Flood Risk Management
ERDC R&D Programs

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Associate Technical Director
Coastal & Hydraulics Laboratory

2013 Regional Sediment
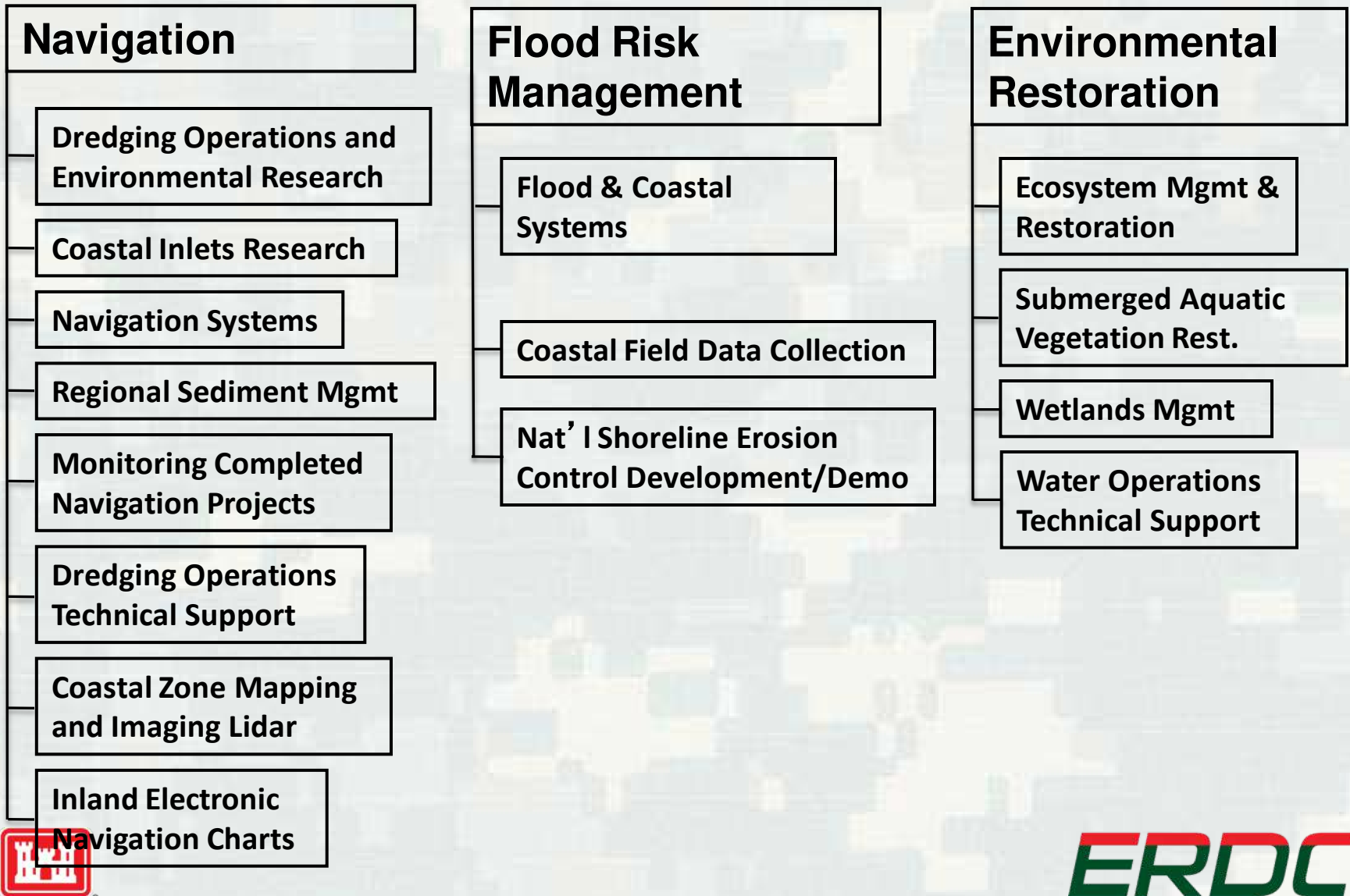Management IPR
20 August 2013

US Army Corps of Engineers®

Civil Works RD&T

Navigation

- Dredging Operations and Environmental Research
- Coastal Inlets Research
- Navigation Systems
- Regional Sediment Mgmt
- Monitoring Completed Navigation Projects
- Dredging Operations Technical Support
- Coastal Zone Mapping and Imaging Lidar
- Inland Electronic Navigation Charts

Flood Risk Management

- Flood & Coastal Systems
- Coastal Field Data Collection
- Nat'l Shoreline Erosion Control Development/Demo

Environmental Restoration

- Ecosystem Mgmt & Restoration
- Submerged Aquatic Vegetation Rest.
- Wetlands Mgmt
- Water Operations Technical Support

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Flood and Coastal RD&T Programs

Flood and Coastal Systems
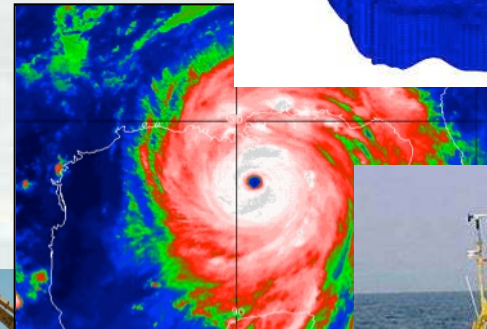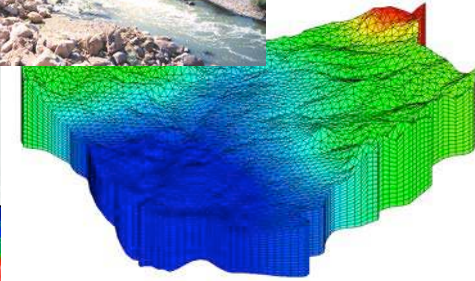(GI - $5.06M)

