

A Proposed Intelligent GIS Protocol for the Revisions of Floodplain Maps

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ABSTRACT

The sequential nature of the process used in floodplain map revisions including technical reviews, “regulation specific” reviews and map re-delineations is examined in the light of efficiency and quality control. The current process is in contradiction to long term objectives of map modernization and automation. The paper will identify common and relatable characteristics of the floodplain regulations to modeling data and mapping. These characteristics were then structured to formulate an automated map review protocol in the form of an extendable GIS System that ensures quality and efficiency of map revision.

This is an intelligent, GIS enabled protocol that substantially improves efficiency of processing, improves requester understanding of NFIP process and thereby abridges the progression of revision process from request to approval. The System also eliminates or minimizes erroneous interpretation while maintaining sound engineering judgment through interactive tools that enable the reviewer and requester to directly work out specific revision.

1. Introduction

One of the prime objectives of the National Flood Insurance Program (NFIP) is to provide a vehicle to minimize the risks associated with floods. To this end, the Federal Emergency Management agency has established the Special Flood Hazard Areas (SFHAs). These SFHAs are delineated along flooding sources and are determined using the 1% annual chance flood (sometimes referred to as the 100-year flood). The extent and location of these flood hazard zones will vary over time due to natural and man made changes within the floodplain. Therefore, the dynamic nature of the floodplain may need periodic revisions of the effective (current) floodplain maps.

Federal laws for regulating man-made changes within the floodplain due to land development or road construction, for example, have increased in number over time. The regulations require assessment of the impact of development on the flooding source and the adjacent floodplain, as defined by the SFHA, and in areas upstream and downstream of the project location. Over the history of the NFIP, regulations have been developed to attempt to address all the technical and regulatory issues involved. The regulations continue to evolve as land development expands throughout the country. However, even though the regulations are extensive, they cannot possibly cover all flooding scenarios.

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2. Current Map Review Process

As stated in the regulations, within six (6) months after construction has occurred within the floodplain, the community must submit information in order for effective flood maps to be revised, so that mortgage lenders, insurance adjusters, and others may have the most up-to-date floodplain information available. These proposed changes are provided to FEMA in the form of a request for a Letter of Map Revision (LOMR). As part of the request, revised hydrologic and hydraulic information must be provided to support the re-delineation of the effective SFHAs and floodways. Due to the varied nature of the requests, not all of the NFIP regulations will apply to all of the map revision requests.

Over time, FEMA has developed a process that initially conducts an inventory of all the information provided in support of the revision request to insure that all the information needed to finalize revision requests has been provided. Once a determination has been made that all the data required has been received, the information submitted is reviewed for technical correctness. The final step is to produce the revised map, sometime referred to as "Attachment". The quality of map revisions has systematically improved over time. For this paper, the sequential nature of the process used in floodplain map revisions has been examined. Several points of improvement in the system efficiency are proposed.

3. Proposed Improvement

The process of reviewing a LOMR request can be streamlined to improve the time needed to complete a review. The authors of this paper advocate for further refinement of the process to improve the quality assurance measures in the review process by taking advantage of technological advances and integrating all aspects of the review process. The following sections serve as support for the use of GIS in floodplain map revisions.

Table 1.1 Possible Combination and case types of a Letter of map revision

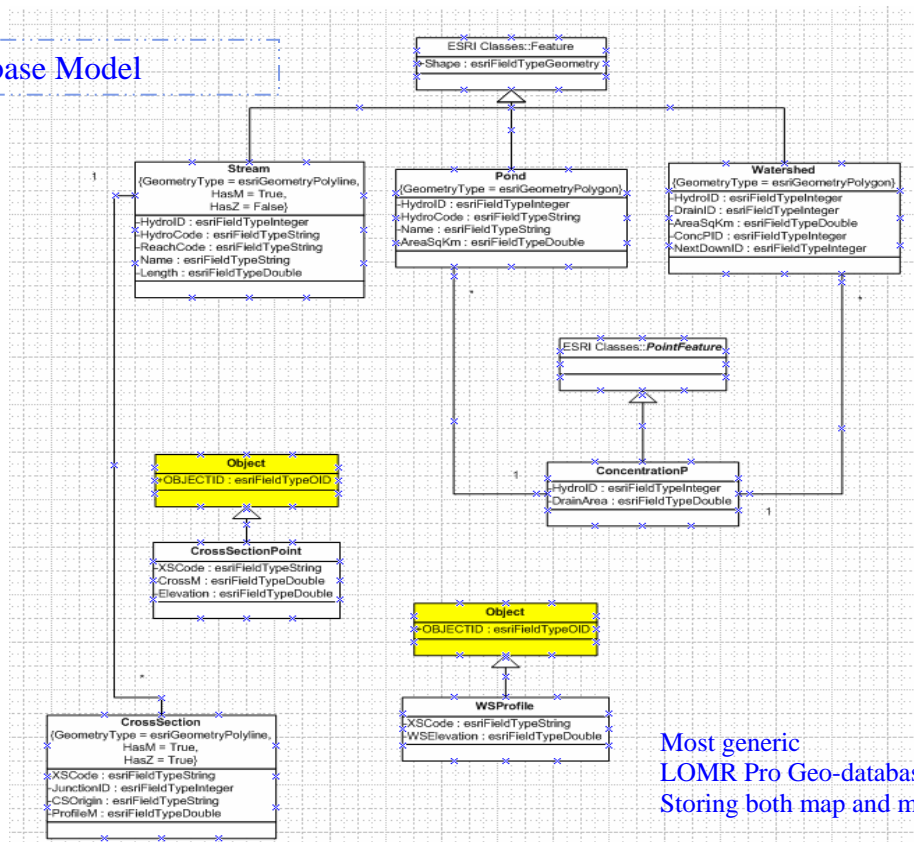
Type of Revision	Special Flood hazard Area / FEMA Zones designations		
	A	AH / AO	AE / (A1A30)
Fill	111	122	133
Cross Drainage	211	222	233
Channelization	311	322	333
Dam	411	422	433
Levee	511	522	533
Scenario of possible LOMR	Fill	Fill	Fill
	Cross Drainage	Cross Drainage	Cross Drainage
	Channelization	Channelization	Channelization
	Dam	Dam	Dam
	Levee	Levee	Levee

