Improving Amite River Basin Flood Forecasting and Hazard Analysis

A Workshop Co-Hosted By:

The Amite River Basin Drainage & Water Conservation District and the LSU Center for River Studies

October 5, 2016 8:30 – 4:00

Louisiana Transportation Research Center

4101 Gourrier Ave, Baton Rouge, LA

AGENDA

Welcome 8:30 – 8:45 *Bob Jacobsen PE (Consulting Hydrologist to the ARBC), Moderator*

Colonel Ben Babin, Retired, President of the Amite River Basin Commission
Dietmar Rietschier, Executive Director of the ARBD&WCD
Clint Willson, PhD PE, Director of the LSU Center for River Studies

Session I 8:45 - 10:15 Review of ARB Rainfall/Flood Forecasts and August 2016 Flood Observations—
Highlights on Scope, Methodologies, Preliminary and Finalized Results, Issues, and Data Availability

1. National Weather Service (20 minutes)
   Rainfall Forecast and Post-Event Estimates, and 2016 Flood Rainfall Estimates
   River Forecast Operations/Methods and 2016 ARB River Forecast Recap
2. Louisiana State Climatologist (20 minutes)
   Additional rainfall information
   Rainfall Return Frequency Estimates for 2016 Flood and Uncertainties (e.g., *van der Wiel et. al.*)
3. US Geological Survey (20 minutes)
   River gauge operations and 2016 Flood data
   2016 Flood FEMA/USGS High Water Mark Survey
   Pending 2016 Flood River Discharge Return Frequency Analysis
4. Additional HWM Surveys and Delineation of the Extent of Inundation (20 minutes)
   US Army Corps of Engineers, ARBC, LSU AgCenter, Communities
5. Other 2016 Flood Data (10 minutes)

Break 10:15 – 10:30

Session 2 10:30 – 12:00 Review of ARB Flood Hazard and Flood Mitigation Analyses—
Highlights on Scope, Methodologies/Models, Findings, Uncertainties, and Issues with Past/Recent Analyses and Current Agency Plans/Goals (Near- and Long-Term) for Improving Analyses

1. FEMA (30 minutes)
   Prior ARB NFIP/Flood Insurance Studies
   Pending Amite River "Base Engineering Analysis" and other future studies
2. USACE (30 minutes)
   Past/Recent/Planned Comite River Diversion Canal Studies
   West Shore Surge Protection, and Other ARB project studies
3. DOTD (30 minutes)
   Post 1983 Flood Studies
   NFIP Continuing Technical Partner (CTP) Studies

Lunch12:00 – 12:30 Box Lunches Provided

<u>Session 3 12:30 – 1:15</u>: Update from NOAA Office of Water Prediction, National Water Center on the National Water Model and Plans for Further Improvements Relevant to ARB Flood Forecasting

<u>Session 4 1:30 – 3:00</u>: Continue Review of ARB Flood Hazard and Flood Mitigation Analyses— Highlights on Scope, Methodologies/Models, Findings, Uncertainties, and Issues with Past/Recent Analyses and Current Agency Plans/Goals (Near- and Long-Term) for Improving Analyses

1. ARBD&WCD (30 minutes)
   Comite River Diversion Canal
   Amite River Diversion Canal Weir Rehabilitation
2. Pontchartrain Levee District (30 minutes)
   Bayou Manchac Flood Control
   Amite River Ecosystem Study
   Other ARB Flood Mitigation Projects
3. Other Relevant Regional Studies(30 minutes)
   CPRA
   LSU Center for Coastal Resiliency
   The Water Institute of the Gulf
   The Nature Conservancy
   Ascension Parish
   East Baton Rouge Parish

<u>Break 3:00 – 3:15</u>

<u>Session 5 3:15 – 3:45</u>: Panel/Open Discussion, Next Steps to Improving Regional Flood Forecasting and Hazard Analysis

Establishment of a *Technical Work Group* to coordinate on improving ARB Flood Forecasting and Hazard Analysis.