Coastal Field Data Collection Program
(GI - 0.92M)

Coastal Ocean Data Systems
(O&M - $2.9M)

National Shoreline Erosion Control Development and Demonstration Program
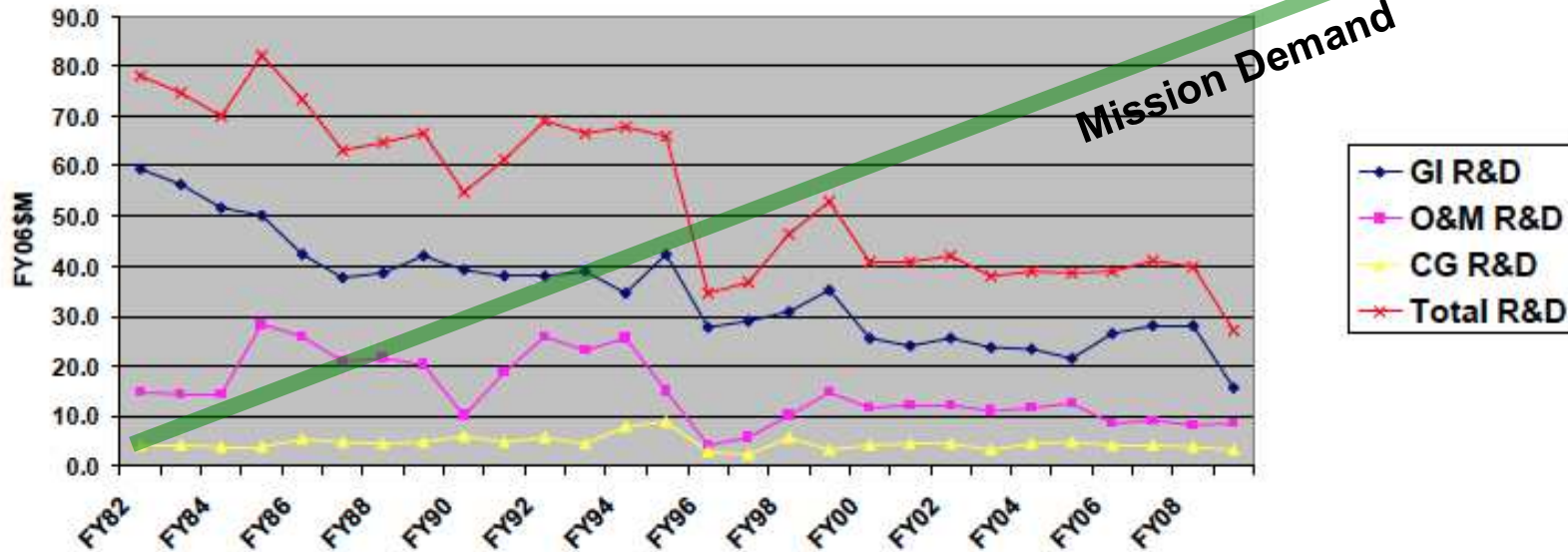
Urban Flood Technology Demonstration Program

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R&D in Constant (FY06) Dollars

| Agency	FY10 R&D	% of FY10 Budget
USACE CW	$27M	0.5%
Reclamation	$20M	2%
NRC	$120M	12%
NIST	$500M	75.5%
EPA	$570M	5.7%
NOAA	$600M	15%
DHS	$800M	1.8%

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Flood & Coastal RD&T Strategic Needs & Priorities

- Determine Risk & Uncertainty for Project Alternatives Evaluation & Performance

- Optimize Management of Coastal & Estuarine Resources

- Assess Comprehensive & Multidisciplinary Management of Watersheds

- Improve Flood Risk Management & Water Control Infrastructure Resiliency & Reliability

- Enable effective disaster preparation, response & recovery

- Engineering with nature to enhance ecosystem and processes, benefits and services

