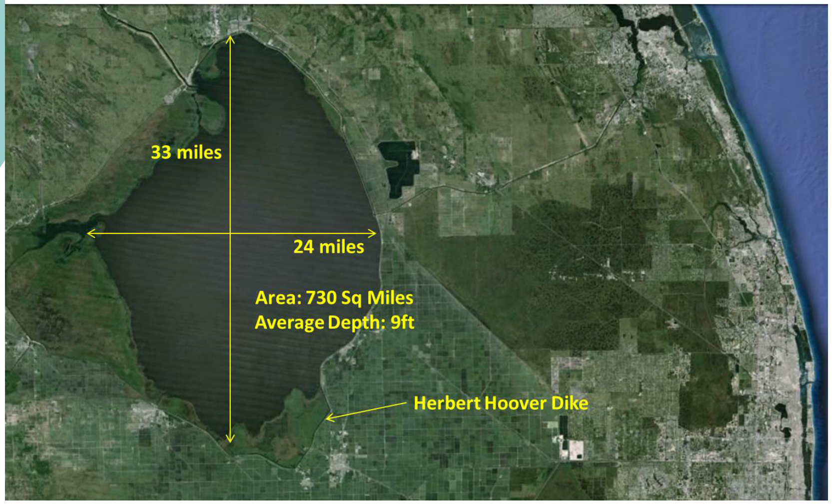
New Orleans
Hurricane Surge Risk Management

Part VI. Lessons Learned



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June 2015

Part VI Topics

- 6 Lessons for Surge Hazard Analysis
- 10 Lessons for Surge Risk Management
- 10 Lessons for Surge Protection Systems
- Comparison of Lake Okeechobee FL & Lake Pontchartrain LA

6 Lessons for Surge Hazard Analysis

1. Be familiar with the nature of surge probabilistic estimates.
   Demand the highest quality estimates of surge hazards when addressing catastrophic risks—i.e., beyond the NFIP. Advances in hurricane climatology, HPC/High-Resolution surge modeling, & JPA are continuing to improve the quantification of the surge hazard curve, including for polder interiors.
2. But appreciate the limitations of surge hazard estimates, especially those developed for NFIP purposes.
   For example, the post-Katrina FIS analysis characterizes Katrina's surge peaks at the New Orleans Lakefront & along the MRGO as 400-yr events. A new analysis taking into account further advances could reduce this return period significantly.
3. Understand the magnitude of uncertainty in the 100-yr estimates.
   Regard more extreme hazard estimates (e.g., 500-yr) as NOMINAL. Understand how uncertainty is treated for the NFIP versus for local residual risk reduction, as well as reasonably conservative treatment of uncertainties. **A reasonably conservative 90%UCL for 100-yr surge exceeds Nominal 500-yr surge**.

6 Lessons for Surge Hazard Analysis

4. Furthermore, understand the nature of multiple independent polder & regional exposures.
5. Institutionalize periodic updating of the surge hazard analysis—including for the polder interiors.

   Moreover, support critical research to improve hurricane climatology, HPC/High-Resolution modeling, JPA, overtopping analysis, breach probability estimation, etc. However, recognize the large uncertainties that are likely to remain for decades to come. Also appreciate different needs within a region: residual risk management should sponsor frequent, high quality re-analyses that closely re-examine extreme hazards, while the NFIP may accept a long lapse before revising FIS.

6. Study additional extreme hurricane surge scenarios—such as MOMs for maximum probable storms—to fully appreciate the "worst case" hazard.

10 Lessons for Surge Risk Management

1. Demand the highest quality quantitative risk assessments to estimate consequences at each hazard level. Educate the whole community on the nature of risk.
2. Understand all flood risks and examine surge risk reduction measures in context with other rainfall and river flood hazards.
3. Set the highest consensus surge risk management priorities in stone.

   Make them a permanent, marquee community commitment that all future leaders must uphold. Don't consider a risk management component a consensus priority if there are significant opposing interests that will work to undermine continuing political and financial support.

