Promoting Community Resilience to Natural Hazards Through Governance, Education, and Technical Assistance

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Background

The Community Disaster Resilience Zones (CDRZ) Act was signed into law in 2022 to reduce the impacts of natural disasters and climate change in at-risk communities across the country. The Act requires the Federal Emergency Management Agency (FEMA) to utilize a national risk assessment, known as the National Risk Index, to identify census tracts most in need of assistance and at risk from the effects of natural hazards. In 2023, FEMA identified the first 483 CDRZs in all 50 states and the District of Columbia. In Florida, 32 CDRZ tracts have been identified. The CDRZ designation is intended to provide geographic focus for financial and technical assistance to communities to plan for and implement resilience projects. CDRZ are eligible for increased federal share under the Building Resilient Infrastructure and Communities program up to 90%, compared to 75%, and receive priority for FEMA's Direct Technical Assistance opportunity. CDRZs in Florida span 15 coastal and inland counties from the Panhandle to central and south Florida. These census tracts span rural and urban areas. Many are located near, or intersect with, critical infrastructure, such as airports, major roadways, and canal infrastructure, providing an opportunity for lower-capacity communities to build resilience to future hazards.

Planning and Process

The Southeast Navigator Network is a one-year pilot effort led by the Geos Institute, a national organization helping communities build climate resilience, to establish "navigators" in four states – Florida, Georgia, South Carolina and North Carolina – who then serve as partners to communities that overlap or lie within a CDRZ-designated census tract. Navigators provide technical assistance and help communities take advantage of funding and capacity building opportunities. In Florida, the Florida Climate Institute convened a team of University of Florida Extension faculty from Sea Grant and the Institute of Food and Agricultural Sciences (IFAS) to serve as navigators and work with CDRZs in their respective regions. Across Florida, Extension agents are embedded in all 67 counties, serve as neutral brokers of research-based information, and are well-known by grassroots and grass top organizations. The project began in October 2023 and this pilot effort will end in October 2024. The navigators in Florida have been working with the Geos Institute as well as regional and national partners including the Resilient Cities Catalyst (RCC), Project IN-CORE, and others to assist communities at different stages of the resilience building process through direct outreach, education, coordination, and collaboration.

Solutions and Results

According to FEMA's National Risk Index, CDRZ tracts represent some of the most vulnerable communities to natural hazards, exhibiting high risk and relatively low capacity to address resilience from a social, cultural, economic, infrastructural, environmental and/or institutional lens. Navigators have been directly engaging with CDRZ communities to better understand their concerns and constraints and identify the best steps forward to address gaps and advance resilience in these highly vulnerable communities. The overall goal of this project is to help as many CDRZ communities as possible advance their resilience efforts by meeting each community where they are and pairing them with appropriate resources and technical expertise to assist them in securing funding for resilience.

Through the outreach and intake process, the team has developed strategies and identified lessons learned in engaging with vulnerable and marginalized communities within their regions. The navigators conducted outreach with their CDRZ communities, provided resources, assessed resilience efforts using national tools and frameworks, and identified ongoing and complementary community efforts. Navigators have collected community intake data, connected with technical service providers, participated in cohort trainings with other states, and contributed to measurement frameworks. Based on work to date, navigators have received varying levels of interest and responsiveness from CDRZ communities. While some communities have been very engaged and interested in receiving additional assistance and support from state and regional collaborations, others have not engaged with the project. Education and information sharing has been crucial from the outset, as most of the CDRZ communities expressed confusion about the CDRZ designation and what it would mean for them moving forward.

CDRZ-designated communities lie across the resilience spectrum, with some communities in the early stages of their resilience planning while other communities have plans and are implementing and evaluating local projects to address flooding and other hazards. Regardless, the CDRZ designation offered community leaders an opportunity to address challenges associated with natural hazards relating to economic loss, increased infrastructure costs, and at-risk and in-need communities. The under-resourced CDRZ tracts may experience lack of capacity (i.e., staff, finances), lack of community proactivity and readiness, and changes in political will. The CDRZ Act supports a range of engagement across public and private sector partners, as well as philanthropic organizations, to enable communities to strengthen resilience outlooks at a local level. We will share insights gained from this work that will be invaluable in other communities and offer important lessons for addressing and supporting under-resourced communities in building resilience to flooding and other hazards at a local level.

