FRM

Flood Risk Management Newsletter

Simulating Coastal and Inland Flooding

Compo
Sur
Ob
Co

Compound (Model): 21 ft
Surge Only: 18 ft
**Observed: 20.5 ft**

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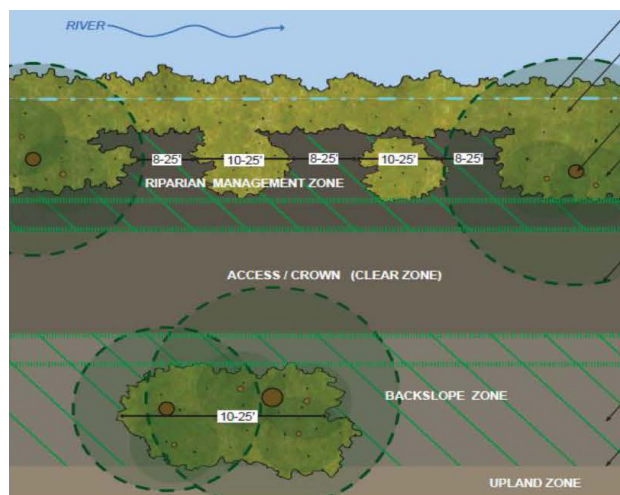
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Flood Risk Management – Expect the Unexpected

By Mark Roupas, Deputy Chief, Office of Homeland Security

As we welcome the fall season, with all of its' associated cooler temperatures, shorter days, beautiful fall foliage, and tropical cyclonic activities, I find myself actively thinking to expect the unexpected. There's a saying in the flood risk management community that "If you've seen one flood, you've seen one flood." As flood risk managers, we acknowledge and understand that each flood event has different characteristics, different causative factors and underlying conditions, and different impacts. We must therefore be flexible and adaptable in order to successfully manage the flood we are experiencing at the time.

In 2019, this was especially true of the flood events experienced across the nation. In the early spring, we experienced extensive and extended flooding along the Missouri River basin. Multiple contributing factors led to unprecedented flooding, including a bomb cyclone event, significant snowmelt, coupled with extended rainfall in the range of 300-500% of the average amount received. And while we have flood risk management systems in place along the Missouri River, much of the rainfall and snowmelt we experienced occurred downstream of our main stem reservoirs. Runoff from the upper Missouri River Basin is second highest in the 121 year record, and is forecasted to be 230 percent of average. This has resulted in keeping the Missouri River above flood stage over most of the lower 600 miles of the river from spring through the summer months.

Similarly, the Mississippi River experienced significant and long-duration flooding. This flood event was also the result of multiple contributing events, including high rainfall over the entire basin, very heavy rainfall over certain parts of the basin at differing times, and snowmelt as well. Over the course of the months-long flood event, the primary floodwater contributions were coming from different parts of the basin (i.e., from the Missouri River versus from the Ohio or Arkansas Rivers). In both the Missouri and Mississippi River flood events, different strategies were needed at different times to address the characteristics of the flood event being experienced.

"In this business, we all know Mother Nature gets the final say, and we can only do our best to understand what is likely to happen so we can act accordingly."

Flexibility and adaptability has also been very necessary in hurricane season so far. Activity began before the official start of hurricane season this year with Subtropical Storm Andrea. This is perhaps no longer unexpected or surprising, given that it's occurred for the past five years. Initial predictions for Hurricane Barry, which hit the Gulf Coast in mid-July, indicated potentially significant impacts in terms of flooding. Fortunately, though there was flooding and damage did occur, the storm was weaker than anticipated and the flood risk management systems in place performed as designed, which resulted in more limited impacts.

A hurricane or tropical storm system over the Labor Day weekend is hardly a surprise to those in the emergency management or flood risk community. This year however, Hurricane Dorian definitely required adaptability as it progressed. The projected track shifted with each day, requiring quick changes to anticipated personnel and resource movements. As the storm moved closer to the continental United States and the predictions began to converge, personnel and resources intended to assist in response efforts were shifted repeatedly as we gained understanding of where the most likely needs would be. Again, the United States was comparatively fortunate in the final track of this storm, especially as compared to early forecasts, but this storm tested our ability to adapt to changing conditions.

As we navigate through the remainder of 2019, including the remainder of this year's hurricane season, I'm sure there will be other reminders of the need for flexibility and adaptability. In this business, we all know Mother Nature gets the final say, and we can only do our best to understand what is likely to happen so we can act accordingly. As always, the Headquarters appreciates all the dedication, effort and hard work that our district and division personnel put into managing these flood events and other emergency events this year. My personal thanks in advance for the additional dedication and hard work I know will be on display through the rest of the year. ⚒

Partnering for a FloodSmart Cairo
By Ken Williams, Memphis District

When Hydraulic Engineer Don Davenport came to the Public Affairs Office seeking help with producing a flood risk awareness brochure for the city of Cairo, Illinois, his timing was perfect. Because at the time, I was looking for an opportunity for our office to engage in more communication planning efforts. Davenport unknowingly walked through the door with a great opportunity to do just that.

Davenport's draft brochure is a risk communication project that resulted from an interagency Silver Jackets emergency action plan completed in 2017. The emergency action plan was sponsored by the Illinois Department of Natural Resources and included key members from the National Weather Service, the Federal Emergency Management Agency, Illinois Emergency Management Agency, Alexander County and the city of Cairo.

Davenport explained that with the brochure he wanted to raise citizens' awareness of the flood risk to Cairo and stress the importance of evacuating if authorities issue an evacuation order. These were important issues emphasized in the 2017 Silver Jackets emergency action plan. I told him that he's expecting too much from a brochure alone; what he really needs is a communication campaign.