- Deliver sound engineering and scientific solutions that meet Planning Modernization guidelines
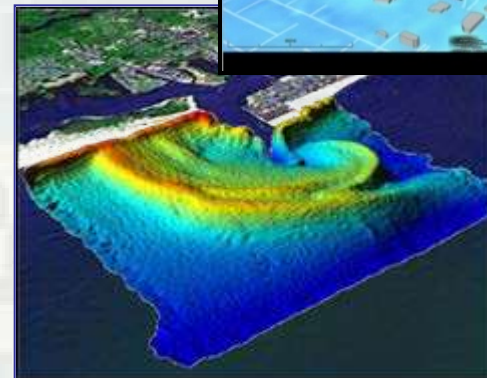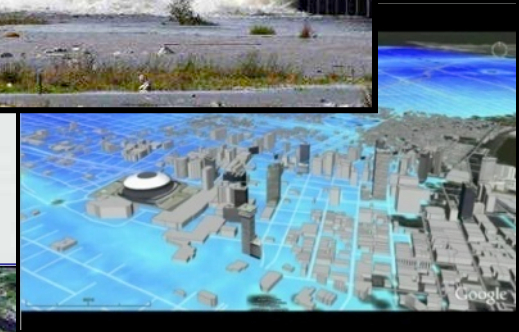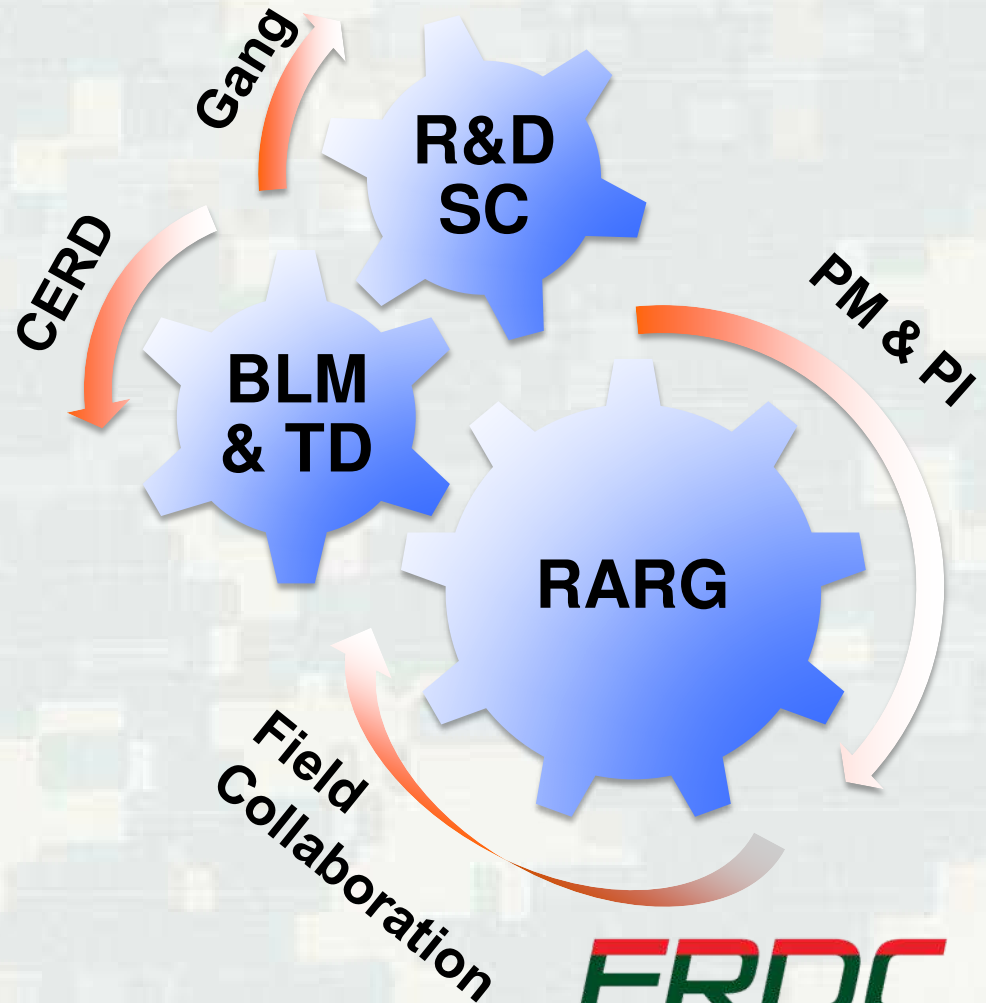

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Civil Works RD&T Process

- Produces Requirement-driven program

- Short-term requirements

- Strategic Requirements

- Leverages other Corps Programs

- Collaborate with Field and Others

- Documentation: SOP

Gang

CERD

R&D SC

BLM & TD

RARG

PM & PI

Field Collaboration

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Civil Works RD&T Process
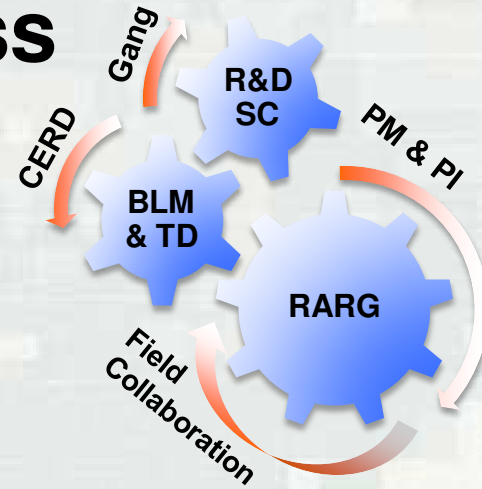
Per HQUSACE SOP:

- HQ Steering Committee establishes strategic goals

- Field (RARG) develops and ranks research needs and requirements

- HQ prioritizes requirements

- ERDC & IWR develop research/work plan for addressing needs

- CERD develops R&D program to maximize output potential

- HQ CW reviews and approves proposed R&D Program

- ERDC/IWR execute R&D

- Field & HQ review, approve, guide, and incorporate products into practice

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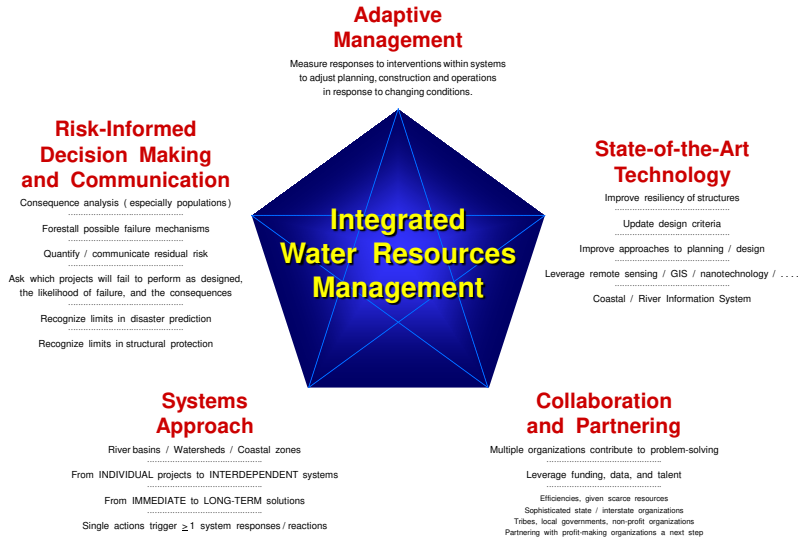*Innovative solutions for a safer, better world*