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Studying the Influence of Housing Conditions on Hurricane and Flooding Evacuation Intentions in Florida

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Background

Literature regarding risk perception has been growing; however, there is generally a paucity of research on how risk perception is shaped in a disaster context, and there is even less research on how housing conditions influence risk perception in the context of severe weather hazards. The few disaster studies that looked into housing conditions mainly focused on one type of housing, such as mobile homes or manufactured housing, and considered a small range of housing characteristics, mostly represented by housing size, age, and location. To our knowledge, no studies have yet been conducted to explore in-depth the relationship between housing conditions and risk perception, and how that relationship influences hurricane and flooding evacuation decisions. Correspondingly, this study aims to fill this research gap by answering the following question: "How can housing conditions influence people's hurricane and flooding evacuation intentions?" Evacuation planning in Florida is a crucial component of disaster preparedness, especially in light of the frequent hurricanes and flooding that affect the state. The significance of evacuation is highlighted by the fact that every county in Florida faces the potential impact of hurricanes and flooding.

Planning and Process

A quantitative approach was utilized in this study, involving a questionnaire filled by participants in five cities in Florida (Miami, Tallahassee, Jacksonville, Gainesville, and Ocala). The questionnaire was initially constructed based on the review of critical literature. To ensure the questionnaire addresses the study's aim, five professors from the University of Florida and three external scholars from various research backgrounds (human behavior, disaster studies, construction management, and interior design) participated in Subject Matter Expert's Validation and Questionnaire Face Validity. The pretesting was conducted on eleven participants, while the pilot-testing was conducted on 42 participants. To ensure an adequate sample size, a confidence level of 95% and a confidence interval of 5 were taken into consideration in determining the sample size. Using Excel, DataTab, and SPSS software package, different statistical approaches were used to uncover patterns and quantify variables in a way that can quantify behaviors and attitudes. The Cronbach's Alpha (CA) and Split Half Reliability (SHR) tests were used here to check internal consistency for the responses gathered. The study lasted for two years: Literature review (09/2021-12/2021), Survey design (01/2022-08/2022), Data collection (09/2022-11/2022), Data analysis (12/2022-04/2023), Report writing and communicating results to emergency management offices (05/2023-09/2023).

Solutions and Results

Based on the analysis, statistically significant variance in risk perception was only found in two housing characteristics: 1) Required Dwelling Repairs, & 2) Whether the Dwelling is on the Ground Floor or not. Moreover, risk perception had an insignificant impact on evocation intentions based on the logistic and multi-linear regression analysis. However, efficacy, social norms, and sense of responsibility had a significant impact on evocation intentions. The data was collected during the hurricane season, but there wasn't an approaching storm; however, if there was an approaching storm, the risk perception could've had a significant impact on people's intention to prepare for that particular storm. Consequently, if we want to motivate people to prepare for the hurricane season at the beginning of the season and without having any detected storm on the radar, the emergency communication should not significantly highlight the danger that a storm can cause or trigger a sense of danger among people because their risk perception (also called perceived threat perception) doesn't have a significant impact on their intentions to prepare at the point. At the same time, if there is a storm approaching, emergency communication needs to change, and risk perception needs to be considered in the communication. Either way, using the same unified emergency communication for the entire hurricane season will not be as effective because people perceive the same communication differently based on whether or not a storm is approaching.

On the other hand, it might be complicated to define the role of risk perception in adopting disaster protective behaviors as explained before, but self-efficacy and response efficacy seem to have a significant impact on people's intentions to take any disaster-related behavior in any context, and that is why our emergency communication should always fully cover these components by clearly explaining how to prepare and how preparing can make a big difference in case of an actual hurricane. Also, here, generalization of the communication can harm the process; it is true that we always want to trigger and build high efficacy among people, but that could mean different things to different groups, and the message needs to be personalized enough for them to take it seriously. Moreover, the two demographic groups with the highest variance (taking into consideration the combined effect on all behavioral constructs) were Dwelling Location and Role/Occupation. Emergency managers are advised to divide communities into demographic groups and target each group separately through customized emergency communication to improve the response rate for evacuations. This study makes several contributions to social studies and disaster research as the findings allow us to have a better understanding of why people are regularly found unprepared for evocations, and that allows emergency managers to serve their communities as a whole better. Even though this study is specific to the context of hurricanes and flooding intentions in Florida, the findings are still relevant to other communities with similar demographics in other hurricane-prone areas in the US, such as Texas, Alabama, and South Carolina.

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City of Panama City Robinson Bayou Drainage Basin

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Background

In 2018, Hurricane Michael impacted the Florida panhandle and the City of Panama City (City) with winds over 160 miles per hour. Along with the loss of life and property, over a million trees were lost within the City limits.

Planning and Process

As part of the disaster recovery process, the city embraced funding made available by FEMA under the Hazard Mitigation Grant Program (HMGP). While Hurricane Michael was primarily a wind event, the city identified flooding as a major risk historically and with the loss of so many trees, it was expected that flooding would be exacerbated. The Robinson Bayou watershed was identified as a known risk area needing a drainage project funded by HMGP. The city hired Halff Engineering to engage, plan and design this project.