I believe every organized endeavor is first and foremost a communication effort. Communication is especially key when you want to influence behavior. And, that is exactly what Davenport was seeking to do—get people to not hesitate, but promptly evacuate when the order is issued. Communication that penetrates needs multiple channels, vehicles, forms and techniques. That's the benefit of a communication campaign.

With his go-ahead, I drafted an initial communication campaign planning
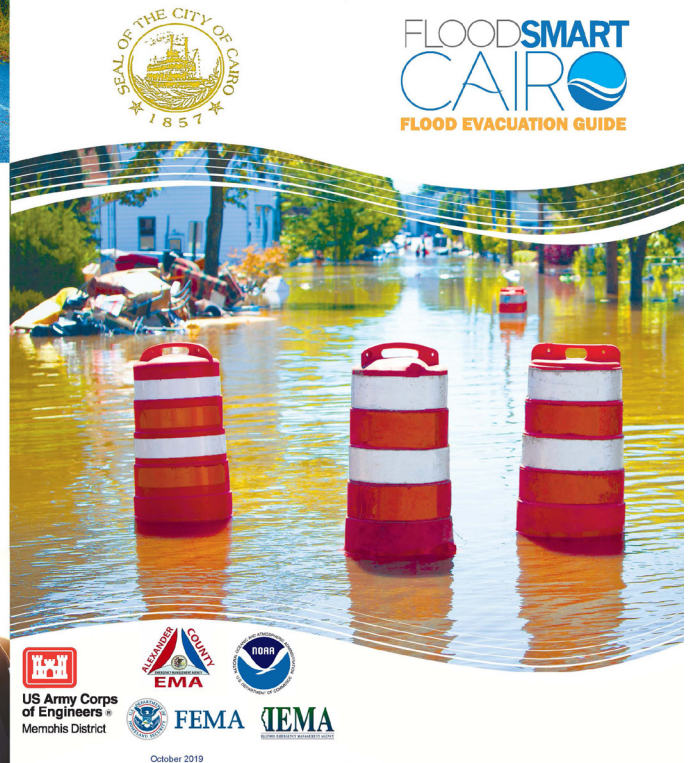

IN THE PHOTO, from left to right, Memphis District's Ken Williams, public affairs specialist; Hydraulic Engineers Don Davenport and Alison Archabal; along with City of Cairo Mayor Tyrone Coleman; John Meyer, City of Cairo Public Works Director and Alexander County Emergency Management; and Vance Harris, Memphis District visual information specialist give the project a thumbs-up.

FloodSmart Cairo Brochure side one. Created by Visual Information Specialist Vance Harris.

document that included the two communication objectives: Increase Cairo residents' awareness of the city's flood risk and stress the need to evacuate if the order is issued. It also identified and described the target audiences, key messages for each audience, themes, and talking points.

The initial planning document also included optional features and a

"communications mix" that includes flood risk awareness week, town hall meeting, local television and radio, print and online newspaper, creative materials like brochure, poster, logo and utility bill insert; website and social media content; and billboard advertising (if funding exists). It also offered ways to measure success. The plan's appendix included a survey of television and radio stations

that serve Cairo, organizational social media pages in Cairo (and number of followers) and billboard advertising prices.

On Nov. 8, 2018, Davenport, Visual Information Specialist Vance Harris, and I traveled to Cairo and had the first meeting with then City of Cairo Mayor Tyrone Coleman and John Meyer, City of Cairo Public Works Director and Alexander County Emergency Management. The purpose of the meeting was to discuss the draft flood risk communication campaign plan.

To ensure our initial target audience personas in the plan were accurate, we first discussed citizens' knowledge and attitudes on flood risk and evacuation. This was an important item to get right because all of the messaging was based on them. We explained to the mayor that this is the city's campaign. It is scalable and designed to meet the city's specific needs—all features are optional.

After a detailed run through of the campaign plan, Mayor Coleman raised a concern about the initial title of the campaign which was "Don't Hesitate, Evacuate!" He knew the audience's temperament and felt the title and message was too alarming for the first campaign. He asked us to shift the emphasis to awareness and education. He felt it would be better to first give citizens the informational resources to develop their own evacuation plans and asked us to reserve the "Don't Hesitate, Evacuate" title for the follow-on campaign.

"We plan to have several subsequent meetings with our Cairo partners to make Cairo Flood Risk Awareness Week a great success. Together, we'll create a FloodSmart Cairo."

IN THE PHOTO, from left to right, Hydraulic Engineer Don Davenport, City Clerk Lorrie Hesselrode, Public Affairs Specialist Ken Williams, and City of Cairo Mayor Thomas Simpson give the project a thumbs-up.

Mayor Coleman requested a follow-up meeting in Memphis to go over the changes he requested and features he wanted in the campaign.

The follow-up meeting with Mayor Colman and John Meyer took place on Dec. 12 at the Memphis District office. Mayor Coleman decided to execute all features of the campaign except the billboard advertising and he changed the town hall meeting to a community leaders meeting. He selected Mar. 10 – 16 as Cairo's flood risk awareness week. We proposed "FloodSmart Cairo" as the new title and shifted the messaging to flood risk awareness, evacuation planning, preparedness and execution. He approved the new title and emphasis.

Starting in Feb 2019, the District went into an extended floodfight which included Cairo. The floodfight understandably became the top priority for both the District and the city, so all work on the campaign plan was put on hold.

In April 2019, Cairo held its mayoral election and swore in a new mayor— Mayor Thomas Simpson.

Our first meeting with Mayor Simpson was May 16, only 12 days after he took office. The purpose of the meeting was to introduce ourselves, briefly explain the

campaign, and answer any questions he might have. Our follow-up meeting with the mayor was Sep. 23.