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4. Methodology

GIS technology can be used for managing reviews and implementing good quality control and quality assurance practices. The practice implemented would become more operation-centric and less GIS-centric. Although any database could be used, GIS is preferred because floodplain revisions involve mapping. Based on a simplified LOMR Scenario of five possible revision basis in three zone types, we came up with approximately 720 scenarios (the possible case types or scenarios are represented by 3d Array with non fixed index see table 1.1)

Proposed Database Model



Most generic
LOMR Pro Geo-database
Storing both map and model

5. LOMR Processor

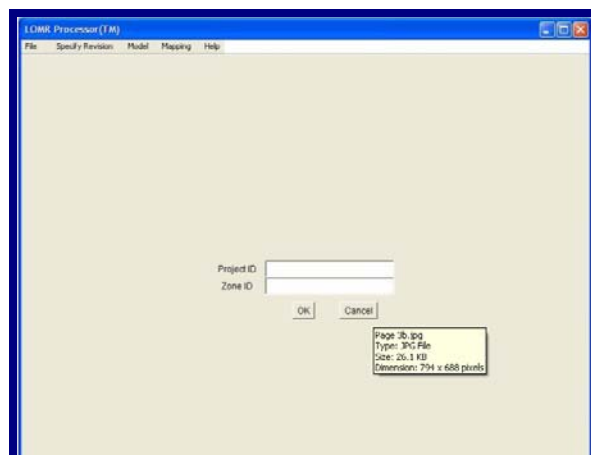
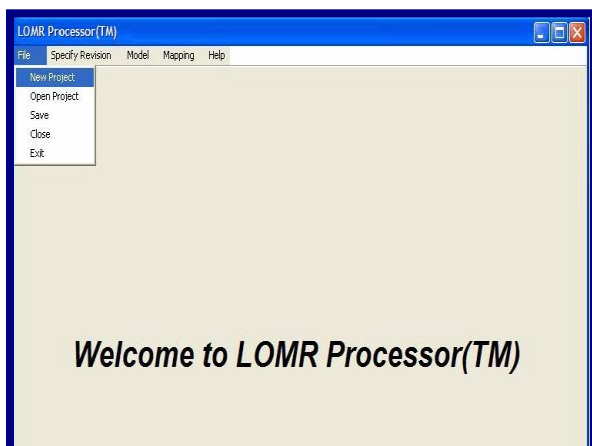
These authors introduce the LOMR Processor for consideration. Because Letter of Map Revisions are case specific, the LOMR Processor is a case-based “decision tree” for every possible case, an intelligent agent with which to streamline the process of map revision. The proposed protocol is based on the concept of case break in object-oriented programming.

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The Beta Version of the LOMR Processor is under tests. Preliminary results are satisfactory, and the processor has, so far, been found to be operationally capable of performing the functions for which it was devised. The LOMR Processor will essentially act as an information management tool, integrating regulations with modeling, and mapping. This system operates under protocols that satisfy FEMA's requirements, while improving the overall quality of the map revisions process. The Beta Version has the following functionalities:

- Map review and detailing
- Data/map query tools
- Data integration tools
- Multi-user environment with user defined security
- On-line/ArcIMS – (under review and evaluation)
- Ability to interface with almost all Hydro GIS tools
- Centralized management and configuration
- Ability to operate /interact with Hydro Models

