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EFFORTS BY THE U.S. ARMY CORPS OF ENGINEERS (USACE) TO CHARACTERIZE NATIONAL FLOOD RISK

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ABSTRACT: The U.S. Army Corps of Engineers (USACE) is investigating ways to characterize the nation's flood risks in order to highlight priority areas nationally and regionally and to identify effective approaches to manage the nation's flood risk, both internally and in partnership with others. Specifically, USACE is developing tools to integrate and display components of flood risk from a variety of sources, identify its contributions to flood risk reduction, frame its projects within a broader and watershed-based context, and identify potential areas of concern in the future.

Flood risk components address the flood hazard (e.g., magnitude and frequency of flooding) and the exposure and vulnerability to that hazard. Typically, the flood hazard includes such things as the extent of flood hazard as shown on digital Flood Insurance Rate Maps, approximate extent of flood hazard for specific probability floods determined via nationwide estimation algorithms, approximate extent of projected future flood hazards for specific probability floods, or the number of historical Federally-declared flood disasters. Exposure and vulnerability to that hazard includes such things as population, number and type of buildings, value of buildings, critical infrastructure, projected population growth, repetitive loss flood insurance claims density, or demographic social vulnerability. Geospatial and assessment tools allow quick visualization of the relative scale of each component or a combination of components, providing a general sense through varying perspectives of national and regional flood risk. They also allow comparisons to national or regional norms, can enable summation of varying exposures for watersheds, political jurisdictions, and the nation, and can highlight potential opportunities for flood risk reduction.

Continued development and coordination is anticipated to refine the approaches and tools and make them and their results more widely available.

Key Words: Flood Management, Flood Risk, Risk Characterization, Risk Classification

1. BACKGROUND

Around the world, significant efforts are underway to better orient flood management to risk-informed approaches that recognize not only the likelihood of the flood hazard, but also the severity of undesirable consequences. In the United States, thinking has moved from a mindset that floods can be controlled to recognition that flood risk management projects cannot completely eliminate all flood risk. The remaining (residual) risk must be appropriately managed. Such flood risk management encompasses measures that address the hazard, such as levees or dams, and emerging approaches such as managing development in floodplains and considering environmental and social functions. Future changes must also be considered, such as driven by changing land use, demographics, and climate change.

Flood risk management in the United States is a shared responsibility. There is no overarching national flood risk management strategy, and key responsibilities are shared among various levels of government (federal, state, local, tribal), non-governmental organizations, and individuals. At least a dozen federal agencies implement programs that help states and communities to reduce flood damages and promote sound flood risk management. The 50 states each maintain and implement their own plans and

programs, including for flood risks. Land use decisions are made primarily by local governments such as through zoning ordinances and adoption of building codes.

The U.S. Army Corps of Engineers is a key player in managing the nation's flood risk. It plans structural and nonstructural projects to manage flood risks, inspects the condition of existing flood risk management infrastructure, provides technical and planning support to states and communities, conducts emergency measures to alleviate flooding consequences, and rehabilitates levees and other flood risk management infrastructure damaged by flooding (USACE, 2012). The Corps of Engineers works with its federal and non-federal partners on collaborative, comprehensive, and sustainable national flood risk management aimed at reducing life-risk to the public and reducing flood damages.

2. EXPLORING A NATIONAL FLOOD RISK CHARACTERIZATION

The Corps of Engineers is investigating development of a nationally-oriented flood risk characterization. National risk characterization can illustrate areas and regions of high risk to inform and prioritize flood risk management investments, identify the potential alignment of those investments with other agencies' and watershed priorities, and support examination of program effectiveness and potential policy implementation. National flood risk characterization can also establish a baseline against which to measure progress (or lack of progress) in reducing flood risk. It can also project future change in flood risk and the impact of factors driving the change, as well as test how policy and program changes might change future flood risk trends.

The Corps of Engineers is considering the characterization of flood risk broadly, encompassing the flood hazard, infrastructure performance where applicable, exposure to the hazard, vulnerability, and consequences. The emphasis is on use at the national and regional levels, as opposed to community and project levels. The approach is to be applicable both where risk is and is not influenced by the presence of a flood management structure. In addition, the approach is to use existing information rather than undertake resource-intensive data collection exercises, albeit with consideration given to ongoing efforts that will generate pertinent additional information in the future (ideally on a national basis).