The meeting with Mayor Simpson and City Clerk Lorrie Hesselrode was very productive. We were able to run through the campaign plan and nail-down some specifics like establishing Nov. 17-23 as Cairo Flood Risk Awareness Week and Nov. 19 for the Town Hall Meeting.

Another great thing that came out of the meeting was a tactical thought sparked by Hesselrode and Public Affairs Specialist Jessica Haas. Since Cairo is a small community, using hometown tactics along with media channels to get the word out would be more effective. So, now we're going to reach citizens through local churches and schools as well.

We plan to have several subsequent meetings with our Cairo partners to make Cairo Flood Risk Awareness Week a great success. Together, we'll create a FloodSmart Cairo. ▨

Flood and Coastal Systems R&D: Reservoir Flushing

By Marielys Ramos-Villanueva and Travis Dahl

Figure 1. Portland District's Fall Creek Reservoir is flushed annually as a part of an environmental drawdown.

The U.S. Army Corps of Engineers (USACE) maintains and operates more than 380 reservoirs within the United States. Many reservoirs are experiencing decreased project benefits due to sediment deposition. Sediment trapped in reservoirs threatens their usefulness while also having the potential to cause problems upstream and downstream of the reservoir itself. Flushing is one simple technique for managing sediment in reservoirs that involves opening low-level gates in a dam to allow the water to remove sediment from the reservoir (Figure 1). This sediment management technique could be one of the key practices to reach sustainability on reservoir performance and maintenance.

A review of current literature identified 36 reservoirs around the world that have attempted sediment flushing. At least nine of these reservoirs were capable of maintaining more than 50% of their original capacity through flushing. There are broad screening criteria in the literature that provide an initial assessment of the feasibility of flushing, but they do not guarantee success. Other reservoir and sediment characteristics such as the presence of suitable low-level outlets, sediment grain size, reservoir purpose and geometry are also important factors to consider for the success of reservoir flushing.

Researchers in the Reservoir Flushing Research and Development Work Unit are currently working to develop an updated and more refined screening criterion for applicability of reservoir flushing to reduce sedimentation at individual projects. Improvements in the ability of USACE one-, two- and three-dimensional flow and sediment transport numerical models to simulate reservoir flushes will also be undertaken. The work unit will also document advice for regulators when evaluating reservoir flushing.

"This sediment management technique could be one of the key practices to reach sustainability on reservoir performance and maintenance."

USACE Conducting Research into Comprehensive Framework to Efficiently Simulate Coastal and Inland Flooding

By Gaurav Savant Ph.D., P.E., Chris Massey Ph.D., Chuck Downer, Ph.D., Mark Wahl Ph.D., Ahmad Tavakoly Ph.D., Drew Loney Ph.D.,P.E., Stephen Turnbull, Nawa Pradhan Ph.D. and Brandon Boyd Ph.D., USACE Engineer Research & Development Center, Coastal and Hydraulics Laboratory

Coastal areas all around the world are at an increased risk of flooding due to rising sea level, climate change and associated precipitation changes along with changes in storm frequencies and intensities. This is especially true for the approximately 100 million people living in the coastal zone. Historically, flooding due to storm surges, riverine flows and precipitation were investigated independently; however, recent hurricanes, Sandy, Harvey, Maria, Irma, Florence and Dorian have shown that storm surges, when combined with precipitation and riverine flows, can significantly exacerbate inland flooding.

A situation where multiple events interact and their combined influence is greater than the influence of a single event is called a compound flooding event. A compound flooding event is defined as *(1) two or more extreme events occurring simultaneously or successively, (2) combinations of extreme events with underlying conditions that amplify the impact of the events, or (3) combinations of events that are not themselves extremes but lead to an extreme event or impact when combined* (Seneviratne et al., 2012).

Accurate and efficient estimation of flood inundation extents and timings due to compound flood events require a robust framework of linked atmospheric models, coastal surge and waves, estuarine circulation, river hydraulics, and overland hydrology models. The US Army Engineer Research and Development Center (ERDC), in conjunction with the US Geological Survey and the National Oceanic and Atmospheric Agency, is conducting research into various coupling
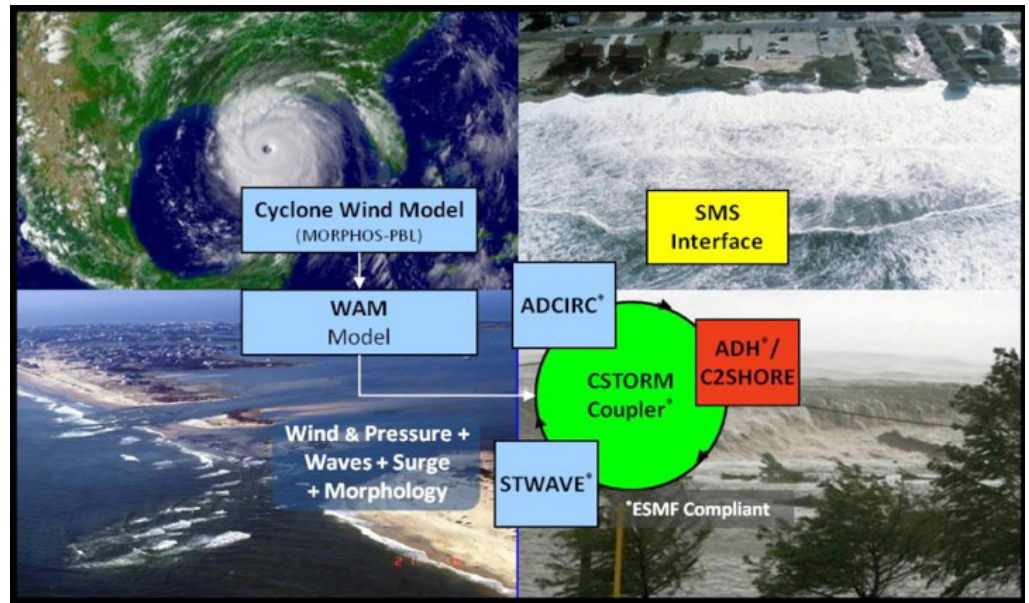