The project entails two major components. First, the Robinson Bayou flood risk reduction project aims to restore and enhance approximately 200 acres of natural wetlands in the upper and middle sections of the watershed to increase floodplain storage and stormwater runoff attenuation while also creating significant habitat for local wildlife including at least one endangered species. Urban wetlands at the upper end of the watershed had been deteriorating for many years and Hurricane Michael decimated these already impaired wetlands by knocking over a sizable portion of the existing wetland tree system. The second part of the project is designed to increase downstream conveyance resulting in a reduction of tailwater conditions and allowing stormwater flows to exit into the receiving waterbody more efficiently thereby reducing flood conditions throughout the watershed.

Solutions and Results

The City utilized nature-based solutions to leverage mitigation grant funding to implement flood risk reduction projects by enhancing the functional activity of urbanized wetlands to increase floodplain storage along with improving the conveyance system of the largest stormwater basin in the City. This project will cost an estimate of $24 million in grant funds

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Three Attitudes Toward Resilience Planning: The Resilient Port St. Joe Project

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Background

Florida's Gulf of Mexico Coast faces significant climate-related risks, including rising sea levels and increasingly severe storms. In 2018, Hurricane Michael, a Category 5 storm, caused catastrophic flooding across the Florida Panhandle, severely affecting Port St. Joe (PSJ). The city faced storm surge between 9 and 11 feet and extensive wind damage. In addition to its coastal location, PSJ faces housing insecurity and social gaps, which renders a significant portion of its population more vulnerable during disasters. The city is expected to grow to 4,300 people by 2050, with an increase of over 15%. While appealing and economically beneficial, this growth demands careful planning to manage infrastructure, housing, and environmental concerns. To address these needs, the city partnered with UF's Florida Institute for Built Environment Resilience (FIBER) on the "Resilient Port St. Joe" project. Although this is a standard procedure by the Florida Department of Environment Resilience (FDEP), it allowed for a community-engaged resiliency planning process through three innovative components: 1) a digital tool to communicate and discuss vulnerability with the community; 2) an adaptation project as a tangible response to a resiliency spatial strategy; and 3) the adaptation overlays as a policy approach to ensure long-term resilience planning.

Planning and Process

Describe the timeline for the project, the process used to plan and develop solutions, the stakeholder groups who were involved. How was the community engaged during the planning and implementation process? How was the multidisciplinary team composed, and how did this influence project outcomes?

The “Resilient Port St. Joe” project focused on 1) conducting a comprehensive vulnerability assessment and 2) developing an adaptation plan. This initiative was built over the course of three years based on previously conducted regional work[1] and targets an exposure and sensitivity analysis to the municipality, ensuring compliance with the Resilient Florida Statute 3380.093. A team of UF FIBER planners, architects, landscape architects, and researchers gathered city data and analyzed it to produce maps, tables, and a publicly accessible online flood-scenario projection tool. A series of public outreach meetings and community projects were carried out so that the vulnerability assessment and adaptation plan would reflect the lived-in experiences of the city’s residents.

Solutions and Results

Describe what solutions were implemented to address the problem. What were the results? You may wish to elaborate on costs, challenges you encountered, and beneficial collaborations. Please share lessons learned—both positive and negative—that may help others address similar challenges in the future. What key advances or innovations are resulting, or are expected, from this project?

Rising flood risks pose a significant challenge for PSJ’s growth. The "Resilient Port St. Joe" project offers a model for addressing this challenge through a collaborative, institutional, and data-driven approach. Funded by the Florida Department of Environmental Protection (FDEP), this initiative aimed to equip the city with the tools and knowledge necessary for sustainable urban planning. The project's core strength lies in its interdisciplinary approach, integrating alternative approaches to three critical elements in the planning resilience process: communication/participation, a tangible response to current needs, and long-term policy strategies to moderate resilient development

[1] Apalachee Regional Planning Council (ARPC), (2023). “Apalachee Regional Vulnerability Assessment,” https://halff.com/project/arpc-nine-county-regional-vulnerability-assessment/

Effective communication is crucial for raising awareness in the community about flood vulnerability and resiliency planning. Our team developed a web platform that visualizes a comprehensive vulnerability assessment detailing flood risk scenarios across the city and suggested adaptation actions. This digital tool transforms the dissemination of first-hand information, enabling residents to explore potential flood conditions at the property level. By providing also accessible and detailed insights into necessary adaptation actions, the platform empowers the community to address and mitigate flood vulnerabilities proactively.

Concerning response, the adaptation project areas employ a design approach that spatially integrates various adaptation actions, creating comprehensive adaptation projects for diverse neighborhoods. This approach not only addresses targeted resiliency needs but also enhances neighborhood spatial qualities, fostering new social and economic dynamics. Focusing on functional resilience and improved neighborhood character, this initiative offers a holistic response to flood challenges, promoting long-term sustainability and community well-being.