10 Lessons for Surge Risk Management

4. ***Eliminating loss of life is the top priority.***
   Ensure readiness of evacuation plans to address the limits of NFIP surge protection systems and their FOSs (see below). Treat uncertainties in protection system performance reasonably conservatively for loss of life risks (unlike in the NFIP). Ensure evacuation plans address those with health, logistical, or financial problems in self-evacuating.
5. ***Expanding flood insurance participation and coverage is the second priority.***
   Consider incentives and even mandates. For a community as a whole, flood recovery will be quicker, broader, and more effective if more property damage is covered by insurance.

10 Lessons for Surge Risk Management

6. Evaluate additional residual risk reduction measures as a "system;" need to function synergistically (Boyd et al 2013). Beyond evacuation and flood insurance, there are eight potential measures:

Surge Protection System

i. Minimal NFIP—100-yr
ii. Greater system FOSs—for uncertainties
iii. Greater breaching resiliency
iv. More extreme design

Other Measures

v. Restoration & protection of large-scale coastal features
vi. Interior compartmentalization
vii. Enhanced interior drainage & pumping
viii. Flood-proofing

NFIP Surge Protection Systems and additional risk reduction measures are to surge what fire departments are to fires—they complement effective evacuation preparedness and property insurance.

10 Lessons for Surge Risk Management

7. Be mindful of apparent complementary interests, as they can become competing interests—as evidenced in the past by SELA Drainage Program & Lakefront revenue generation. ***Coastal restoration/protection has the potential to be a competing interest to surge protection. Optimizing a project for ecosystem function & extreme surge reduction are not same thing. Ecosystem & surge risk reduction $s both deserve to be spent well.***
8. Ensure that professionals are allowed independence to choose their methodologies, provide authoritative findings and recommendations, and discuss limitations and uncertainties.
9. Ensure transparency in surge risk reduction planning and implementation.
10. Recognize surge risk management is never finished. Leaders must invest in continuous improvement in all areas.

10 Lessons for Surge Protection Systems

1. Surge protection systems are usually built to complement implementation of the NFIP.
   Therefore, understand the programmatic goals and limitations of the NFIP, NFIP hazard analysis, NFIP surge uncertainty treatment, NFIP overtopping analysis and *limited* FOS, and NFIP accreditation. (See Lessons 8 and 9 above.) Ensure that the public understands that NFIP surge protection systems leave considerable residual risk to life and property.
2. Surge protection systems can have significant adverse impacts on areas outside the system—both communities and coastal landscapes.

10 Lessons for Surge Protection Systems

3. Additional life-saving and economic drivers for urban centers can warrant systems that exceed NFIP requirements.
   - Higher FOSs to address uncertainties in the 100-yr condition.
   - Higher resiliency against greater storms.
   - Higher hazard level design.

   Understand what this entails and determine who will pay for and maintain system enhancements.

   Resiliency can be a better investment than more height—but there are many factors to consider: residual overtopping and breaching risks, authorizations, costs, long-term performance of resiliency measures, O & M, etc.

10 Lessons for Surge Protection Systems

4. Some communities with excellent evacuation programs and modest uninsured exposure may be satisfied with a minimal NFIP levee system (e.g., minimal FOS). If NFIP credit becomes available for levees below 100-yr hazard, these may be optimal for some communities.
5. Don’t allow federal support for design/construction to excuse local buy-in. **<u>Local communities must regard themselves as the ultimate owner of the system and its limitations!</u>** Remember the adage that “no one washes a rental car.”
6. Understand the responsibilities as well as the limits of the federal agent—particularly if it is the USACE. Understand the special USACE culture of narrowly construing Congressional authorizations and the impact this will have on any need for flexibility in the face of new information. Also understand the typical timetable and budgeting approaches of the USACE.

10 Lessons for Surge Protection Systems

7. Establish one local agent to represent the community as the co-sponsor for all NFIP surge protection system design, construction, and O & M decisions. This entity should also be the local NFIP coordinator and in charge of residual property risk reduction measures. This will facilitate clear lines of authority, responsibility, and ultimate accountability.
8. Monitor for inevitable design issues which pit cheaper/faster construction alternatives versus those with lower long-term O & M costs and headaches.