Figure 1: Schematic of the CSTORM-MS workflow for combined storm surge, waves, and riverine and overland flow simulations.

mechanisms for these models. Current techniques for this coupling fall under one of four types: One-Way, Loosely-Coupled, Tightly-Coupled, and Fully-Coupled. One-Way coupling involves passing information from one model to the next, but providing no feedback between them. Loosely-coupled models run sequentially and pass information, often via file input/output, after a user-specified time interval. Tightly-coupled models have the underlying numerical codes of two or more models linked through computer memory and solve the models independently, but using dynamic two-way information exchange during the solution process of each to allow for feedback. Fully-coupled models involve solving multiple equation sets inside the same model. ERDC is involved in research in each of these coupling techniques but the greatest progress has been made in the field of tightly- and fully-coupled models.

The USACE ERDC Earth System Modeling Framework (ESMF) compliant CSTORM modeling system (CSTORM-MS; Massey et al., 2011) has been operational since 2011 and found to provide robust linkages to all USACE open source software such as ADCIRC, AdH, GSSHA, STWAVE, and Wavewatch3 (Figure 1). CSTORM-MS, considered a tightly-coupled method, has been applied to the simulation of hurricane surge, wind wave generation and riverine hydraulics for a variety of storms and locations and served as the modeling backbone of the North Atlantic Coast Comprehensive Study (NACCS), Coastal Texas Comprehensive Study (CTXCS) and the South Atlantic Coastal Study (SACS) efforts. The fully-coupled technique for compound flooding has been demonstrated using the capabilities inherent to the AdH modeling system.
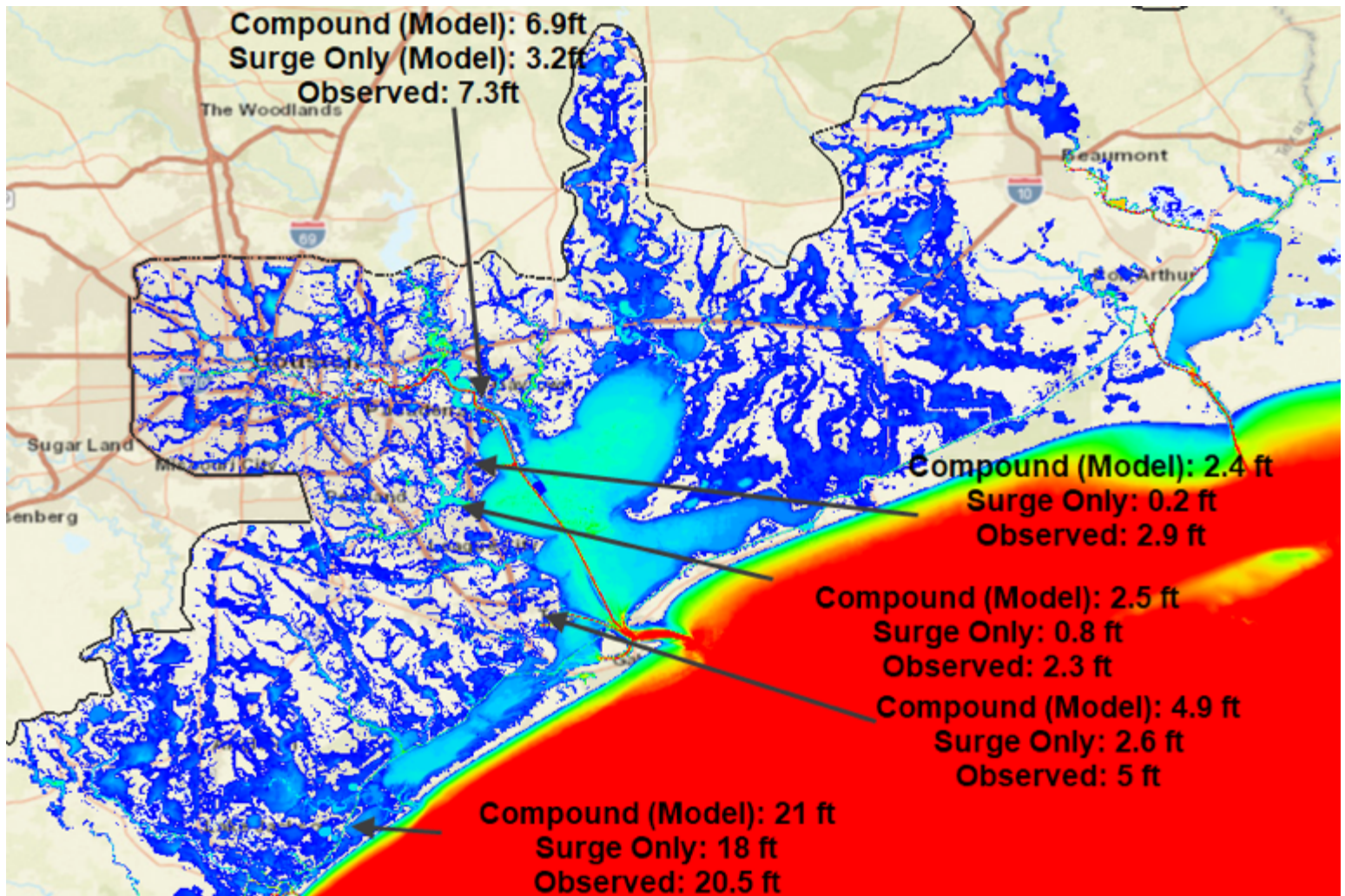
Figure 2: Simulations Vs. Observation from Texas Coastal Ocean Observation Network (TCOON)

Systems of equations involving the spherical surge, riverine hydraulics, and overland diffusive wave within the capabilities of AdH were unified in a single system of equations to simulate inundation observed during Hurricane Harvey. Results from this fully-coupled effort are extremely encouraging (Figure 2) and indicate that fully-coupled compound flooding simulations are not only possible but are more accurate than one-way and loosely-coupled simulations. ▰

Massey, T.C., Wamsley, T.V., and Cialone M.A. (2011). "Coastal Storm Modeling-System Integration." *Solutions to Coastal Disasters, American Society of Civil Engineers Conference Proceeding*, pp: 99-108.

