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Flood Apex Program



Homeland
Security

Science and Technology

Rethinking America's Costliest Disaster

Program Overview

The Department of Homeland Security Science and Technology Directorate's Flood Apex Program was created at the request of the Administrator of the Federal Emergency Management Agency (FEMA) to bring together new and emerging technologies designed to increase communities' resilience to flood disasters and provide flood predictive analytic tools to FEMA, state and local governments, and other stakeholders.

Key Objectives

- Reduce fatalities and property losses from future flood events.
- Increase community resilience to disruptions caused by flooding.
- Develop better investment strategies to prepare for, respond to, recover from and mitigate against flood hazards.

Approach

The Flood Apex Program will deliver these objectives by:

- Building on existing programs and efforts at the federal, state and community levels;
- Operationalizing new methods and technologies; and
- Empowering communities with the right data and decision support tools to enable pre- and post-event flood resilience planning.

National Flood Decision Support Toolbox

The effort will culminate in a National Flood Decision Support Toolbox ("the Toolbox"), which will contain a suite of knowledge products, data sources, models and visualization tools to support decision-making before, during and after flood events.



Charter Goals

The Flood Apex Program will create a decision support system-of-systems for community risk assessment and resilience planning to save lives, reduce property losses and enhance community resilience to disruptive events.

- **Goal 1:** Leverage existing data sources to create multi-domain representations of critical community functions using an integrated, systems-of-systems approach.
- **Goal 2:** Enhance collaboration and coordination around disaster risk reduction.
- **Goal 3:** Identify indicators of community resilience and opportunities to introduce advanced technologies.
- **Goal 4:** Empower communities with a decision support tool to enable both pre-event, scenario-based risk planning and adaptive recovery in the post-event environment.
- **Goal 5:** Enable faster decision-making and more efficient mutual aid in the operational theater for warnings and evacuations.

Five Flood Apex Research Tracks

Work under the program follows five activity tracks, each of which will contribute products and decision tools to the Toolbox over the four year life of the program (2016 – 2020).

Reduce Flood Fatalities

- Automated, geo-targeted alerts and warnings integrated with the National Weather Service (NWS) "Turn Around, Don't Drown" (TADD) campaign.

Reduce Uninsured Losses

- New tools and outreach efforts to encourage uptake of flood insurance.

Improve Mitigation Investment Decisions

- New decision tools to maximize the benefit of mitigation investments.

Enhance Community Resilience

- Standard operating procedures (SOPs), outreach and decision tools to integrate resilience as a core concept in flood risk management planning.

Improved Management of Flood Support Data

- Integration of data, models and decision tools into the Toolbox.

Research Track 1: Flood Fatalities

The Problem

According to the National Weather Service, more than 80 flood fatalities occur annually, based on a 30-year average. Most flood fatalities result from people driving their vehicles into floods or wading in flooded areas. Most of these deaths are preventable through a combination of earlier and better warnings, and outreach campaigns to make the public more aware of the full risk of floods. Further, catastrophic events can cause hundreds of deaths in a single event.

Desired Outcomes

- Reduce flood fatalities by 10 percent per year.
- Improve alerts and warnings through earlier warning times, more details and locational targeting.

Enhance public awareness through more effective outreach programs.



R&D Goals

- Develop and test an integrated flood warning system incorporating inexpensive, deployable flood sensors; information integration and modeling software; and an automated smartphone-based, geo-targeted alert system.
- Integrate this new capability, to the extent possible, into the existing FEMA Integrated Public Alert and Warning System (IPAWS) (non-smartphone) alert system.
- Develop improvements to the existing NWS TADD program to significantly improve public appreciation of flood risk.

Toolbox Contributions

- An architecture design for the automated alert system.
- Low cost Internet-of-Things (IoT) flood sensor technology.
- Standards for flood sensor data sharing within and between regions.
- Flood tool for geo-targeted flood warnings, including use of third-party technology and path forward for IPAWS integration.
- Guidance on ancillary requirements for local geo-targeted alerts, including flash-flood prediction models and supporting data requirements.

STUDY QUESTIONS

- Can deployable, low-cost flood sensors deliver accurate and reliable information to support an automated alert system?
- Can low-cost monitoring devices be deployed to help dam and levee managers reduce fatalities and prevent catastrophic failures?
- Can existing digital networks be used to provide geo-targeted alerts?
- How can rich media (e.g., video, photo) evidence be used in addition to sensor data to enhance responder situational awareness?
- Will residents trust automated alerts over communications from community leaders?
- What are the potential liabilities if automated alerts fail to work properly (e.g., produce false positives or false negatives)?
- What are the opportunities to enhance the existing NWS TADD program and alerts to appreciably change the public's appreciation of flood risk?