The project also emphasizes alternative policy approaches for long-term resiliency planning and land development. Key to this initiative is the proposal to update the Coastal Management Element in Port St. Joe's Comprehensive Plan, offering concrete recommendations to enhance resilience. Complementing this, the team has developed adaptation overlays—distinct regions within the city characterized by unique characteristics that necessitate tailored resilience strategies. These overlays, each with a specific focus—disperse, drain, retain, consolidate, and conserve—provide a nuanced framework to effectively mitigate the impacts of storms and flooding, ensuring a more resilient urban environment.

Finally, expanding community outreach presented a challenge. However, valuable collaborations and the critical participation of several community members mitigated these issues. Engaging the public through events in recognizable local organizations like the garden club fostered a sense of ownership. Additionally, showcasing potential alternatives, as seen in the Porch Project, is highly effective in sparking community buy-in.

The "Resilient Port St. Joe" project offers valuable lessons for urban planners facing similar challenges. An interdisciplinary approach ensures a well-rounded understanding of the issues at hand. However, the project also highlights the importance of solidifying innovative strategies for continuous outreach to sustain community interest in this process in the long term. The "Resilient Port St. Joe" project demonstrates the power of combining data analysis, community engagement, innovative policies, and solutions to build urban resilience. This framework can be replicated in other communities facing climate challenges, paving the way for sustainable growth and a more resilient future.

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Mainstreaming Environment and Equity in Resilient Infrastructure Assessment (MEERIA): An Alternative Valuation Methodology

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Background

Federal policy guidelines and traditional benefit-cost analyses (BCA) that inform US Army Corps of Engineers' (USACE) decision-making for the planning and implementation of risk management projects, fail to address the environmental degradation and social inequities deeply associated with climate change impacts faced by at-risk communities.

Planning and Process

We reviewed the common pitfalls and limitations of the traditional BCA and developed a robust decision-making framework and rubric, the *Mainstreaming Environment and Equity in Resilient Infrastructure Assessments* (MEERIA) based on new and existing transdisciplinary research. We then tested the framework to evaluate three US coastal resilient infrastructure projects.

Solutions and Results

Our study reveals that in most cases, the selection process for resilient infrastructure projects undervalues ecosystem services and equitable outcomes and lacks effective and inclusive public participatory processes. We present the MEERIA Rubric as an easy-to-use tool for project planners, managers, local and federal resilience officers, and engineers involved in coastal and flood resilience projects. The MEERIA Rubric is meant for use in conjunction with traditional BCA or multi-criteria analysis to enable projects to incorporate considerations of procedural and distributional equity and plurality of ecosystem services for the comprehensive evaluation of project benefits and tradeoffs. The MEERIA rubric cultivates a highly informed decision-making process by helping project managers identify their project's strengths and weaknesses, highlighting areas where improvements can be made prior to project implementation.

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Flood Mitigation and Adaptation for a University Campus in Southwest Florida: Multi-Component Runoff Detention via Land Uses and Stormwater Ponds

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Background

Florida Gulf Coast University, established 1998, preserves approximately half its 800-acre campus as open space, consistent with its sustainability mission and teaching-laboratory approach to environmental learning and research. Stormwater detention ponds on campus conform to Florida regulations specifying volume proportional to impervious surface area, intended for water quality mitigation but widely misconstrued as flood protection. Much of the open space is inundated for all or part of each wet season, constituting wetlands typical of southwest Florida's pre-development ecosystems, constituting a substantial surface storage component for stormwater. The campus effectively detains runoff even from extreme events, contributing near-zero discharge from Hurricane Irma (2017; 24-hour precipitation ~25cm) and Hurricane Ian (2022; 24-hour precipitation 20cm) events which caused flooding in downstream residential neighborhoods. The research quantified surface water and groundwater elevation on campus watersheds relative to precipitation, with the objective to characterize contributions to stormwater detention and flood mitigation of three compartments: 12 stormwater detention ponds, typically 2 to 4 meters deep; depressed-surface storage, fluctuating between zero and 0.5m deep across highly variegated surfaces; and soils, including a saturated zone rarely more than 2–3m below surface that intersects the surface to varying extent during most wet seasons.

Planning and Process

Researchers measured surface water elevations on the FGCU campus beginning in 2017 with daily and weekly visual gauges in detention ponds, determined to be expressions of both the shallow water table and the hydraulically adjacent seasonal wetlands. Early results identified three distinct sub-watersheds, discharging through a common channel to the Estero River, a low relief (~5m), short (~25km), tidal stream flowing through suburban residential and commercial zones into Estero Bay at the Gulf of Mexico. The time scale of runoff effects on elevation was documented: for events <2cm, nearly 100% of precipitation entered soils/groundwater with no expression in surface ponds; for larger events, initial elevation change was too rapid to capture with daily observations, and event transport completed within 3 days of precipitation. By spring 2022 observations extended to three groundwater stations (contributed from colleagues' networks) and 12 ponds, 8 with automated gauges at 10-minute intervals. Stakeholders Lee County and Village of Estero seek improved flood-mitigation and pond-management strategies by understanding of hydraulic storage mechanisms and land-use/runoff relationships. Six years of researchers were drawn from The Water School's Senior Research Project courses and volunteers from FGCU's student chapter of American Water Resources Association.