Seneviratne, S.I., N. Nicholls, D. Easterling, C.M. Goodess, S. Kanae, J. Kossin, Y. Luo, J. Marengo, K. McInnes, M. Rahimi, M. Reichstein, A. Sorteberg, C. Vera, and X. Zhang, 2012: Changes in climate extremes and their impacts on the natural physical environment. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. *A Special Report of Working Groups I and II* of the *Intergovernmental Panel on Climate Change (IPCC)*. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 109-230.
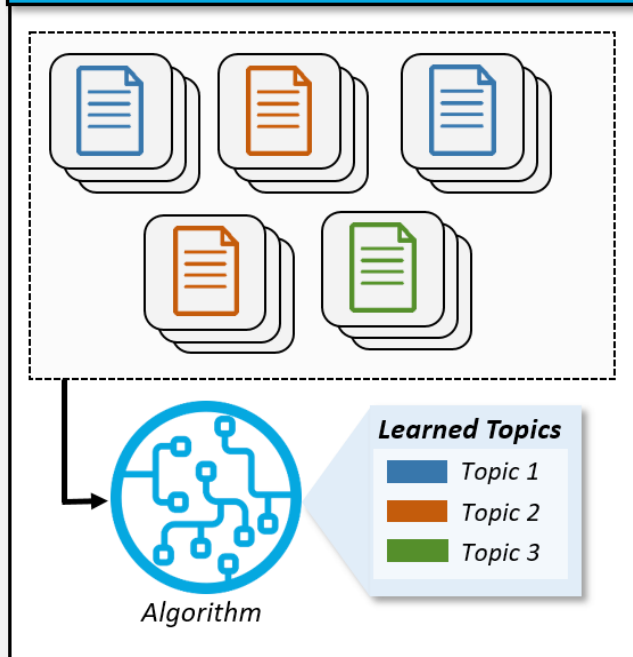
How Do I Find the Best Partners For My Resilience Needs?

By Aaron Sant-Miller and Kate White

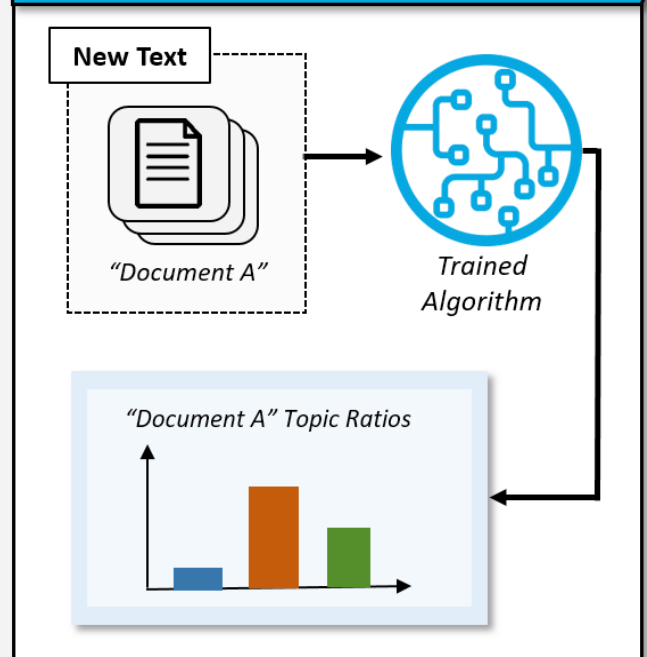## Machine Learning – Natural Language Processing Explained

STEP 1

Provide machine learning algorithm with text data from which it will learn valuable topics and themes

Learned Topics
- Topic 1
- Topic 2
- Topic 3

Algorithm

STEP 2

Feed new text data into algorithm and it can detect which topics and themes are discussed

New Text

"Document A"

Trained Algorithm

"Document A" Topic Ratios

Overview: Training a natural language processing model and applying it to new text

The missions and operations of many government agencies are affected by evolving conditions, from changes in stakeholder needs to natural disasters that present new challenges. As these changes and their impacts become more pronounced, organizations must develop practical, tailored, and justifiable adaptation measures that will reduce risks and improve resilience. For most, these are rarely challenges to be tackled alone. But there is a bewildering array of agencies, and no complete mapping exists to help guide agencies or their stakeholders to identify the best agencies with which to collaborate. This challenge is exacerbated a lack of familiarity with each candidate agency and their programs, especially during disaster preparedness and recovery.

The Resilience Opportunity Identification (ROI) Tool aims to address this issue by helping organizations answer the question: with which agencies should I partner to solve my particular problem?

How it works

The ROI tool uses machine learning to learn the core themes integral to each Federal agency. Here, we use the agency Strategic Plans, which are approved by the Office of Management and Budget and periodically updated at their request. The natural language processing model evaluates word usage in each agency's Strategic Plan and links words to learned thematic concepts, identifying the core topics aligned to each agency. Once these topics are learned, the trained algorithm can be applied to new text – namely the needs statements or other descriptions prepared by a community or organization seeking a Federal collaborative partner – identifying which topics are discussed in that text.