USACE Flood Risk Management Mission

Save lives and reduce property damage by reducing flood and coastal storm damage risks with structural and non-structural measures, and assist community response to these risks and hazards.
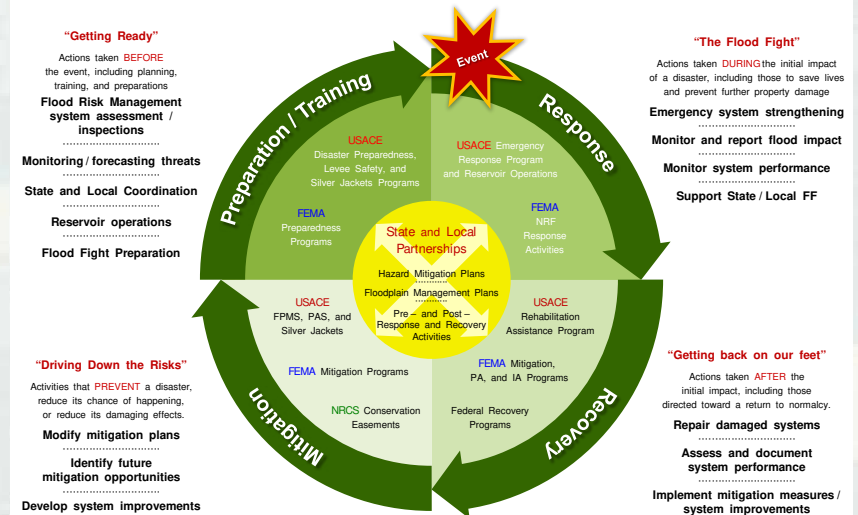
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Flood Risk Management Doctrine

Overarching Approach

Adaptive Management
Measure responses to interventions within systems to adjust planning, construction and operations in response to changing conditions.

Risk-Informed Decision Making and Communication
Consequence analysis (especially populations)

Forestall possible failure mechanisms

Quantify / communicate residual risk

Ask which projects will fail to perform as designed, the likelihood of failure, and the consequences

Recognize limits in disaster prediction

Recognize limits in structural protection

State-of-the-Art Technology
Improve resiliency of structures

Update design criteria

Improve approaches to planning / design

Leverage remote sensing / GIS / nanotechnology / . . . .

Coastal / River Information System

Integrated Water Resources Management

Systems Approach
River basins / Watersheds / Coastal zones

From INDIVIDUAL projects to INTERDEPENDENT systems

From IMMEDIATE to LONG-TERM solutions

Single actions trigger ≥ 1 system responses / reactions

Collaboration and Partnering
Multiple organizations contribute to problem-solving

Leverage funding, data, and talent

Efficiencies, given scarce resources
Sophisticated state / interstate organizations
Tribes, local governments, non-profit organizations
Partnering with profit-making organizations a next step

Life-Cycle Risk Management

"Getting Ready"
Actions taken BEFORE the event, including planning, training, and preparations

Flood Risk Management system assessment / inspections

Monitoring / forecasting threats

State and Local Coordination

Reservoir operations

Flood Fight Preparation

"The Flood Fight"
Actions taken DURING the initial impact of a disaster, including those to save lives and prevent further property damage

Emergency system strengthening

Monitor and report flood impact

Monitor system performance

Support State / Local FF

"Driving Down the Risks"
Activities that PREVENT a disaster, reduce its chance of happening, or reduce its damaging effects.

Modify mitigation plans

Identify future mitigation opportunities

Develop system improvements

"Getting back on our feet"
Actions taken AFTER the initial impact, including those directed toward a return to normalcy.

Repair damaged systems

Assess and document system performance

Implement mitigation measures / system improvements

Preparation / Training — Response — Recovery — Mitigation

Event

USACE Disaster Preparedness, Levee Safety, and Silver Jackets Programs

USACE Emergency Response Program and Reservoir Operations

FEMA Preparedness Programs

FEMA NRF Response Activities

State and Local Partnerships

Hazard Mitigation Plans
Floodplain Management Plans
Pre – and Post – Response and Recovery Activities

USACE FPMS, PAS, and Silver Jackets

USACE Rehabilitation Assistance Program

FEMA Mitigation Programs

FEMA Mitigation, PA, and IA Programs

NRCS Conservation Easements

Federal Recovery Programs

Shared Disaster Risk Management
" Driving Down the Risks with an Informed and Engaged Public "

Risk

Initial Risk

Outreach	Federal / State / Local
Natural Storage	Federal / State / Local
Structural	Federal / State / Local
Non – Structural	Federal / State / Local
Contingency Plans	Federal / State / Local / Individual
Building Codes	State / Local
Zoning	Local
Insurance	Individual / NFIP

Residual Risk

Resulted from Hurricane KATRINA Lessons Learned

All Stakeholders contribute to reducing risk !

Risk-Informed Decisionmaking
RISK = expected value of an unwanted event which may or may not occur

Step 1: Screening — **Consequences** x
("Threat – Agnostic")

Step 2: P (Consequence | Threat) — **Vulnerability** x
(Internal)

Step 3: P (Threat) — **Threat**
(External)

A rigorous process of:

"Threat-Agnostic" Consequences Prioritization

"Threat-informed" Vulnerability Assessment

Probabilistic Prioritization of Investments

Consistent Analysis of Alternatives

Common Operating Picture

Systems / Portfolio "Mastery"

Relative Risk Value Matrix (1-5 Matrix)					
	Overall Project Condition Classification				
Condition / Consequence	F (1) Failed	D (2) Inadequate	C (3) Probably Inadequate	B (4) Probably Adequate	A (5) Adequate
1 High	1	1	2	2	3
2 Medium High	1	2	2	3	4
3 Medium	2	2	3	4	4
4 Low	2	3	4	4	5
5 Minimal	3	4	4	5	5