Solutions and Results

Results document differing elevation responses across different precipitation events, denoted as "elevation rise per unit precipitation" or Ri/P. Variation in Ri/P is governed not by seasonality as initially expected, and does not differ but is governed by a hypothesized mechanism identified as Stages 1, 2, and 3 conditions of the runoff detention components as indicated by antecedent elevation of the pond system. When the water table and surface ponds' elevation is low, typical of Southwest Florida's 6- to 8-month dry season, Stage 1 conditions predominate: there is enough excess capacity in the soils and the stormwater ponds to capture all or most runoff. Those conditions are not routine except after months-long dry conditions. During the 4-month wet-weather season, ponds stand at higher elevation – caused by higher water table and groundwater discharges into the ponds, reducing the volume available to receive runoff. On the FGCU campus that produces Stage 2 conditions, where ponds directly feed into adjacent open spaces that can be hydrated as wetlands, activating extensive storage on some 200 acres of land that can accept standing water up to at least 0.5m depth before overflowing into developed land uses. Those conditions explain the campus's success in detaining runoff from moderate and extreme events. Only during Stage 3 – when soils are saturated; ponds are at maximum control elevation, discharging into wetlands; wetlands have filled their depressed capacity – does runoff overflow into drainage pipes and channels and thence into the Estero River, causing the campus discharge to receiving waters and contribute to high flows that could inundate downstream land uses. This did not occur during the extreme, hurricane-level precipitation events of 2017 and 2022. The research continues, with two seasons of precipitation added to the observation record since the partitioning was identified, confirming validity of the hypothesized 3-stage mechanism. Results document, and help educate the local communities, that runoff storage – thus flood mitigation capacity – is minimal in the wet detention ponds but is distributed across multiple components: the ponds; the near-surface dry and vadose soil atop the shallow aquifers of south Florida; and surface storage when the aquifer intersects the surface and hydrates the open space to function as wetlands. The documented success of runoff detention by the FGCU campus is largely attributed to the nearly 400 acres of open space on the 800-acre campus constituting a robust storage component. That amount of storage is not the norm in nearby Southwest Florida, where about 75% of development has occurred since 1990, predominantly single-purpose residential developments with runoff detention mostly relying on ponds and a small riparian fringe.

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Flood Adaptation Through Urban Green Stormwater Infrastructure: The City of Cape Canaveral's "Smart Rain Garden" Project

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Background

Summarize the background of the situation, problem or challenge being addressed. What happened to lead to the situation? Was it the result of a disaster event or a change over time? Where did it occur? Who/what was impacted? What entities were involved in responding to the challenge?

The City of Cape Canaveral is a coastal barrier island community that was rapidly built out during the early development of the U.S. Space Program in the 1950s and 1960s. In recent years, a combination of factors including sea-level rise, increased frequency of extreme rainfall events, high amounts of impervious cover, and antiquated stormwater infrastructure have caused severe and repetitive pluvial flooding episodes in several of Cape Canaveral's residential neighborhoods. A consortium of partners including Stetson University's Institute for Water and Environmental Resilience (IWER), East Central Florida Regional Planning Council (ECFRPC), Florida Sea Grant, and Embry-Riddle Aeronautical University (ERAU) have been working closely with the City of Cape Canaveral officials over the past several years to develop innovative responses and interventions to help address these challenges. Through this process, Cape Canaveral has emerged as a state and regional leader in adoption of urban green stormwater infrastructure principles for municipal flood adaptation and climate resilience, including a holistic commitment to monitoring and research as an integral part of project implementation.

Planning and Process

Describe the timeline for the project, the process used to plan and develop solutions, the stakeholder groups who were involved. How was the community engaged during the planning and implementation process? How was the multidisciplinary team composed, and how did this influence project outcomes?