Preparation of Near-Term "White Paper:" How to construct a basin-wide hydrologic/hydraulic model with current practice methods, capable of:

1. Simulating the August 2016 Flood.
2. Re-evaluating critical Stage-Discharge Relationships.
3. Supporting those evaluations needed within 12 – 18 months.
4. Depicting many more gradations of flood hazards.
5. Rigorous assessment of local uncertainties.

Preparation of Longer-Term "White Paper:" How to achieve a "2020 State-of-the-Art" High Resolution/HPC model capable of:

1. More physically detailed 2D runoff and floodplain inundation analysis.
2. Supporting detailed inundation forecasts and publishing as with "http://cera.cct.lsu.edu/" .
3. Further modernizing the evaluation of hazards, risks, projects, and scenarios.

Other White Papers

See *Background on Forming Technical Work Group and White Papers* (attached), including the List of White Paper Topics.

1. When do we need?
2. Who should lead/participate/do what?
3. How can we fund?

<u>Final Wrap –Up</u>

What is the purpose of this Workshop?

This Workshop is intended to set a path forward for developing appropriate flood forecasting and hazard analysis *TOOLS to:*

- Facilitate coordinated, sound, and TIMELY decisions—based on facts and science and not sound bites—which
  1. Incorporate the most advanced PRACTICAL technical approaches available.
  2. Are fully transparent with regard to technical issues.
  3. Assess and communicate relevant uncertainties.
  4. Allow for a clear assessment of ALL flood risk consequences and comprehensive benefits/costs.
- Support Federal, State, and Local Agency decisions—the Corps, FEMA, NWS, DOTD, CPRA, GOHSEP, ARBD&WCD, PLD, and the Parishes and Cities
- Enable the public to make informed decisions about their property, with a better appreciation for gradations of flood risk and uncertainty.
- Assist in *Near-Term* decisions in the coming months—enhancing the current practices, typically sub-basin scale, one-dimensional, limited scenarios, desktop computing.
- Assist in *Longer-Term* decisions in the coming years—incorporating the state of the art—i.e., "supercomputing" technology and related resources.

*The focus of this Workshop is on how to improve ARB flood forecasting and hazard analysis **tools** for ALL types of regional floodplain management decisions, and ALL decision-makers.*

The AMRD&WCD strongly supports holding other workshops and forming additional work groups—in conjunction with federal, state, and local government partners and other entities—to address:

- Program-level issues with the FEMA/DOTD/Community implementation of the NFIP in the ARB (program design, NFIP FIRMs, FIRM changes initiated by local communities, Community Rating System, community floodplain development planning and regulation, programs to ensure "No Adverse Impact," regulation of rebuilding structures damaged in the August 2016 Flood, etc.).
- Program-level issues with other Federal (USACE, NWS, USGS, etc.), State (DOTD, GOHSEP, CPRA), and local agency (ARBD&WCD, PLD, EBR/Ascension/Livingston Parishes, cities, etc.) flood-related efforts—jurisdiction, authorizations, funding, management, and execution—past, present, future.
- Issues with specific projects and their potential impact on ARB flooding—and past, present, future decisions related to those projects.
- Issues with the regulation/management of sedimentation and other ARB environmental issues.

About the Hosts

The Amite River Basin Drainage and Water Conservation District (ARBD&WCD) is the state agency designated to oversee Amite River Basin basin-scale floodplain management and has been actively promoting the advancement of basin-scale cooperation, coordinated decision-making, and advanced decision tools since its inception in 1981. (The ARBD&WCD is one of many sister regional agencies with similar missions, such as the Pontchartrain Levee District and the Southeast Louisiana Flood Protection Authorities—East and West.) Please see the attached excerpt from the ARBD&WCD's recent update to their basin Floodplain Management Plan, first drafted in 2002.

The LSU Center for River Studies, which is located on the Water Campus, was recently constituted to lead multi-disciplinary research on key processes in the floodplain of the lower Mississippi River and other major rivers of the Louisiana delta, and to support technical outreach and education for stakeholders and the public on critical riverine topics.