PROJECTS & PILOTS

- Small Business Innovation Research (SBIR) Awardees Evigia / AECOM, Progeny and Physical Optics: Develop low-cost flood sensors to be tested with Lower Colorado River Authority (LCRA) and other stakeholders.
- Ping4: Develop alert software for LCRA to test geo-targeted flood alerts.
- LCRA: Provide a test-bed for Ping4 and SBIR concept and technology evaluations.
- National Alliance for Public Safety GIS Foundation (NAPSG): Assist in coordination with the first responder community.
- G&HI: Facilitate the *National Flood Conversation* forum to discuss individual decision making and concepts to reduce flood fatalities.
- Geocent: Document conceptual and logical information technology architecture required to include as a knowledge product in the flood Toolbox.

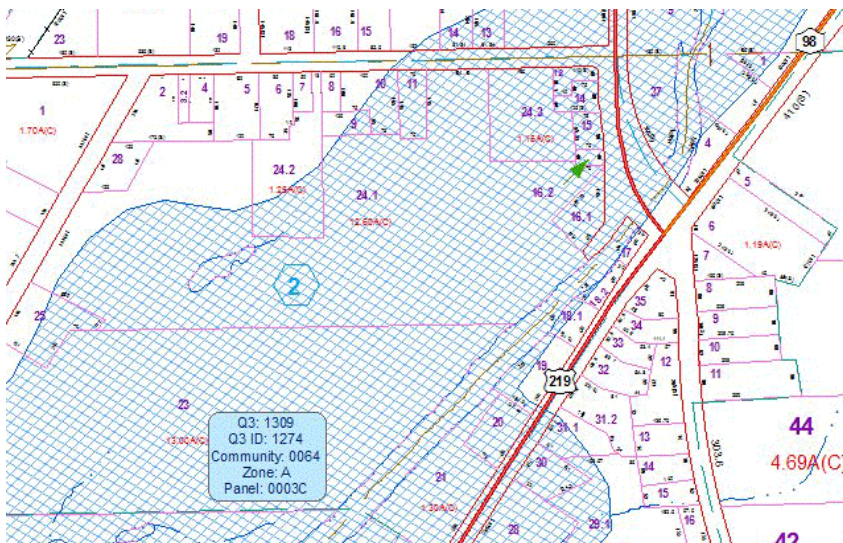
Research Track 2: Reducing Uninsured Losses

The Problem

FEMA estimates more than 50 percent of property owners in areas with significant flood risk may be uninsured or underinsured against flooding. FEMA, property owners and other stakeholders need improved capabilities to understand flood risks, make flood insurance purchase decisions and take other actions to mitigate risk. To help reduce uninsured losses, additional insights into consumer perceptions of flood risk, their motivations to buy or not buy insurance and methods to encourage wider insurance coverage are needed.

Desired Outcomes

- Decrease uninsured losses by 10 percent: an average of 8,300 claims per year or an estimated \$350 million in annual insurance payouts.



R&D Goals

- Assess technologies and practicality of developing a national inventory of structures database for flood-prone areas, especially identified FEMA Special Flood Hazard Areas; including type of structure, elevation and other relevant data.
- Develop concepts to maintain such a data set and provide access to stakeholders.
- Better understand the social patterns and human behavior associated with flood risk.
- Foster private market tools to help consumers understand their risk.

Toolbox Contributions

- Definition of data types needed to support property owners, insurance agents, banking regulators and renters in determining flood hazards.
- Conceptual architecture for access to required data.
- Conceptual design for decision support tools to allow stakeholders to identify flood prone areas and make flood purchase decisions.
- Identify and inventory existing public and private tools that can help consumers understand their risk, including real estate marketing tools, sea level rise calculators and insurance products.

STUDY QUESTIONS

- What is the current status of flood insurance coverage?
- Why do property owners and renters not buy and hold flood insurance, especially when it is a mandatory requirement of a mortgage?
- How can developers, real estate companies and lenders contribute to decreasing flood risk and promoting insurance?
- Is it feasible to develop a national structure inventory — probably on a federated, distributed basis — that can provide adequate flood hazard and structure status information to stakeholders?
- How can FEMA better foster and promote products made by other public and private sources?

PROJECTS & PILOTS

- G&HI: Facilitate the *National Flood Conversation* to better understand owner and renter motivations in buying flood insurance.
- Commonwealth of Virginia: Pilot studies and research on uninsured losses.
- Research Review Board (RRB): Provide insights and recommendations from academic literature and other research.
- MITRE: Identify research considerations for federated access to building footprints, tax assessor and insurance data for the Data Road Map and Structures Database.
- Geocent: Develop conceptual and logical architecture for access to key data and concepts for stakeholder query interface / SOP.

