transition from FISs for individual communities to the more current countywide FIS and DFIRM format. Furthermore, since the data is published in a digital environment, it can be easily updated to incorporate future watershed development or changes, as the need arises. The end result is a sustainable digital product which is easily adaptable as technologies evolve.

LITERATURE CITED

FEMA Map Modernization Publication, *Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix B: Guidance for Conversion to North American Vertical Datum of 1988. Federal Emergency Management Agency, April 2003*, at http://www.fema.gov/pdf/fhm/frm_gsab.pdf

FEMA Map Modernization Publication, *Guidelines and Specifications for Flood Hazard Mapping Partners – Appendix C: Guidance for Riverine Flooding Analyses and Mapping – Federal Emergency Management Agency – February 2002*, at http://www.fema.gov/pdf/fhm/frm_gsac.pdf

ESRI ArcGIS, ESRI Developer Network, at http://edn.esri.com/

U.S. Army Corps of Engineers, Hydrologic Engineering Center, *HEC-RAS River Analysis System*, Version 3.1.3, Davis, California, April 2004.

U.S. Army Corps of Engineers, Hydrologic Engineering Center, *HEC-GeoRAS*, Version 3.1.1, Davis, California, October 2002.