Background on Forming Technical Work Group and White Papers

The August 2016 flood has been recognized as potentially one of the most damaging in our nation's history. Clearly, just as after Katrina for coastal surge flooding (see below), there needs to be a concerted effort to develop state-of-the-art basin-scale, decision-making tools for riverine floodplain management. Today, as we approach the year 2020, the use of *High Performance Computing* (HPC, aka "Supercomputers") to analyze coastal flooding at extremely *High Resolution* is a standard practice, not just for academic researchers, but in the consulting engineering and within government agencies themselves. However, many key riverine floodplain management decisions are using models that are still rooted in 1990s-era approaches, including coarse-watershed scale hydrology, 1D flow routing, and limited inundation analysis within the capabilities of desktop computing.

This Workshop is intended to be a catalyst for forming a Technical Work Group and developing appropriate White Papers for advancing ARB flood forecasting and hazard analysis.

*See the **List of White Paper Topics for Improving ARB Flood Forecasting and Hazard Analysis**.*

Post-Katrina Technical Work Group and White Paper

In the Fall of 2005 a similar workshop/brainstorming session was coordinated by Don Resio (USACE) in Vicksburg on the topic of surge modeling and hazard analysis. The USACE, FEMA, NOAA, and others recognized the need to ensure that post-Katrina surge management decisions would have state of the art tools.

The most significant advance in surge modeling and hazard analysis was not in understanding concepts for surge physics and hazard statistics, but in the ability to use HPC to analyze the surge physics and hazards in High Resolution and provide greater spatial accuracy, precision, and *confidence* for decision-making. A state of the art High Resolution/HPC tool was recognized as essential for many post-Katrina purposes: revised NFIP FIRMs, an IPET study of New Orleans risk reduction, the new HSDRRS design, regional surge mitigation study for extreme surges (The La CPR Study), and more studies in the future.

The 2005 workshop led to the formation of a Technical Work Group to produce "White Papers" on how to advance the High Resolution/HPC surge modeling and statistical tools to fit the decision making requirements. (see Figure 1 for a list of some of the participants; note that participants represented a wide range of backgrounds—Corps, FEMA, NOAA, State, Academia, as well as Private Practice!)

The Surge Technical Work Group efforts led to improvements in

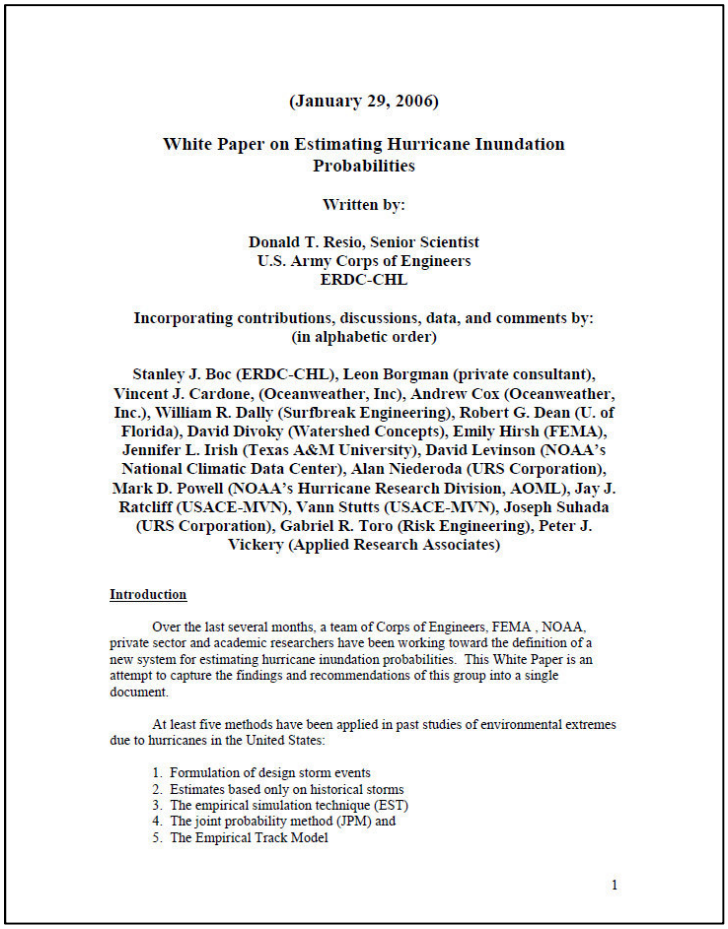
- High Resolution/HPC version of the ADCIRC 2D code—which prior to Katrina was primarily a research tool—to make it a "Prime-Time Production" tool; including: issues of numeric stability, better wetting and drying, spatial varying Manning's n, boundary inflows (e.g., rivers) etc.
- ***Crucial model coupling requirements:*** ADCIRC with wave models (SWAN and STWAVE), hurricane wind/pressure models, and levee overtopping models.
- Techniques for HR/HPC model setup (given millions of elements), testing, validation, "calibration," and managing production runs on "supercomputers."
- JPM statistical techniques for Hazard/Probability Analysis: specifically the Surge-Response and JPM Optimum Sampling techniques.
- Considerations of Climate Change and Relative Sea Level Rise.
- Further coupling with detailed flood damage models to assess the range of surge RISKs associated with various mitigation proposals.