Consequence Category

Risk and Uncertainty Frameworks for Project Alternatives Analysis

HEC-WAT/HEC-FRA

CSTORM-DB

HEC-FIA

Beach-fx

H&H Models

Improve Corps' planning, design and formulation capability through advanced software that integrates engineering computations with FRM analysis tools. Software is designed to enhance evaluation and comparison of project alternatives in a risk and uncertainty framework
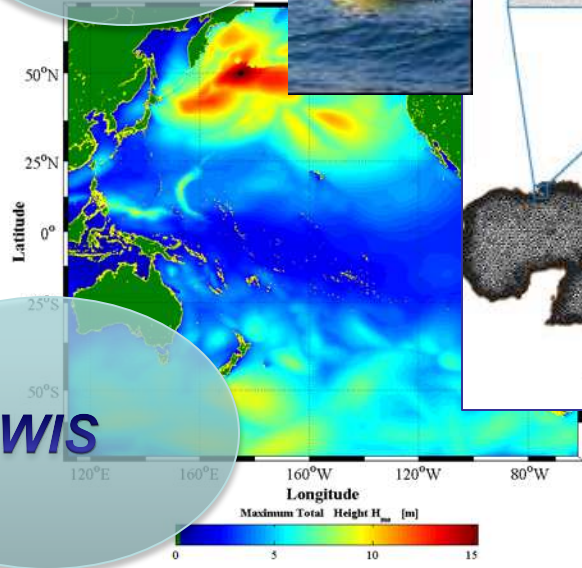
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Optimize Management of Coastal and Estuarine Resources

CDIP

AdH

WIS
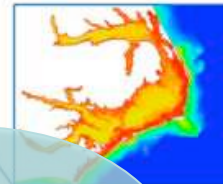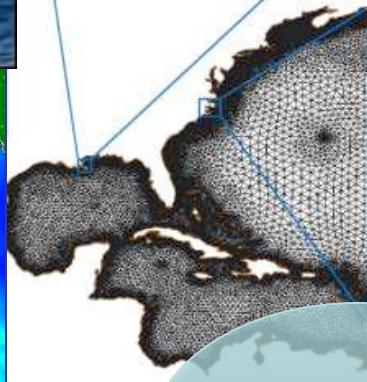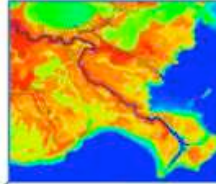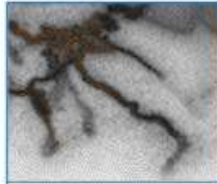
CSTORM-MS
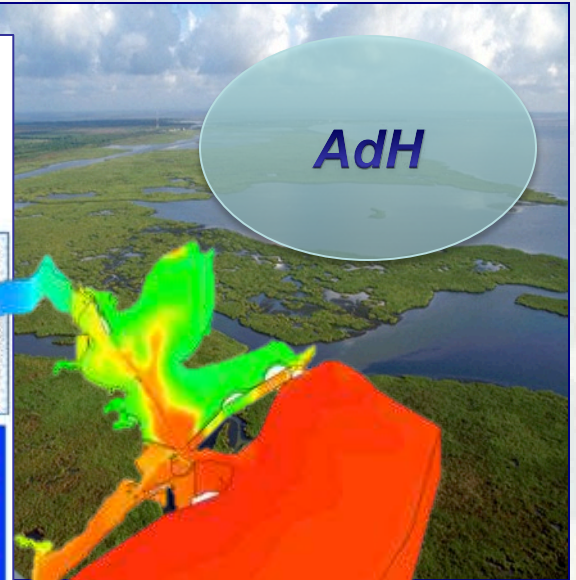
Provide USACE and its partners and stakeholders the framework and analytical tools to balance human development activities with natural system requirements in a sustainable manner through regional management of coastal and estuarine water and sediment resources

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Watershed Management
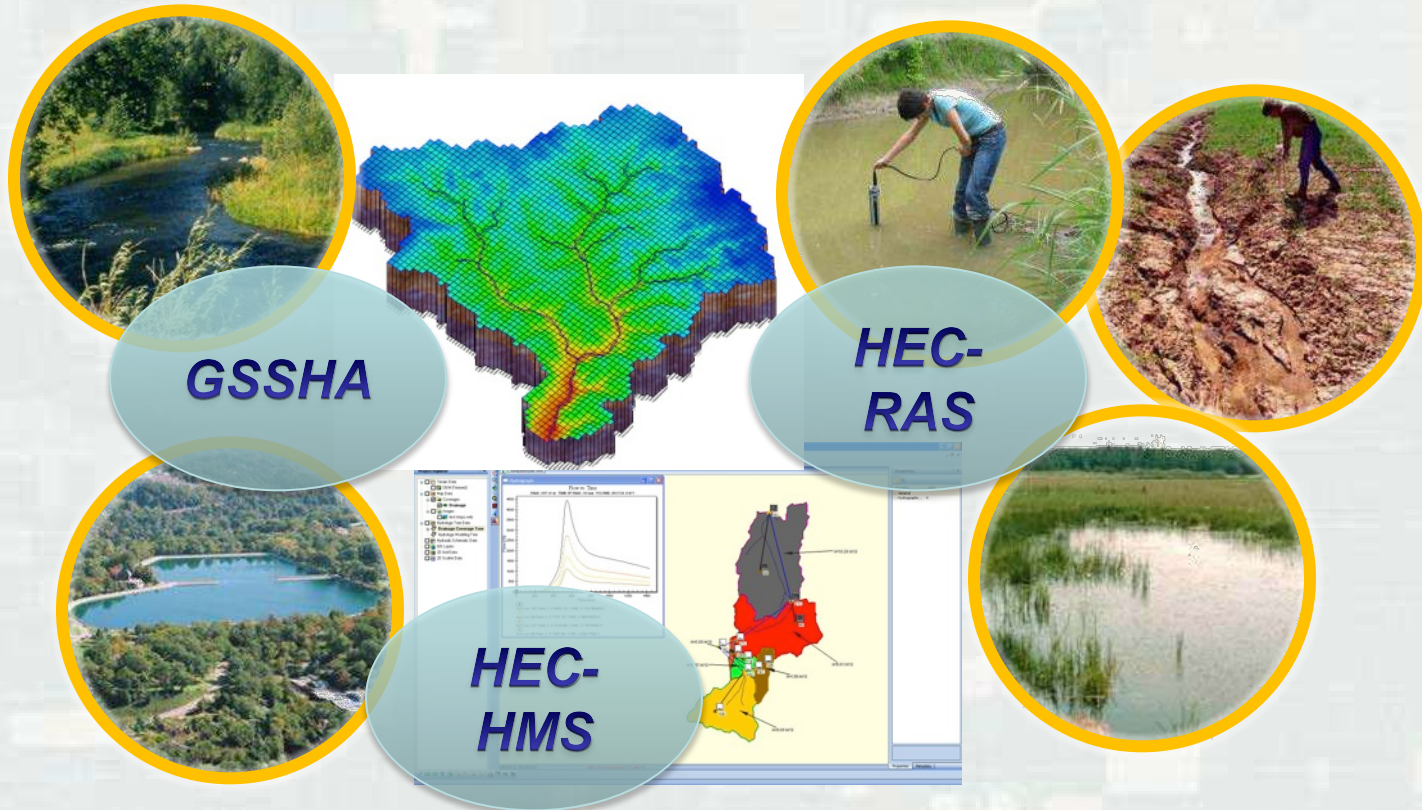
GSSHA