10 Lessons for Surge Protection Systems

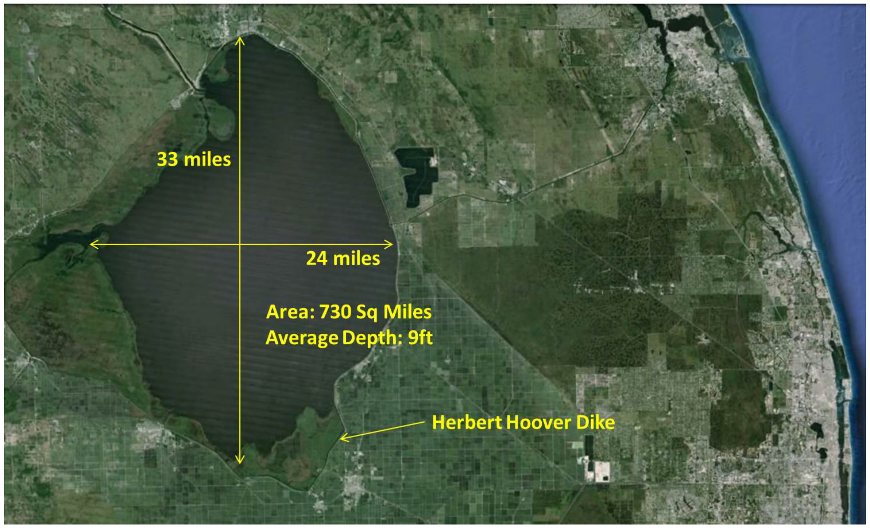
9. Ensure appropriate local funding commitment.
   Don’t pursue alternatives that have local O & M budgets that the community cannot afford. Provide perimeter systems that are “right sized” are carefully weigh decisions to encompass low density areas (especially wetlands). Leveeing canals may be preferable to enclosing them behind massive gated structures and pump stations that impose complex and expensive O & M requirements.
10. Make sure that the local community understands all long-term needs and costs associated with keeping NFIP accreditation, such as for levee lifts.

A Final Lesson:

Comparison of Lakes Okeechobee and Pontchartrain

Lake Okeechobee in south Florida

- Over 700 square miles in area
- 2nd largest lake lying entirely within the lower 48 states.
- Extremely shallow, averaging only about 9 feet (ft) in depth.
- 1928 strong Cat 4 storm (145 mph winds) made landfall at WPB.
- Residents along the shores of Lake Okeechobee—40 miles plus inland—thought themselves safe from surge.



A Final Lesson:

Comparison of Lakes Okeechobee and Pontchartrain

- Combination of long fetch, strong winds, & very shallow depth all contributed to a severe "tilting" of the water surface, without any "filling" from the ocean.
- Southward winds created a surge depth reportedly reaching 20 ft, overwhelming an existing dike on the south shore.
- After the eye passed & winds reversed direction, northward winds caused a surge on the north shore.
- The Lake Okeechobee surge caused over 2,500 deaths, making it the second deadliest hurricane in US history.
- The dike was subsequently reconstructed to provide greater protection from future wind-driven tilting of Lake Okeechobee.
- The Herbert Hoover Dike has been raised several times & is currently about 30 ft above the surrounding ground.

A Final Lesson:

Comparison of Lakes Okeechobee and Pontchartrain

- The NFIP 100-yr SWL surge depth (above mean level) for the south shore of Lake Okeechobee is about 1 ft greater than for the south shore of Lake Pontchartrain.
- However, the crest freeboard above the 100-yr SWL for the Herbert Hoover Dike is much greater than for the HSDRRS—by almost 10 ft.
- The catastrophic 1928 Lake Okeechobee Hurricane produced a surge reportedly 10 ft greater than the current NFIP 100-yr SWL.
- On the other hand, Hurricane Katrina produced a surge about 2 ft above the 100-yr SWL at the New Orleans Lakefront.

It is apparent that the Herbert Hoover Dike was not designed simply for NFIP accreditation.

Conclusion

1. All flood tragedies—and Katrina was not an exception—are due to the underestimation of the hazard and the failure to prioritize appropriate risk management measures, with the former heavily influencing the latter.

2. The Supercomputing Era has produced—and will continue to produce—remarkable high-resolution refinements in surge hazard analysis.

HOWEVER,
dramatic risk reductions—for loss of life and economic devastation—are only attainable if . . . SEE NUMBER 1!