Upgraded HR/HPC surge modeling and hazard analysis tools that were developed as a result of the Surge Technical Work Group has gone on to be used for FEMA FISs across the Gulf of Mexico and Atlantic Coasts, and for other regional surge mitigation studies and coastal engineering designs.

Importantly, the upgraded High Resolution/HPC surge modeling and hazard analysis tools—coupled with the Coastal Louisiana Risk Assessment (CLARA) tool—are today an essential element of the Louisiana CPRA's Master Plan. The tools have also been used by consultants to the Southeast Louisiana Flood Protection Authority—East (an ARBD&CD sister agency) in a recent evaluation of New Orleans East-Bank residual surge risk.

The HR/HPC approach has also moved into surge forecasting. The ADCIRC Surge Guidance System (ASGS) developed initially at the behest of the Corps for managing HSDRRS floodgates and pump stations, has been expanded to provide national surge "guidance," (see http://cera.cct.lsu.edu/).

The High Resolution/HPC surge modeling/hazard analysis tools continue to be advanced. Today's High Resolution/HPC surge modeling/hazard analysis tools are even better than the ones used in wake of Katrina. Other competing High Resolution/HPC codes have been advanced (FVCOM, MIKE, DELFT, etc.). Supercomputing is the now the norm among commercial coastal engineering firms engaged in surge hazard analysis.



(January 29, 2006)

White Paper on Estimating Hurricane Inundation Probabilities

Written by:

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ERDC-CHL

Incorporating contributions, discussions, data, and comments by:
(in alphabetic order)

Stanley J. Boc (ERDC-CHL), Leon Borgman (private consultant), Vincent J. Cardone, (Oceanweather, Inc), Andrew Cox (Oceanweather, Inc.), William R. Dally (Surfbreak Engineering), Robert G. Dean (U. of Florida), David Divoky (Watershed Concepts), Emily Hirsh (FEMA), Jennifer L. Irish (Texas A&M University), David Levinson (NOAA's National Climatic Data Center), Alan Niederoda (URS Corporation), Mark D. Powell (NOAA's Hurricane Research Division, AOML), Jay J. Ratcliff (USACE-MVN), Vann Stutts (USACE-MVN), Joseph Suhada (URS Corporation), Gabriel R. Toro (Risk Engineering), Peter J. Vickery (Applied Research Associates)

Introduction

Over the last several months, a team of Corps of Engineers, FEMA , NOAA, private sector and academic researchers have been working toward the definition of a new system for estimating hurricane inundation probabilities. This White Paper is an attempt to capture the findings and recommendations of this group into a single document.

At least five methods have been applied in past studies of environmental extremes due to hurricanes in the United States:

1. Formulation of design storm events
2. Estimates based only on historical storms
3. The empirical simulation technique (EST)
4. The joint probability method (JPM) and
5. The Empirical Track Model

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Figure 1. January 2006 Draft of Hurricane Surge Hazard Analysis White Paper

List of White Paper Topics for Improving ARB Flood Forecasting and Hazard Analysis

These topics may be approached differently for *Near-Term* versus *Longer-Term* improvements.