HEC-RAS

HEC-HMS

Provide capability to Districts and stakeholders to conduct holistic studies on watersheds, rivers, reservoirs and estuaries for multidisciplinary water resources management. Capability includes interoperable hydrology, hydraulics, sediment and material transport and ecologic processes

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Improve Infrastructure Resiliency & Reliability

Monitoring, Sensing, and Testing of Earthen Structures

Airborne

Satellite

Ground -based

Waterborne
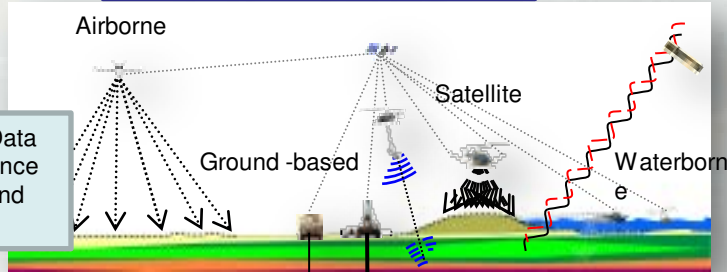
Sources of Data for Performance Monitoring and Observation

I-Wall Analysis
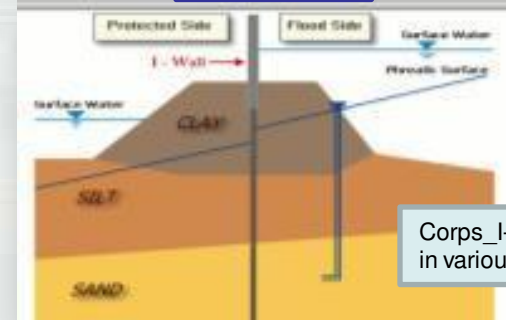
Corps_I-Wall example of I-Wall in various soil types

Woody Vegetation on Levees

Woody Vegetation on Levees, New Orleans, LA

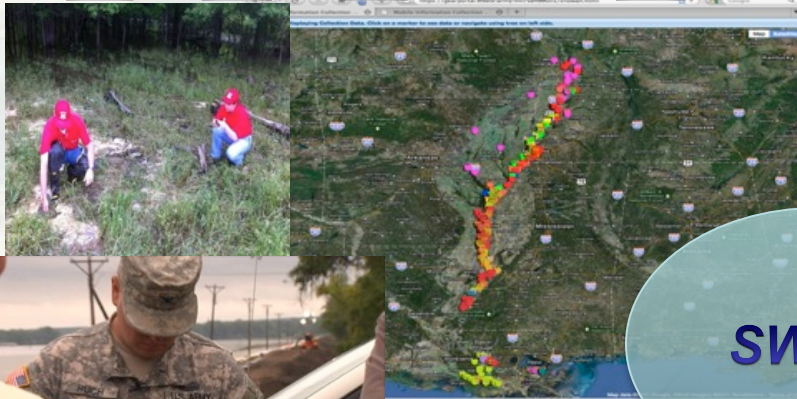Embankment and Foundation Seepage & Piping for Risk Based Decision-Making
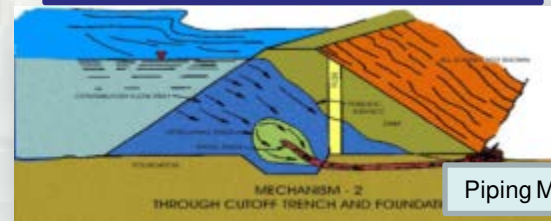
Piping Mechanisms

Identify near term opportunities for gaining new capability and longer term science-based initiatives to make greater strides in improving the condition and functioning of infrastructure.
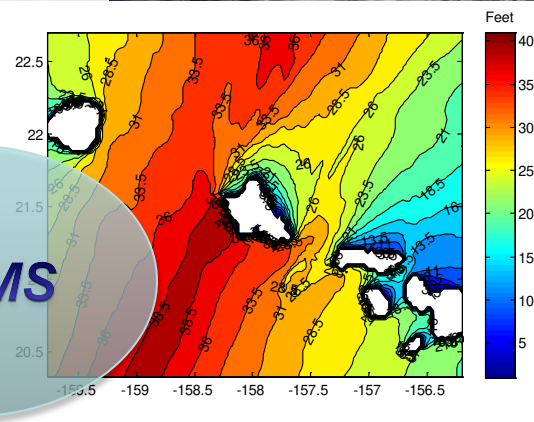
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Effective Disaster Preparation, Response & Recovery

MICA

CSTORM-DB

SWIMS

Enable expedient, efficient, and effective data acquisition, data management and information dissemination for life-cycle public safety and all hazard risk mitigation. Capability includes rapidly deployed models and reliable damage assessment technologies

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MICA – USACE 2012 Innovation of the Year

