IRIS
Intelligent Resilient Infrastructure Systems
August 12, 2016 – 15,000 structures flooded after levee along Amite River overtopped. Ascension Parish (LA)

September 3rd, 2005 - 17th Street canal breach during hurricane Katrina. New Orleans (LA)
IRIS Vision

• Intelligent and resilient systems that organically interact (i.e., inform as well as adapt to demands) with local communities and decision makers in order to function efficiently and effectively.

• Vanderbilt has a hub for intelligent resilient infrastructure systems research and education innovation.
The IRIS initiative is funded by Vanderbilt Trans-Institutional Programs (TIPs) 2016. Different Departments and Schools are involved in the multi-disciplinary program.

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The emphasis of the project is on flood protection systems (FPS) such as levees, earthen and concrete dams. A fully integrated, multi-disciplinary, cyber-physical systems strategy is designed to effectively monitor FPS health and inform actionable information to decision makers.

Research Approach

Intelligent Resilient Infrastructure System (IRIS)

- DATA Sensing & Analytics
- MODELING & SIMULATION System Prognosis
- RISK-BASED DECISION MAKING Decision Metrics
- HUMAN INTERFACE Decision Support

Physical System

Decision Support System
Levees failure mechanisms
Variational Multiscale Enrichment (VME) Method

The response of the system is evaluated at different scales, according to the required detail in the measured response. Results obtained from different scales are then linked by means of appropriate mathematical tools.

Collaborating members: Oskay, Baroud, Bennartz, Fascetti

Image retrieved from: https://www.soilvision.com/features/levee_3d_intersection_analysis.shtml
Hydro-mechanical coupled lattice model

The flow and mechanical problems are solved on dual lattice assemblies, and their response is dependent on each other (full coupling)

• No bias in evaluated flow path
• Adaptive remeshing of critical zones
• Easy scaling between different domains
Land Surfaces Classification

- Unsupervised classification
- Flooded areas detection

Collaborating members:
Abkowitz, Baroud, Bennartz, Philip
Unmanned aircraft systems

Nano-Hyperspec

Velodyne LiDAR

Headwall

CTEMPs (Center for Transformative Environmental Monitoring programs)
Data Collection for Disruption Scenarios

- Compile database of historic dam/levee disruptive events
- Assess causal factors and consequential impacts, including:
  - human casualties
  - physical damage
  - loss of use
  - community disruption
  - regional, national and international impacts
- Identify suite of high vulnerability disaster scenarios associated with levee resilience
- Define a process for identifying levees most in need of implementing sensing and detection technologies
Vulnerability Analysis

Resilience Modeling of Flood Protection Infrastructure

- Qualitative/Quantitative resilience metrics
- Quantification Tools
- Predictive Modeling Approaches
- Data Sources and Collection


Figure taken from [Kang and Lee, 2012].
• Identify gaps for scientific research advancement
• Incorporate interdependencies in resilience metrics and frameworks
Cognitive Modeling

Developing methodologies to assess:
- human casualties
- physical damage
- loss of use
- regional, national and international impact

Building a decision support interface allowing to:
- consider each strategic alternative
- update strategies
- explain the alternatives to individuals with different risk preferences

Collaborating Members: Adams, Baroud, Trueblood