Research Track 3: Improving Mitigation Investment Decisions

The Problem

Over the last 30 years, property damages from flooding have averaged \$7.9 billion annually. To reduce these losses, communities need to fully understand their flood hazards and better tools to support investment decisions to reduce the costs of future flooding, including how to most effectively apply both pre- and post- disaster mitigation grant funds. Better analytical tools are also needed to assess the inter-relationships of built systems with social, economic and natural systems.

Desired Outcomes

- More cost-effective investment decisions improving both residential property, business continuity and public/private infrastructure resilience.
- One percent reduction per year in property loss (saving \$80 million annually).



R&D Goals

- Evaluate Kentucky's Community Hazard Assessment and Mitigation Planning System (CHAMPS) to support mitigation investment decision making.
- Evaluate the potential to use low cost historical satellite imagery to identify flood prone areas outside of those mapped to date by FEMA.
- Provide decision support tools to help communities and other stakeholders maximize use of mitigation resources and effectively assess alternatives to minimize flood risk.
- Effectively recover and mitigate to prepare communities for future risks associated with urbanization, aging infrastructure and climate change.

Toolbox Contributions

- Pilot implementation of CHAMPS, with possible linkages to FEMA's Threat and Hazard Identification and Risk Assessment tool, as a Toolbox capability.
- Identification of key data types needed to support PDM decisions.
- Conceptual architecture for access to data to support resiliency recommendations and possible roadmap for integration of CHAMPS with SUMMIT as core aspects of the flood Toolbox.

STUDY QUESTIONS

- Can better tools be developed for communities to make more effective decisions when spending pre- and post-disaster funds?
- Is CHAMPS a practical model for improving pre- and post-disaster investment decisions?
- Can historical satellite imagery provide a rapid, inexpensive means to identify areas prone to flooding outside of areas mapped by FEMA?
- How can communities plan for and evaluate the interdependencies of critical social, built and natural systems for improved resilience?
- What assessment methodologies will help communities prepare for future flood risk?

PROJECTS & PILOTS

- CUSEC: Evaluate the use of CHAMPS for disaster mitigation grants decision support, including pilot testing and scalability assessment.
- MDA Corp: Develop low-cost technology to rapidly identify areas prone to flooding nationwide, including areas outside FEMA mapped hazard areas.
- Geocent: Provide architectural concepts for the inclusion of disaster mitigation decision support tools as part of the flood Toolbox.

Research Track 4: Enhancing Community Resilience

The Problem

As defined by DHS, the term “resilience” refers to the ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies. Whether it is resilience towards acts of terrorism, cyber-attacks, pandemics or catastrophic natural disasters, our national preparedness is the shared responsibility of all levels of government, the private and nonprofit sectors, and individual citizens. The challenge the Flood Apex will address is how to integrate resilience as a concept into flood risk management planning and investment decisions at all levels of government, especially the local community level, including the use of quantitative measures, if practical.

Desired Outcomes

- Faster and more complete recovery from flood disasters.
- Less community reliance on external resources, especially federal funding.



R&D Goals

- Identify quantitative indicators of resilience that have practical use in guiding and mitigation investment decisions.
- Develop standard operating procedures, planning methodologies and quantitative methods to integrate resilience analysis into local and state flood planning, response and mitigation activities.

Toolbox Contributions

- Identification of the most appropriate national level data sources for key resilience indicators, starting with those identified by the Mitigation Framework Leadership Group.
- Identification or development of resilience models and visualization tools of practical value to agencies.
- Guidance to state/local governments for developing resiliency data and practical solutions for which adequate national sources are not available.

STUDY QUESTIONS

- What academic models of resilience and resilience indicators have practical value at the local level?
- Can selected pilot studies based on individual community experiences in resiliency planning have general relevance to other communities?
- Is it possible to identify a small number of resilience indicators (a dozen or fewer) that have practical predictive value in planning for, responding to or recovering after a flood?
- What modeling, analytic or visualization tools might be useful to analyze resilience issues for a typical community (i.e., that are simple, inexpensive, reliable and quick to apply without outside assistance)?
- Can we make best practices accessible through NFDST that offer viable engineering resilience solutions and alternatives for community flood resilience?
- What SOPs or informal approaches are available to integrate resilience thinking into day-to-day agency activities?

PROJECTS & PILOTS

- MITRE: Compile an index of resiliency indicators, including for Community Rating System communities that can be tested in community pilot studies.
- RAND (RRB): Conduct a landscape survey of resiliency indicators used by public and private entities in the U.S. and internationally.
- Talus Corp: Conduct gap analysis of resiliency models and indicators that could support resiliency implementation based on work by the FEMA Modeling and Data Working Group.
- Commonwealth of Virginia: Resiliency indicators and dashboard development.
- National Academy of Sciences: Collaboration through the National Resiliency Roundtable on community pilot projects.

Research Track 5: Improving Flood Data Quality and Access

The Problem

Decision makers often lack timely access to the most critical data and information. Overwhelmed by volumes of data and data sources, they need tools to streamline the best resources and make them usable.