1. Hydrologic Modeling—for runoff :
   Spatial scale: watershed vs more detailed catchments vs very High-Resolution grids/cells
   Physical process detail vs degree of empirical lumping: rainfall, interception, evaporation, infiltration/subsurface flow, and overland flow
   Overland flow: catchment scale unit hydrograph vs fine-cell routing (kinematic wave vs diffusive wave vs full dynamic)
2. Channel/Floodplain Hydraulic Modeling—for inundation:
   1D vs 2D vs combination
   Sufficient representation of urban area street drainage systems
   Channel routing method: diffusive wave vs full dynamic routing everywhere
   Floodplain representation: off-channel 1D or 2D storage vs part of the extended channel flow or some combination
   Appropriate numerical method (finite difference vs finite element vs finite volume), must be locally conservative
   What types of inundation/wetting schemes are acceptable?
3. Appropriate hydrologic/hydraulic model coupling approach:
   Should hydrologic and hydraulic processes be modeled separately, (as typical with 1D channel) or combined, as can be done with a very High-Resolution/2D cell model?
4. Sufficient model refinement to capture detailed floodplain inundation (e.g., role of roads, culverts, bridges).
5. What is optimal for various watersheds within the ARB?
   Should different models be used for different watersheds?
   How would total Basin modeling be achieved? Loose coupling?
6. Given options selected for above, what are the priority criteria for suitable codes?
   Open/public vs proprietary/commercial vs private/in-house source codes
   Amenability to, and extent of research on, continuous future code improvement
   Computational parallelization—how much parallelization/scalability is required/appropriate, MPI vs OpenMP
7. What are the High Performance Computing requirements?
   Additional programming requirements, e.g., coupling of separate models
   University vs commercial resources—R&D, specialized labor, operations, etc.
8. Data requirements:
   "Living GIS" with data layers that are continuously updated—topo/bathy polylines (key breaklines); channel cross-sections, inventory/details for hydraulic structures (bridges, culverts, weirs, gates, pump stations); ARB Topo/Bathy DEM
   Runoff and other watershed/catchment hydrologic monitoring for calibrating hydrologic models
9. Model evaluation, calibration/validation issues:
   Stage-Discharge Relationships
   Hindcast of 1983, 2001, and 2016 floods
   Local accuracy limitations of flood inundation hindcasts
10. Improving hazard (return period) analysis:
    Stochastic analysis of flood hazard; simulating numerous rainfall scenarios/probabilities; analogous to surge JPM analyses with hundreds of hurricane scenarios
    Incorporating joint rainfall-surge events into ARB riverine flood hazard analyses
    Many more gradations of flood hazard—e.g., 10-, 25-, 50-, 100-. 200-, 500-, 1000-, 2000-, 5000-, 10000-yr return periods
11. Comprehensive evaluation of local uncertainties in flood hazard estimates; Monte Carlo analyses
12. Addressing Sea Level Rise (see *Louisiana Coastal Master Plan*).
13. Addressing increased extreme rainfall hazard (see van der Wiel et. al., *Rapid attribution of the August 2016 flood-inducing extreme precipitation in south Louisiana to climate change*).
14. **Publishing High-Resolution web-GIS maps showing more gradations of flood hazard with margins of uncertainty.**
15. Explaining difference between NFIP FIRMs vs maps with more hazard gradations and margins of uncertainty.
16. "What if" scenario modeling for flood hazard mitigation proposals.
17. Major sediment erosion/deposition issues—river morpho-dynamics—and their impact on stage-discharge relationships and flood hazard.
18. Integration with High-Resolution flood damage assessment, analogous to CLARA.
19. Providing Operational Real-Time Flood Guidance? Example: similar to ASGS/CERA for ADCIRC surge guidance (see http://cera.cct.lsu.edu/); addressing rainfall forecast ensembles.
20. Life expectancy of various advances—what is the evolutionary trajectory? What investment is warranted now and over the next few years in various improvements?