Beginning in 2018, Cape Canaveral initiated a partnership with ECFRPC to develop a comprehensive assessment of climate vulnerabilities among its infrastructure, residents, and overall economy. In early 2020, Cape Canaveral leveraged the information developed in this vulnerability assessment to develop a broader planning and outreach partnership with IWER, ECFRPC, and Florida Sea Grant, through funding provided by NOAA Sea Grant's Karl Havens Memorial South Atlantic Regional Research Competition. Despite substantial outreach challenges associated with the COVID-19 pandemic, the multidisciplinary team – including ecohydrologists, economists, lawyers, planners, engineers, and extension professionals – held a series of virtual an in-person workshops that engaged residents and elected officials in a process of co-learning about the City's flooding challenges. In mid-2022, the team successfully applied for a Stage 1 National Science Foundation (NSF) CIVIC Innovation Planning Grant, which focused on identifying a specific GSI pilot project for possible implementation in a research context through a much larger NSF CIVIC Stage 2 "Pilot Project" proposal. Two design charrettes resulted in the identification of a site in the City of Cape Canaveral's Veterans Memorial Park to develop a large rain garden as an applied research site for flood mitigation, urban beautification, and water quality improvement.

Solutions and Results

Describe what solutions were implemented to address the problem. What were the results? You may wish to elaborate on costs, challenges you encountered, and beneficial collaborations. Please share lessons learned—both positive and negative—that may help others address similar challenges in the future. What key advances or innovations are resulting, or are expected, from this project?

In mid-2023, the team was informed by NSF that the Stage 2 CIVIC proposal for building and monitoring the Cape Canaveral "Smart Rain Garden" project would be fully funded at $1 million over a 12-month project implementation period to run from October 1, 2024 – September 30, 2025. Construction of the rain garden began in December 2023 and was completed in April 2024, generally ahead of the original project timeline. Time-series imagery of the project construction was captured on a weekly basis by uncrewed aerial systems (i.e., "drone") flights run by ERAU faculty and students, providing a compelling visualization of the site's transformation into a green stormwater infrastructure demonstration and research hub. Scientific monitoring of the rain garden has only just begun, but is focused on quantifying infiltration rate-capacity, nutrient-load reduction performance, plant establishment and survivability, habitat values for native pollinators and other beneficial urban wildlife, and long-term maintenance costs. Supply chain issues for key scientific equipment has unfortunately resulted in some unexpected delays and associated challenges to the hydrological research components of the project. However, the project team expects to have most of the needed monitoring equipment installed by early June 2024, thereby providing opportunity to begin systematically evaluating system performance during the summer rainy season.

Importantly, the project team continues to engage with residents and elected officials in a variety of ways. For example, volunteer "citizen scientists" are being recruited and trained to assist with long-term monitoring of native plants, pollinators, and other wildlife within the rain garden site, as well as to provide "on the ground" documentation of any continued flooding challenges within the local neighborhood. The team also continues to closely with staff and elected officials in City of Cape Canaveral to find ways of transferring improved knowledge about green stormwater infrastructure into potential revisions of the City's local ordinances, codes, and regulations, for the express purpose of improving long-term flood resilience at a municipal scale. Ultimately, we are hopeful that key innovations and lessons learned about green stormwater infrastructure performance in Cape Canaveral may be directly transferrable and applicable to other communities within the Indian River Lagoon watershed, many of which are experiencing similar flooding challenges and water quality challenges associated with antiquated urban stormwater management systems. While green stormwater infrastructure currently still has a status (at least in Florida) as a somewhat marginal "alternative" flood mitigation practice, we believe that the long-term data provided by the "Cape Canaveral Smart Rain Garden" may play an important role in operationalizing green stormwater infrastructure into a preferred, front-line tool for flooding and climate adaptation in Florida's coastal zone (and beyond).

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Florida Resilient Cities: Developing Community-University Partnerships to Advance Climate Adaptation Initiatives

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Background
Located along Florida's Nature Coast, Cedar Key, faces a number of significant climate hazards including vulnerability to hurricanes, tropical storms, and sea level rise, which poses a serious long-term threat. Coastal erosion, accelerated by storms and rising sea levels, has led to the loss of wetlands and critical habitats. While Cedar Key is a smaller municipality, the city has an outsized influence on Florida's $14 million hard clam aquaculture industry. In late August of 2023, Hurricane Idalia made apparent many of the city's vulnerabilities- the Category 3 storm brought a nearly 7-foot storm surge causing extensive flooding and damage throughout the town. However, many longtime residents said it could have been worse if the storm had made a direct hit. Addressing Cedar Key's hazards requires a mix of adaptation strategies to enhance the community's resilience against these storms and climate-change impacts.

Planning and Process
To address the challenges of sea level rise and storms, the Cedar Key partnered with the University of Florida on the "Resilient Cedar Key" project, which aims to develop a comprehensive vulnerability assessment and adaptation plan for the municipality. This process illustrates how communities can successfully leverage university-based research and faculty expertise to create a data-driven planning framework that articulates flood risk-reduction goals, develops realistic adaptation actions, and catalyzes the procurement of future grant and funding resources for implementation.