The ROI Tool then uses statistical measures to score the similarity between the new text's topic breakdown and the topic breakdown of each individual Federal agency, returning a score between zero and one for each Federal agency (where a score of one implies a near perfect match thematically to a particular agency and a score of zero implies there is little in common).

Heatmap of Topic Similarity
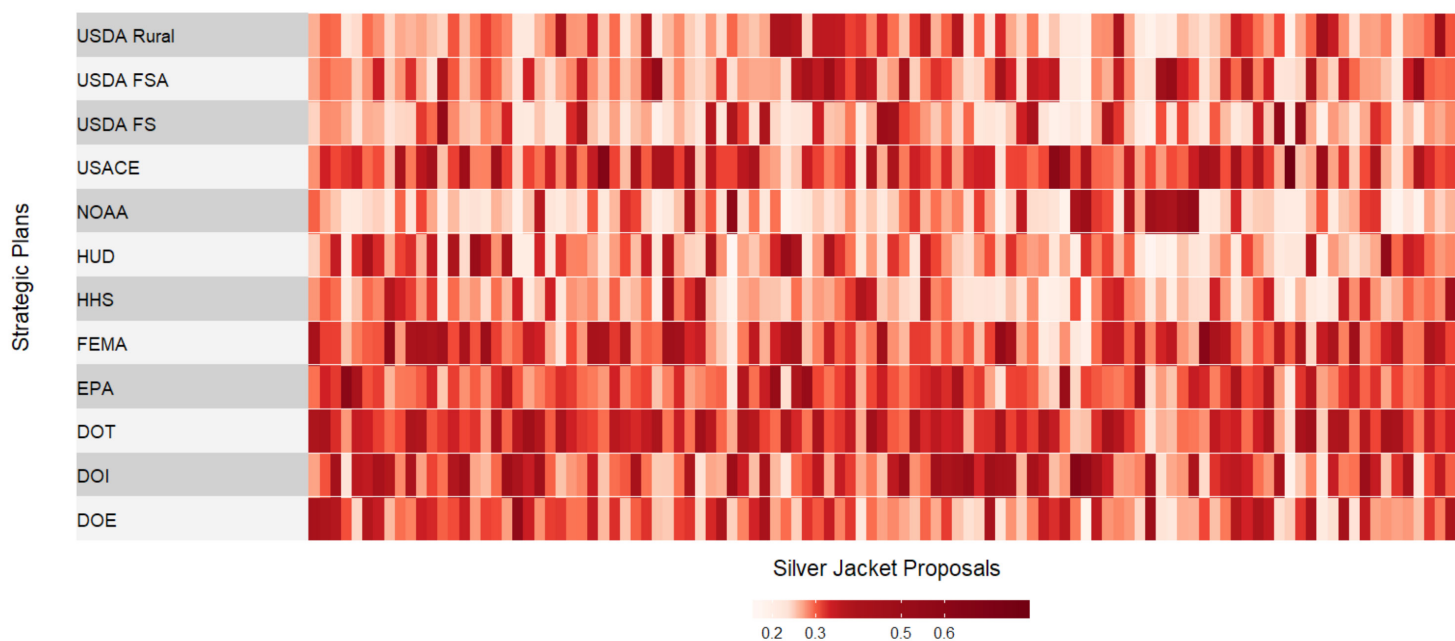
Heat map of agency topic similarity scores for the interagency nonstructural proposals

In practice, these findings can be used to help inform flood risk management in several ways. Generally, the ROI Tool can identify the optimal collaborative partner(s), as it outputs a rank-ordering of candidate agencies (based on their mission's similarity to the organization's need). These rankings may produce surprise matches that prompt the consideration of non-traditional mission partners. If there was a particular Federal program in mind, the findings can either reinforce that assumption or help refine the assumption to produce a more optimal partnership.

Applying the ROI Tool to the FY20 Interagency Nonstructural Proposals

This summer, we applied the ROI Tool to the text contained in all of the FY20 FPMS Interagency Nonstructural Flood Risk Management Proposals, with the objective to: (1) provide valuable feedback to applicants, and (2) evaluate the generalizability of the tool's underlying method. Each proposal had multiple text fields, but the two most important fields – the field describing the project proposal and the field providing

more detail – were used together as a text representation of that project's objectives. The ROI algorithm was applied to each proposal in turn, returning a rank-ordered list of candidate agencies for each. As a final output, each proposal applicant was provided with a custom report of their ROI Tool scores, with the objective of helping these applicants identify the optimal partner to drive their objectives forward following the assessment.

"These rankings may produce surprise matches that prompt the consideration of non-traditional mission partners."

We aggregated the proposal evaluations into a heat map with the proposals shown in columns and the agencies in rows. Boxes in red represent stronger matches in the heat map of the proposal scores shown below. Overall, the spread of high scores across all agencies shows that neither the proposals, nor the

ROI method, were biased toward any particular agency, though the natural weighting toward expected candidate agencies helps validate the accuracy of the method. It is also worth noting that some proposals received their strongest similarity scores with agencies that less frequently received high scores (e.g., NOAA). This reinforces assumption that every proposal is unique and has its own distinctive set of requirements and objectives.

What's ahead?

Over the next few months, the development team is focusing on testing and validating the tool for public, production access. This involves testing the generalizability of the method and the experience of the tool itself. If you would like to participate in the beta testing of the ROI tool, or learn more about the tool and its uses, please contact the authors (Kathleen White, USACE Climate Preparedness and Resilience CoP lead, HQ (Kathleen.D.White@usace.army.mil) and Aaron Sant-Miller, Senior Lead Data Scientist, Booz Allen Hamilton (Aaron.M.Sant-Miller@usace.army.mil)).