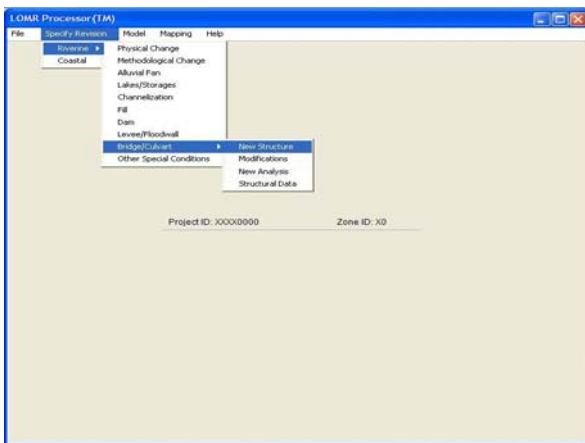
By pointing at a map display, the proposed LOMR processor can retrieve documents and generate a map that provides a spatial context for documents of interest. These documents can be data tables, hydro results, or LOMR letters. The processor can provide new ways of finding documents, by harnessing powerful GIS query functions. Similarly, it enables one to incorporate information stored in the LOMR Processor in their geographic queries. The GIS serves as an index of spatially enabled documents and data allowing users to find the information they need in new, more intuitive ways. GIS system allows for the first time raster in Geo-database. Many existing graphical/raster format maps can be loaded.



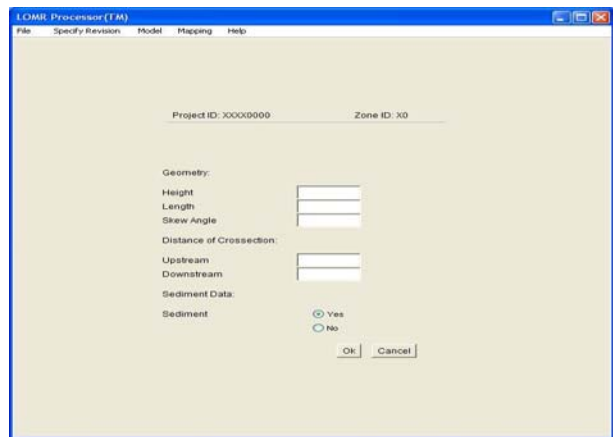
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6. Spatially Enabled Data for Map Revisions

The system would support a flood insurance program more closely aligned with public interest, encourage wise floodplain management, and increase the public's flood hazard awareness. Because the power of visualizing LOMRs and CLOMRs in an area of interest occurs instantly, The LOMR Processor has the potential to become a planning tool, by providing information related to the evolution of floodplain boundaries over the years. As a by product, the LOMR processor and the GIS system would together identify areas for which LOMRs are required. Auxiliary information could be used to streamline, check history of previous reviews for a given flooding source or floodplain subject to land development, which would help improve FEMA's floodplain management program.



LOMR Pro Beta Version allows interfacing with regulations as well as hydraulic and hydrologic data. Within A GIS Environment, it can help plot profile and flood boundaries.



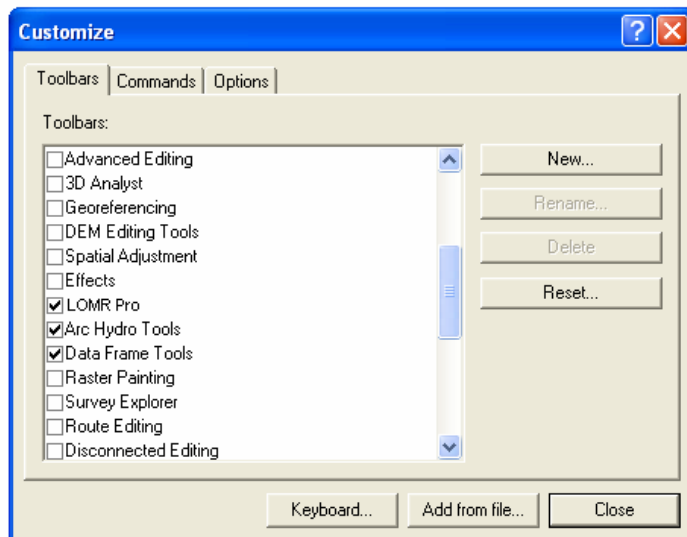
LOMR Pro Beta Version's Bridge Data Coding can be used for modeling or retrieved from the model itself, if required.

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7. LOMR Processor as Arc-GIS Extension:

Recently most water resources GIS interfaces are embedded in Arc-GIS as an extension; There are many extensions that have been popular, these include GeoRAS and Arc-Hydro Tools among others. It would therefore be sensible to design the LOMR Pro as an extension that could interact with existing software/extensions in the industry.

The LOMR Processors engine recognizes the case being reviewed (as data about the case is entered into LOMR Pro). This is achieved by a case based categorizing of any given LOMR case into “a certain case type” among all possible LOMR scenarios or “possible LOMR case types”. Accordingly, the engine selectively populates a corresponding database of model and maps to update effective information.



The LOMR processor relates model, map and regulatory data and stores them in a flexible evolving database. This database is based on possible LOMR model scenarios. Therefore the LOMR processor selectively populates the LOMR database depending on the type of LOMR data it encounters or receives.

Changes due to a new LOMR/CLOMR that affect the effective model and map are processed by and the effective database is retired but not obliterated. This would culminate in huge historical database that could be used to investigate how certain stream or flooding zone evolved over the years.

References:

Maidment, D. R. 2002; Arc-Hydro GIS for Water Resources, ESR Press