Undertaken by the City of Cedar Key, Florida Sea Grant/IFAS Nature Coast Biological Station, Florida Institute for Built Environment Resilience, Center for Landscape Conservation Planning, Shimberg Center for Housing Studies, and IFAS Food and Resource Economics Dept, the project goal was to determine the actions needed to build a more resilient future through a process informed by meaningful community engagement. The planning process was driven by 1) comprehensive technical analysis, 2) meaningful stakeholder engagement and public outreach, as well as 3) unique data visualizations and digital tools that made a complex vulnerability analysis more understandable and engaging.

Solutions and Results
As part of the planning process, the team developed a web-based application to highlight the impacts of a range of flood hazard scenarios on buildings, critical infrastructure, and other natural and cultural resources. The flood hazard exposure assessment was comprehensive, but also paid particular attention to issues critical to the Cedar Key community including affordable housing and the ecological impacts on the shellfish industry. The digital tool can serve as a model for other communities conducting vulnerability assessments as it enabled the planning team to communicate complex data more easily.

Based on the analysis, the framework that guided Cedar Key's adaptation plan was that the island-city was historically established on a less contiguous archipelago, and reestablishing this hydrologic connectivity through the island will reduce flood risk overall. Furthermore, the city's natural ecosystems have defined its past and will sustain its future. These principles underly a series of adaptation actions that focus on 1) maintaining transportation connectivity, 2) restoring Cedar Key's natural hydrology and enhancing ecologic infrastructure, and 3) safeguarding homes and businesses. These principles were used to identify several priority adaptation projects such as:
Elevating 3rd Street to improve connectivity in the Downtown area, and redeveloping businesses and homes on higher ground near Cedar Key's existing community center.

Elevating parts of Gulf Blvd. and buying out properties along Hodges Ave. that are particularly vulnerable to flooding to facilitate water flow during extreme high tides in Mid-Cedar Key.
Increasing awareness about adaptation activities that individual property owners can take on the west side of town, such as how to enhance the adjacent shoreline with salt-tolerant plants.

Following Hurricane Idalia, specific project ideas are now at the forefront of community conversations and gaining additional momentum for implementation. For example, City Hall was relocated to an area of higher ground just west of downtown, and there are ongoing discussions about relocating other community services and businesses to the area. Also, property buyouts are occurring in several areas that were recommended for hydrological connectivity / wetland restoration projects. The adaptation plan is also being incorporated into the city's new Community Redevelopment Agency (CRA) Plan to ensure it "include[s] research-based and community-cognizant long- and short-range projects to promote the city's resiliency in the face of growing gradual and episodic flooding."

In addition to community benefits, the project also provided a learning opportunity for university students to develop real-world based planning and design projects. As part of her final landscape architecture capstone project, recent Gator graduate Abby Boe won the department's 2024 "Best Design Project" for her project, "Beyond the Storm: A Resilient Future for Cedar Key, FL."

The Resilient Cedar Key project is an exciting demonstration of how community partnerships with university researchers can create a robust vulnerability assessment and impactful adaptation plan, whose impact extends beyond the initial project goals.

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Gulf South Studio | Innovating Community-Based Design and Planning Approaches in Lee County

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Background

For decades, the state—and southwest region in particular—has been undergoing widespread development, which has provided low-density neighborhoods to millions across the U.S. seeking more "affordable" housing located along Florida's sunny coasts and sandy shores. The actual cost of this development to coastal ecosystems, public infrastructure, housing affordability, and community resilience has long been deferred as more land has been consumed by sprawling waterfront suburbs. However, in 2022, Hurricane Ian exposed the fragility of this "endless growth" paradigm when it made landfall in Southwest Florida and devastated Ft. Myers and much of Lee County. A year after the storm, the region is undergoing a rapid transformation – both *seen* through a recovery and construction boom, and *unseen* through policy changes and billions of dollars in property transactions.

Supported through a grant from the National Academies of Science, Engineering and Medicine (NASEM) Gulf Research Program and in partnership with the Collaboratory, this project illustrates how an innovative interdisciplinary studio in the University of Florida (UF) College of Design Construction and Planning (DCP) is helping the greater Ft. Myers area to imagine a more resilient future.

Planning and Process

This studio was co-created by faculty in the UF Departments of Architecture, Landscape Architecture, and Urban & Regional Planning as well as local stakeholders from the nonprofit The Collaboratory to advance the Lee County recovery plan ("Resilient Lee- Resilience and Recovery Initiative") in three specific neighborhoods within the greater Ft. Myers area. These sites were selected as they were lower-income communities hit hard by Hurricane Ian, but also had strong community partnerships deeply invested in the neighborhood's recovery:

- Harlem Heights- A low-income neighborhood in Lee County with predominantly black and brown homeowners living in multi-generational homes.
- Sunshine Village- Before Hurricane Ian, Sunshine Estates was a 55+ community primarily inhabited by middle-class retirees and mid-western snowbirds.
- Downtown Ft. Myers/Seaboard- Situated in between the river and Billy's Creek, this area of downtown Ft. Myers includes high-rise condominiums, single-family homes, two- and three-story apartments, industrial lots, and commercial properties.