Pierce County Washington SWIF - Vegetation Management Strategy

By Robert Wenman, Pierce County Planning and Public Works, and Charles Ifft, P.E., Seattle District

Pierce County located in Washington State is the local sponsor of 28 levee segments in the PL 84-99 program totaling more than 39 miles. Since 1990, the program has provided more than $20 million of assistance by the USACE to rehabilitate damaged levees due to high flow and flood events.

In 2011, the USACE established a System Wide Improvement Framework (SWIF) policy allowing participating levee sponsors to address maintenance deficiencies identified through the PL84-99 Continuing Eligibility Inspection (CEI) program to remain in the program while correcting the identified issues in a risk informed approach. Excessive unwanted levee vegetation has been a typical deficiency identified during inspections for Pierce County, due to local interest to retain riparian vegetation along the salmon bearing Puyallup River system. It was soon apparent that the conflict between USACE levee vegetation maintenance standards and Pierce County's need to retain levee vegetation for habitat would be a major obstacle for compliance.

In 2014, the USACE issued an interim policy for determining continued eligibility for levees enrolled in the Corps PL 84-99 program. This policy recognizes the complexity of balancing the competing mandates of maintaining a vegetated riparian corridor that is both beneficial to fish habitat and consistent with USACE levee vegetation maintenance standards. The interim policy further clarifies that vegetation will no longer be a direct determinant for eligibility under the PL84-99 program. Levee systems will continue to be inspected under the full Continuing Eligibility Inspection (CEI) 15 inspection criteria that includes vegetation, but eligibility will only be

Trees can topple damaging levee bank

based on a subset of those items.

Although vegetation is no longer one of the items by which the USACE determines levee eligibility under the PL84-99 program, the control of vegetation remains important to levee operations and function. Unwanted vegetation can impede access by inspectors, obscure serious defects and can adversely affect levee structural integrity by uprooting and redirecting flows, potentially resulting in levee failure.

In the development of the SWIF, Pierce County identified levee vegetation management as a key issue to be resolved. The Puyallup River system supports a variety of salmonids including three species listed as threatened under the ESA. Riparian habitat identified as important to the survival of these species is found along the levee system. Along many levee segments, the vegetation growing upon the levee represents the extent of the vegetated riparian corridor. These rivers are also part of the "Usual and Accustomed"

gathering areas of three local tribes and are managed as a shared resource. A portion of the lower Puyallup River levee system falls within the Puyallup Tribe of Indians reservation boundary, necessitating close coordination of levee vegetation management works within the area of tribal settlement. In 1988 Pierce County had entered into a formal court-adjudicated agreement with the tribe over land claims, that also reflected agreement on how vegetation management upon the levees was to be conducted.

Before the interim guidance was published in 2014, Pierce County had made the choice to pursue a vegetation variance as part of their SWIF under the USACE PGL process, but ultimately decided to create their own maintenance standard as part of the SWIF and not obtain a formal variance. The SWIF vegetation maintenance plan was developed with direct stakeholder input that included resource agencies, cities, and the tribes. To help develop a collaborative approach, an outside

facilitator and tribal liaison were brought in to help with the discussions. It soon was apparent that vegetation management would be a major component of the SWIF plan. Emphasis was placed on receiving feedback from the stakeholders on developing a vegetation management strategy that would prevent further degradation of riparian habitat, allow for USACE inspections and access, and ensure that vegetation growth does not result in unacceptable conditions affecting levee structural integrity and PL84-99 program eligibility.

The Strategy provides basic guidelines to help establish an appropriate balance between maintenance of the levee embankment, level of risk and habitat considerations. The Strategy recognizes the distinctions among various types of levee structure and associated levee vegetation growth, describing five specific levee structure scenarios upon which the strategy is formulated. Each levee structure scenario is divided into management zones with performance standards for each zone that balance concerns of risk, habitat and maintenance. This vegetation management zone guidance is not intended to be prescriptive, but is intended to guide long-term maintenance, risk management and operations and decision-making.