There is much information needed to accurately assess flood risk, including hydrodynamic data, precipitation and storm forecasting, flood policy implementation and enforcement. Flood Apex will focus on two types of data particularly critical to flood resiliency and decision support: accurate elevation data and structure foot prints. Both of these data sets are technically difficult and expensive to create, maintain and share.

Desired Outcomes

- Decision makers have access to the data and information they need, when they need it.
- Required data and information are available, reliable and can be transformed in real time for use in models and other decision support tools.



R&D Goals

- Develop a roadmap of flood decision data for all data categories — including geophysical, infrastructure, economic/insurance, vulnerability/resilience, hazard/risk and demographics — that identifies the best, most current and accurate national data sources.
- Develop technologies to create, maintain and share elevation and structure footprint data.
- Where data is not available, develop SOPs and technical methods for filling data gaps.

Toolbox Contributions

- Web services and application programming interfaces to obtain clean data with the correct formats, aggregations and data schema to satisfy the Toolbox information sharing, modeling and visualization applications.
- Data specifications and standards to use in the development of specialized local data sets, such as structure footprints, elevation data, local vulnerability/resilience indicators and detailed socio-economic data.

STUDY QUESTIONS

- What are the best methods to create, maintain and share structure footprint and elevation data?
- What are the key gaps in data identified in the other Flood Apex research tracks: geo-targeted alerts and warnings, insurance coverage, mitigation investment planning and vulnerability/resilience indicators?
- Are adequate sources of data, of high quality and currency, with national coverage available?
- What are the tools, procedures, specifications and standards required to fill data gaps?
- What data manipulation tools, such as aggregation or formatting, are required to support information sharing, analytic models or visualization requirements?
- What other issues of concern pertain to these data sources, such as personally identifiable information or confidential business information (CBI) restrictions, that Toolbox users may need to address? What guidance is necessary to satisfy such restrictions?
- How can private sector information be shared with government partners during flood disasters? What is the optimal ConOps for private sector information sharing with FEMA, state and local governments?

PROJECTS & PILOTS

- Talus, Inc.: Transform the results of the FEMA Modeling and Data Work Group flood project.
- NAPSG: Identify local first responder data needs.
- AECOM: Adapt FEMA data to support enhanced flood warnings, situational awareness and multi-frequency flood boundaries.
- FEMA Geospatial Office: Develop enhanced decision support capabilities for the NRCC.
- FEMA FIMA: Develop Natural Hazards Vulnerability Indices and a Tsunami module for HAZUS.
- MITRE: Develop data road map.
- Geocent: Assist in SUMMIT and vUSA assessment as a starting architecture and policy framework.
- MIT Lincoln Laboratory: Complete the HURREVAC-eXtended (HV-X) hurricane evacuation program and integrate it with SUMMIT.
- MIT Lincoln Laboratory: Transition advanced Light Detection and Ranging (LIDAR) collection and data processing technology to the private sector.
- National Institute for Hometown Security: Prototype SABER, the Single Automated Business Exchange for Reporting, for business / industry / private sector status sharing with government during disasters.

Partnerships (Evolving)

FEMA

- Sponsors the Flood Apex

National Weather Service

- National Water Model and National Water Center (NWC) initiative
- Partnership to reduce flood fatalities and improve flood warnings
- NWC coordination with partners, including the United States Geological Survey, the U.S. Army Corps of Engineers and FEMA

National Academy of Sciences (NAS)

- Collaboration with the Resilient America Roundtable community pilots

Greater New Orleans

- Partnership Intermediary Agreement to perform research on flood resiliency issues

Flood Apex Research Review Board

- Provide recommendations and subject matter expert insights

Association of State Floodplain Managers

- Provide focal point for collaboration with state floodplain managers

National Dam Safety Program

- Collaboration on risk perception and warning systems

National Alliance of Public Safety GIS Professionals

- First responder collaboration on use of spatial analytics to reduce flood fatalities and damages

Central United States Earthquake Consortium

- Decision support analytics and regional information sharing / interoperability

Housing and Urban Development

- Flood Disaster Resilience Grant Programs

Rockefeller Foundation

- Chief resiliency officers

Zurich Insurance

- Resilience indicators and metrics

Commonwealth of Kentucky

- Post Disaster Mitigation grant decision support tools

Commonwealth of Virginia

- Partnership to explore causes and solutions for lack of insurance coverage

National Institute for Hometown Security

- Private sector – government information sharing

Private Sector (ongoing)

- Long Range Broad Agency Announcement / Broad Agency Announcement and Small Business Innovation Research Act Awardees
- Realtors, bankers, insurance companies, builders and renters trade associations
- Technology transition partnerships

Flood Apex Charter Sponsors

Federal Emergency Management Agency

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Flood Apex Research Review Board

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