- **Seattle District** – Flood Fight 2012 and Earthquake exercise
- **FEMA** – Austin, TX post fire fighting operations
- **NO District Hurricane Isaac** damage assessments
- **Pittsburgh District** – Power mission
- **Portland District** – MICA Architecture used for custom dredging operations tool
- **Jacksonville District** – Invasive species data collection project
- **FEMA** – Pump location inspections post Isaac
- **State of Michigan** – capture locations and information on abandoned homes - 6250 points
- **NAD (NAP, NAB, NAN)** – Hurricane Sandy Response/Recovery (effort ongoing)

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Thank You

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BACKUP SLIDES

MICA Approach

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MICA User Interface

Field Personnel have a very intuitive screen for capturing field photos and videos

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Mobile Data Collection Kit

•60 Android Smartphones in ready-to-go kit, easily replaceable - $150 each

•In addition to computer applications, they can make calls, email and text message for field communications

•Platform to support multiple applications at once

•Voice Recognition, internet research, maps, calculators, engineering applications

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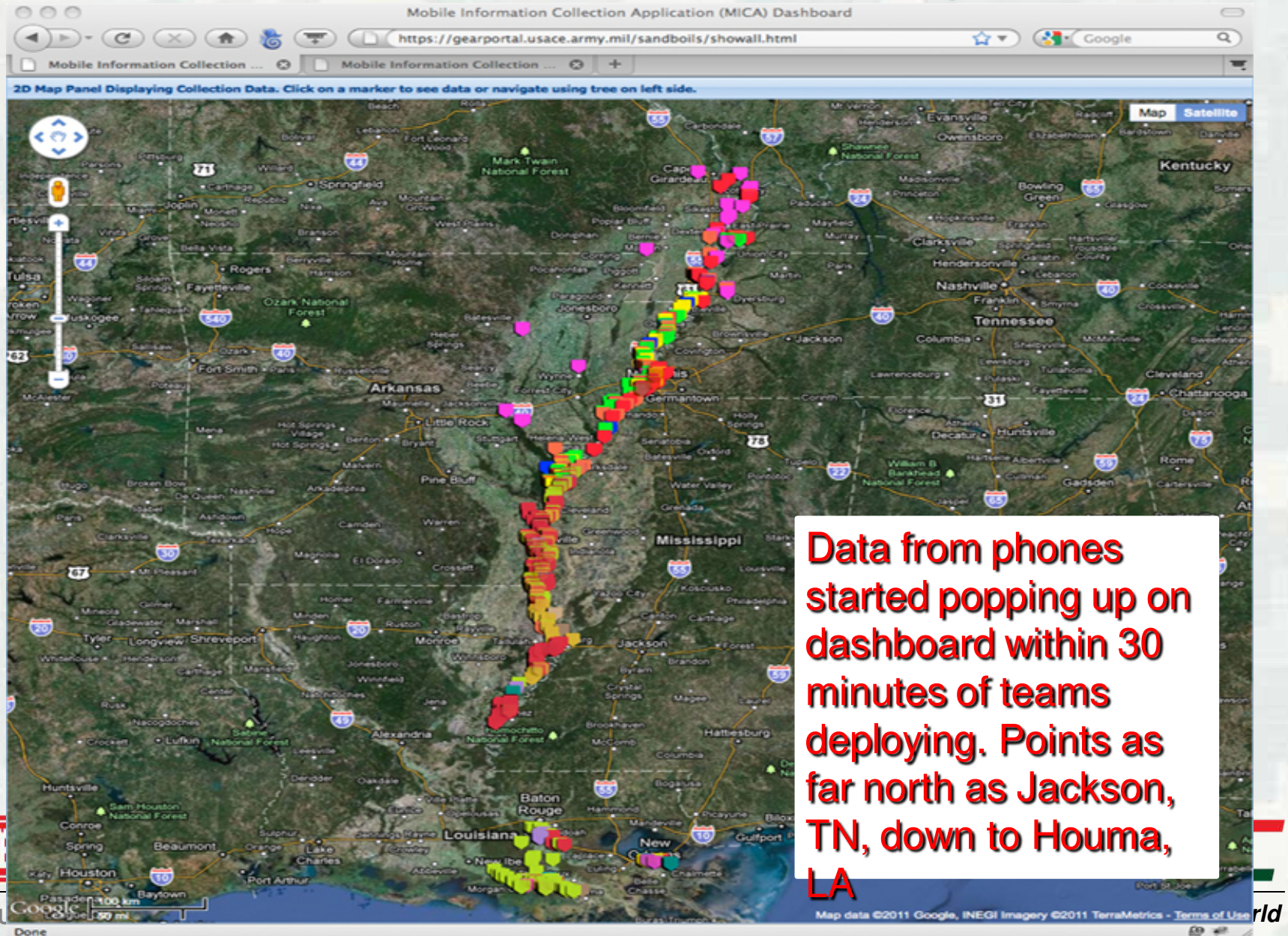# 2011 Flood Fight – MICA Data Collection

Team members during their levee walks took photos, videos, and notes of sandboils, seepage, pumping efforts, and any other points of interest to send back to command center.

world

MICA – 2011 Flood Fight

Data from phones started popping up on dashboard within 30 minutes of teams deploying. Points as far north as Jackson, TN, down to Houma, LA