From an operational perspective, levee vegetation is managed to maintain levee accessibility, inspectability, and structural integrity. Levee vegetation is thinned to provide for inspection windows, preserving woody vegetation and larger trees as feasible to provide riparian functions including roughness, cover, shade, wood and nutrient contribution, water quality filtering, and moderation of water temperature. A multi-layered canopy composed of mature trees, overhanging branches and lower understory brush are recognized components of a well-functioning riparian buffer.
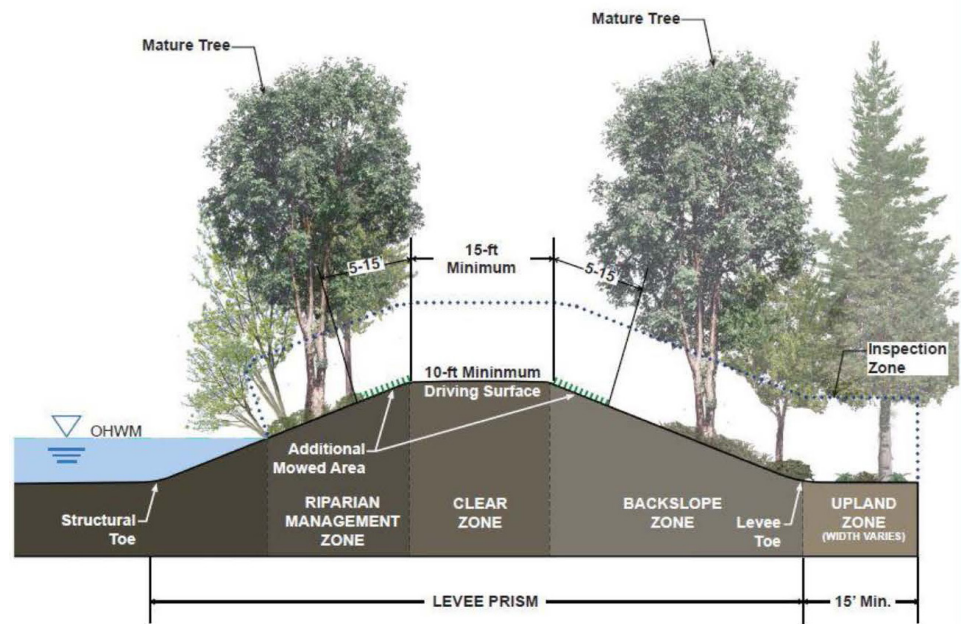
Levee vegetation management cross section schematic
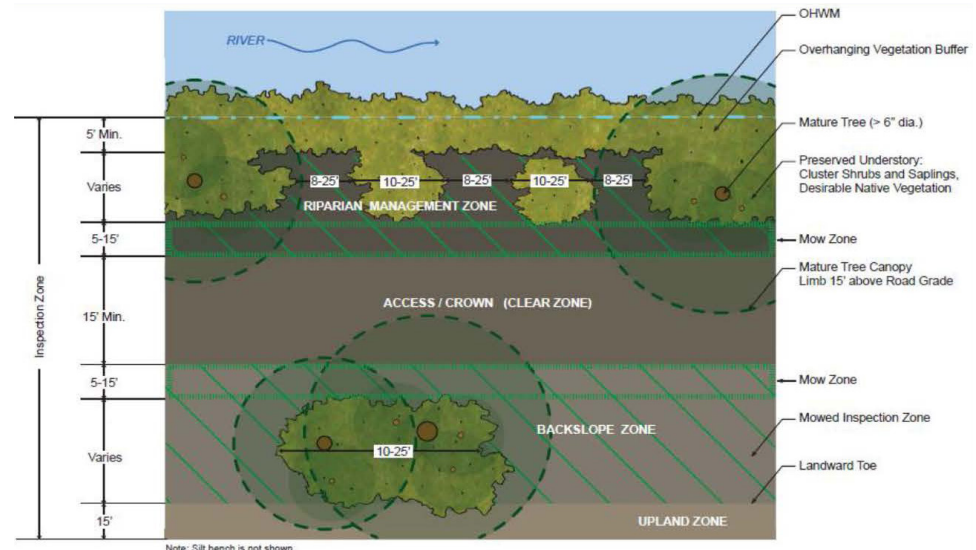
Levee vegetation management plan view schematic

Generally, trees 6 inches in diameter or greater will be retained where possible, unless the tree interferes with minimum inspection standards, accessibility or is considered a hazard tree. Levee vegetation understory within the riparian management zone will be thinned to provide visibility and physical access for inspections, retaining clusters of trees shrubs and saplings (for successional growth) approximately 10 to 25 feet in diameter. A cleared inspection area of approximately 8 to 25 feet will be provided depending on site conditions and character of vegetation. Tree branches within the inspection zone will generally be limbed 8 to 10 feet above

grade for visual and physical access. Limbing is also extended 5 to 15 feet on either side of the levee clear zone (levee crest) for visual access, visual inspection, and maintenance efficiency (referred to the "mow zone").

Pierce County's SWIF has now been accepted by HQUSACE, and implementation of the Levee Vegetation Strategy is now underway. Specific protocols have been developed to ensure consistency in the application of the standards.

Other Important Information

Events

This listing is for information only and is not a complete list of FRM-related meetings. These meetings are not endorsed by the Corps of Engineers unless specifically stated. If we have failed to list a conference/meeting/symposium that would be of interest to the Flood Risk Management community, please forward the conference details to us.

3-7 November 2019 – **2019 AWRA Annual Water Resources Conference** – Salt Lake City, UT – https://www.awra.org/

12-16 January 2020 – **100th American Meteorological Society Annual Meeting** – Boston, MA – https://annual.ametsoc.org/index.cfm/2020/

23-26 March 2020 – **2020 AWRA Spring Conference** – Austin, TX – https://www.awra.org/Members/Events_and_Networking/Events/Spring_2020_Specialty_Conference.aspx

6-9 April 2020 – **2020 National Hurricane Conference** – Orlando, FL – https://hurricanemeeting.com/

7-11 Jun 2020 – **ASFPM Annual Conference** – Fort Worth, TX – https://www.floods.org/index.asp?menuID=223&firstlevelmenuID=181&siteID=1

17-19 August 2020 – **8th International Conference on Flood Management** – Iowa City, IA – https://icfm2020.org/

Be sure to check out floods.org for the dates of state conferences and training opportunities: http://www.floods.org/n-calendar/calendar.asp?date=3/12/2016

FRM Statements of Need: Submitting "Statement of Need" is the first step in the process of a concept becoming a requirement for research and development. If USACE District personnel have problems or situations they feel should be addressed by research, the Flood Risk Management Gateway, http://operations.usace.army.mil/flood.cfm, is the place to submit these research Statements of Need (SoNs).
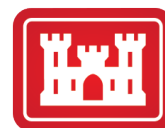
Past issues of this newsletter, various links, news items, and presentations, are all available on the Flood Risk Management Gateway, https://operations.erdc.dren.mil Check it out!

This newsletter is a product for and by the Flood Risk Management Community. The views and opinions expressed in this unofficial publication are not necessarily those of the U.S. Army Corps of Engineers or the Department of the Army.

If you would like to submit an article or an idea for an article for the next edition of the newsletter, or if you have any comments or questions about articles in this edition, please email Stephanie.N.Bray@usace.army.mil.

FRM Flood Risk Management Newsletter

US Army Corps of Engineers