One desire is to characterize flood risk at a relatively high level in order to provide an indication for federal policy-making on a nationwide basis. This desire is driven by concerns about timeliness of information to support ongoing policy-oriented decisions, which are not always possible to delay, as well as concerns about avoiding detailed data collection and processing which could be difficult to support and maintain. Scale and level of detail are important. An approach is desired that is not overly data-intensive or detail-oriented; the challenge is to provide a suitable approach that, given the site-specific nature of flood risks, meets the need without being inadvertently misleading.

National flood risk characterization will necessarily build on existing progress in characterizing flood risk. Federal progress within and beyond the Corps of Engineers includes the following.

2.1 Dam and Levee Safety Approach

The Corps of Engineers' dam and levee safety programs use a risk-informed approach to manage their portfolio of dams and levees. Consistent risk characterization of this infrastructure has allowed more effective communication and has improved decision-making. This has enabled decisions to be made with consideration to the full portfolio and facilitated the smartest option for reducing project risk cost-effectively (Halpin, 2014). A classification system provides a means of classifying a dam or levee system informed by particular risk characterizations associated with each class (ranging from 1=highest urgency to 5=lowest or normal urgency) and prescribing actions that can be taken in light of risks associated with each class. Infrastructure risks are characterized on a consistent basis across the portfolio, providing a defensible process and results that can be compared across the portfolio and nation. The approach considers incremental risks above the flood risk and non-breach flood risk.

2.2 HAZUS

HAZUS is the Federal Emergency Management Agency's (FEMA's) nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods and hurricanes (FEMA, 2014). It uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. It graphically illustrates the limits of identified high-risk locations, and then users can visualize spatial relationships among populations, assets, and resources for the hazard being modeled. Its Level 1 and 2 analyses can usually be performed by emergency services or planning staff since the data base is national data sets provided with HAZUS. Its Level 3 analysis typically requires technical expertise (Berman, 2014) and additional data development and input to HAZUS. FEMA compiles a National Average Annualized Flood Loss assessment using HAZUS-MH.

2.3 Risk MAP

The Federal Emergency Management Agency implements an ongoing Risk Mapping, Assessment, and Planning (Risk MAP) program to deliver quality data that increases public awareness and leads to action that reduces risk to life and property (FEMA, 2012). Risk MAP focuses on products and services beyond the traditional Flood Insurance Rate Map. Strategies include project prioritization, elevation data acquisition, a watershed study approach, engineering and mapping, risk assessment, mitigation planning support, and risk communication. Risk assessment allows communities to make informed mitigation decisions by providing products and technologies that communicate and visualize risk, including a flood risk report, flood risk map, and flood risk database. The focus is at the community level, and communities can enhance Risk MAP products by including additional information. Flood risk datasets include graphic illustrations of changes since the last Flood Insurance Rate Map comparing current (previous) with proposed (new) flood hazard mapping, flood depth and analysis grids, flood risk assessment data that identifies flood prone areas and communicates relative risk to vulnerable people and property, and areas of mitigation interest that would benefit from raised local awareness. Flood risk products include a flood risk database, a flood risk report with risk awareness and risk reduction information, and a non-regulatory flood risk map focused on specifically-identified risk areas (Read, 2014).

2.4 National Flood Risk Characterization Tool (NFRCT)

The Corps of Engineers is developing the GIS-based NFRCT (Jensen, 2014) to test the feasibility of identifying areas of relatively high flood risk using publicly-available, national-level data sources (such as from HAZUS). The tool will also facilitate comparisons of watersheds using various flood risk-related metrics in support of the Corps of Engineers' flood risk management budgeting decisions. The tool accesses and displays information regarding flood hazards (extent of available 1% and 0.2% mapped floodplains). It includes methodology to calculate estimated flood depths by overlaying mapped floodplains with digital elevation data and presuming zero depth at the floodplain boundary (a national dataset of flood depths does not exist). It also estimates human exposure and asset exposure and damages, vulnerability metrics, and future population projections. Quartile-based displays provide easy visualization and comparisons, while reporting features provide additional detail. The focus is nationwide, with limitations related to unavailable data, infrastructure performance, and extrapolation.

3. INTERAGENCY CONSIDERATIONS

Numerous federal agencies' missions directly affect or are affected by flood risk. For example, agencies work with communities to take flood risks into account through zoning, fund post-disaster recovery, build flood control structures or install "green" infrastructure, and provide a flood insurance program. No one federal agency within the U.S. has authority for all aspects of flood risk management. Recognizing that flood risk characterization can provide a means by which particular agency concerns are integrated into a more broadly-shared whole, and acknowledging that its work will build on national "building blocks" developed by many (as only partly illustrated in the previous section), the Corps conferred with key federal agency partners regarding national flood risk characterization.