Flood & Coastal Problem Statements

Statement of Need	Weighted Score	Rank
Economic Monitoring of Coastal Storm Damage Reduction Projects	4.80	1
Levee Breach Mechanics	4.60	2
Boussinesq Modeling Technology Improvements for Flood Risk Management Projects	4.33	3
Hypothetical Storm Development	3.80	4
Cohesive Shoreline and Bank Erosion and Recession Tools	3.44	5
Sediment Flushing and Other Means of Sediment Bypass for Reservoirs	3.40	6
Survivability and Sustainability of Grass Cover on Levees	3.40	7
Ice Engineering Tool Development	3.20	8
Snow Hydrology Tool Development	3.00	9
Quantification of Nearshore Transient Water Level Induced by Storm Wave Action	3.00	10
Integration of H&H Engr. with Ecological Components of Project Planning and Design	3.00	11
Development of Non-stationary Frequency Analysis Methodology	3.00	12
Repair/Replacement of failed in-service water stops for Civil Works structures	3.00	13
Guidance for Risk and Uncertainty Analysis in combined tidal and riverine flood zones	3.00	14
Geotechnical site characterization of complex foundations under extremely long levees	3.00	15
Systems Approach to Water Resources Planning	3.00	16
Computer program to analyze i-walls in cohesive soils (total stress analysis)	2.80	17
Erosion and Mass-Wasting Failure of Cohesive Sediment	2.75	18
Sediment Data Collection Techniques and Model Applications	2.60	19
Integrating Non-Monetary and Life Cycle Risks for Improved FRM Decision Making	2.60	20
Rock Anchor Corrosion Evaluation	2.43	21
Underwater Inspection of Bridges using High Resolution Underwater Acoustic Imaging Sonar	2.33	22
Rapid estimation of post-storm debris volumes	1.89	23
Mold Flood Damage Functions	1.80	24
Sediment Impact Assessment for Dam Removal Activities	1.67	25
H&H Tools for River Diversion Assessment	1.60	26
Urban watershed application of systems approach developed for Demonstration Erosion Control (DEC) watersheds	1.40	27
Ice Storm Tool	1.40	28
Data structure and management for disaster response	1.40	29
Spoiled food issues in debris management	1.29	30
Best Management Practices for Debris Management	1.20	31
Multi-dimensional Numerical Hydraulic Modeling of Bridges	1.00	32

Flood & Coastal RD&T Strategic Needs & Priorities

- **Determine Risk & Uncertainty for Project Alternatives Evaluation & Performance**
  - Field capability to evaluate project performance with respect to system response to loadings and failure, and application of risk-based concepts for plan formulation and levee certification (HEC-WAT, HEC-FDA)
  - Continued development of methods/tools for estimating fatality rates and expected damages from levee failure for project planning and risk assessment (HEC-FIA)
  - Field tool for conducting joint probabilistic forcing and response analyses of coastal and riverine projects for risk-based project lifecycle planning
  - Develop evidence-based depth damage functions for erosion, inundation, and wave impacts for coastal storm damage functions
  - *Capability to monitor & evaluate project performance in the context of actual damages prevented and risk of future damages for better informed resource allocation and adaptive management decisions*
  - Develop broadly applicable analysis tools to support uncertainty assessments as an integral part of hydraulic, hydrologic, and sediment transport model studies
  - Develop an enterprise coastal storm database and standard storm processing toolbox for planning, design and emergency management

- **Optimize Management of Coastal & Estuarine Resources**
  - *Techniques and guidance for evaluating the mitigating effects of storm surge and waves using natural features*
  - Development of computational tools and framework for coupled wind, wave, and sediment simulation leading to reduced uncertainty w/r coastal storms, coastal processes and coastal project design and risk assessment (CSTORM-MS)
  - *Development of tools for simulation of wave run-up and overtopping using Boussinesq modeling techniques*
  - Field tools for simulation of critical physical and biological processes and their interactions to optimize coastal resource management activities
  - Consistent strategy and methodology for approaching multi-scale and multidisciplinary modeling, linking coastal and estuarine processes with riverine and watershed
  - Operational wave observations & wave hindcast data
  - Innovative coastal morphology evolution data collection methods
  - Development of an interagency coastal surge & wave model evaluation system

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Flood & Coastal RD&T Strategic Needs & Priorities

- **Assess Comprehensive & Multidisciplinary Management of Watersheds**
  - Consistent analytical approaches for integrated water resource management within an enterprise suite of tools (HEC-RAS, HEC-HMS, HEC-RESSIM, GSSHA, AdH, SEDLIB)
  - Improved accuracy in snow melt simulation through implementation of snowpack flow simulation capability
  - Develop methods to simulate fine scale features in large-scale hydrologic models
  - Implementation of an efficient, effective, and complete model calibration process for hydrologic models
  - Improved capabilities for modeling Urban Areas (overland flow on streets, gutters, drop inlets, etc.)
  - *Implement improved methods to route sediment in unsteady flow and simulate reservoir slucing & flushing*
  - *Development of guidance for incorporating snow melt hydrology into USACE project flood estimations*
  - *Development of tools to simulate hypothetical storms for flood risk management*
- **Improve Flood Risk Management & Water Control Infrastructure Resiliency & Reliability**
  - *Capability to simulate potential failure mechanisms due to woody vegetation on levees*
  - *Develop techniques for remote, non-destructive and rapid testing of levee structures, complementing existing efforts in the Levee Safety Program to collect surficial data on levees*
  - *Investigate seepage, piping and internal erosion, the primary failure mechanism and concern for dams and levees*
  - Field Corps I-Wall analysis tool to provide capability to perform deterministic or probabilistic analyses
- **Enable effective disaster preparation, response & recovery**
  - Development of Mobile Information Collector Application (MICA) tool for effective preparation, response and recovery from natural and other disasters through improved measurement, instrumentation, and decision making methods and technologies
  - Effective preparation & response for coastal and hydrologic events through application of expert analysis tools to high resolution storm databases

Flood & Coastal RD&T Strategic Needs & Priorities

- **Engineering with nature to enhance ecosystem and processes, benefits and services**
  - Techniques and guidance for evaluating the mitigating effects of storm surge and waves using natural features
  - Development of a numerical wave flume for high resolution simulation capability of storm surge-vegetation interaction
- **Deliver sound engineering and scientific solutions that meet Planning Modernization guidelines**
  - Develop & field the Flood Impact Analysis tool (HEC-FIA) which utilizes FEMA HAZUS data to efficiently quantify economic and social consequences associated with project alternatives at a level beyond recon studies
  - Develop CSTORM-DB, a database of high-fidelity numerical model solutions of simulated coastal storms for use in rapid retrieval of

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