A workshop setting offered opportunity for relevant presentations and detailed discussions. Advance material providing common grounding from which to explore various perspectives. The Corps of Engineers hosted the workshop February 25-27, 2014, with approximately 30 participants from a variety of federal agencies, including the Federal Emergency Management Agency, the National Oceanic and Atmospheric Administration (including the National Weather Service), the U.S. Geological Survey, the Environmental Protection Agency, the Department of Housing and Urban Development, the Bureau of Reclamation, and the Natural Resources Conservation Service. Participants assessed the potential benefits and uses of national flood risk characterization approaches. They evaluated existing approaches and noted their supporting tools and datasets for potential in further developing national risk characterization. Participants also explored information-sharing and the potential for collaborative mechanisms to move toward a more consistent national flood risk characterization approach addressing not only Corps of Engineers but also other agency needs. The workshop included numerous agency presentations on various current approaches applicable to national flood risk characterization, ecosystem and socioeconomic considerations, climate change and flood risk, estimating loss of life from flooding, and flood risk classification. Significant opportunity was provided for discussion of existing characterization approaches, agency perspectives, potential new approaches, and observations regarding further development of national risk characterization.

One approach considered was the possibility of extending the Corps of Engineers' classification system used by the dam and levee safety programs to a national risk classification scheme. This approach was explored in advance and described in a white paper prepared for consideration during the workshop (Davis and Munger, 2014). The work invested in developing the levee safety program classification could be built upon to address risk in scenarios in where there is not a levee breach or in which no flood risk management infrastructure is present. The approach would be complementary to the levee safety classification, would address residual risk, and could be applied nationwide (with appropriate data and procedures) in coastal and riverine areas regardless of whether an area is or is not influenced by the presence of a flood management structure.

Participants confirmed that existing tools and data could be leveraged in developing a national flood risk characterization, noting the multiple on-going efforts related to flood hazard and risk. They noted that hazard mapping for sea level rise in particular is well advanced, although some question remains as to whether that mapping is sufficient for risk characterization. They acknowledged a more limited understanding of climate change impacts on riverine hydrology (and therefore floods).

Participants agreed that further development of national flood risk characterization would be valuable to them, and could serve as one input to decision-making by agencies beyond the Corps of Engineers. Participants were generally supportive of the Corps of Engineers' continued development of national flood risk characterization. They recognized that the Corps of Engineers could use such characterization to provide a rational basis for allocating its resources and justifying its actions, measure progress and improvement, and better understand and communicate risk. They urged that methodology and concepts be applicable to both coastal areas and watersheds for any nationwide approach. Given that available data is not uniformly robust, participants noted that it may be possible to identify "discriminators" such as for cultural and other social impacts, other ecosystem impacts, climate change, or economic context. These "discriminators" could serve to further distinguish appropriate risk characterizations when data is insufficient for use as primary risk characterization input. They might be considered separately from the underlying risk assessment but could provide additional context, trends, or procedural means of addressing uncertainty or potential impacts.

Workshop information, including all read-ahead material and presentations, is available online at <http://www.iwr.usace.army.mil/Missions/FloodRiskManagement/FloodRiskManagementProgram/NewsandEvents/FloodRiskCharacterizationWorkshop.aspx> .

4. FURTHER DEVELOPMENT

Informed by the results of the workshop and encouraged by general interagency support, the Corps of Engineers continues to pursue national flood risk characterization. It is convening a small group of

experts to apply characterization approaches for specific sample areas as a means of both further developing the approach and testing it in specific areas. Initial development is expected to focus on flood risk management budget decisions (for example, how best to allocate limited resources by watershed or coastal region to best slow the national rate of rise of flood risk). Development will occur keeping in mind the advantages of having an approach complementary with approaches used in dam and levee safety classification, being applicable to riverine and coastal areas, relying on existing data and information, and incorporating advances such as life loss risk and ecosystem risk once additional data becomes available. Additional consideration is being given to pursuing a parallel developmental approach for policy-oriented questions that would explore a separate but complementary use of national flood risk characterization. This parallel effort would allow the effects of potential national flood risk management policy changes to be explored in advance. This would inform the development of sound national policy, ideally by identifying potential unintended consequences as well as policy tools with the most potential to effectively reduce flood risk.

5. REFERENCES

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