Following the initial wave of water, Hurricane Ian brought a flood of federal funds for rebuilding, however these dollars are not reaching communities that need them most. Here lay the challenge that this studio sought to explore- how can storm recovery catalyze a more resilient and equitable future? Working with community leaders from the local neighborhoods, the studio challenged undergraduate and graduate students to develop architectural and neighborhood designs, nature-based infrastructures, and land-use and housing policies to envision recovery and long-term adaptation of communities facing flood increased risk.

Solutions and Results

Students worked in 5-6 person teams to develop design and planning strategies for each neighborhood that focused on 1) reducing current and future flood risks, and 2) supporting affordable housing and other community needs. The studio defined a "resilient neighborhood ecosystem" as a network of spaces with affordable housing, social gathering places, robust ecosystem services, and infrastructure to sustain and enhance life; the neighborhood must be able to absorb the shock of natural disasters and support an equitable process of recovery after a disaster. Several creative proposals arose out of the studio including ideas such as:

“The Nest” at Sunshine Village– Inspired by the determination of Sunshine Village's residents to rebuild, the team developed a rebuilding strategy to ensure the longevity of Sunshine Village, which could be applied to other similar manufactured home subdivisions in the area. The strategy operates at two scales: regional and neighborhood-level. Regionally, the threats of sea level rise and frequent flooding are addressed by creating extensive living shorelines to attenuate wave energy and slow the flow of water. At the neighborhood level, abandoned home lots are repurposed into parks and a network of trails is introduced to manage water flow and address flooding issues. Community blight is combatted by increasing housing density and establishing a community center as a gathering space for residents. Lastly, a model of "greening manufactured home subdivisions" is proposed through amendments to homeowners' association (HOA) regulations, land swaps, and utilization of mitigation banking credits as a mechanism to implement these projects and to ensure resilient futures for similar communities.

Harlem Heights– As a neighborhood with strong social and multi-generational ties and relatively affordable housing, Harlem Heights can lean into these strengths. The project team created solutions that would allow the neighborhood to recover from disaster and generate its own resilient future by creating new affordable housing, preserving preexisting housing through landscape interventions, as well as developing a community land trust can preserve community wealth and/or create new wealth from excess municipal land. Specific project ideas included 1) modular housing that facilitates new, flexible, and accessible forms of creating generational wealth; 2) a neighborhood care facility that allows elders to age in place while receiving the care they deserve; 3) landscape infrastructure that increases safety and reduces flood risk; and 4) protecting property ownership by reducing heirs’ property (lack of clear property titles) that enables both access to wealth and federal resilience grant opportunities.

After the studio’s final presentations, the stakeholders at The Collaboratory noted that the results were inspiring, and that they planned to try and implement some of the ideas in the coming months. They wanted to take up advocacy for projects ideas like working with local conservation groups to pursue property buy-outs and create long-term conservation easements. In this way, the Gulf South Studio has not only created an innovative interdisciplinary educational experience, but also serves as a model for local stakeholder-academic partnerships that can positively impact local communities.

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House Relocation: A Flooding Adaption Strategy for Florida's Coastal Communities

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Background

House relocation is the physical movement of a house within a property or from one property to another, often in response to risk, redevelopment, and/or infrastructure changes. Many flooding adaptation plans list house relocation as part of a 'retreat' strategy, without guidance on how to undertake the process. This gap in public education spurred research in house relocation for Florida's coastal communities. The goal is to create a publicly accessible guide of considerations, best practices, and how to information with an initial focus on Pinellas County, one of Florida's most populous coastal counties, as a test case. This Florida-focused research was preceded by Texas-based research on house relocation to combat rampant demolition within rapidly redeveloping urban neighborhoods, leading to losses in affordable housing and cultural history during unmet zero waste goals. House Relocation: A Practical Guide for Austin, Texas, released in June 2023, has led to a working group with city council staff; a passed city council resolution directing development staff to explore process/policy changes and public education opportunities to foster the practice (Nov 2023); local media coverage of the issue; and current stakeholder engagement.

Planning and Process

For Florida, research began in Fall 2023 to assess the past and current use of house relocation in Pinellas County through permit records analysis, case study identification, review of climate change / flooding adaption plans, and stakeholder interviews. City/county government staff were/are a primary source of information in relationship to local policy and permit processes, yet researchers assessed an overall lack of familiarity with the process due to its rarity. Researchers sought out publicly accessible information on how to undertake a house relocation, but this information could not be identified. Starting in Summer 2024, the project focus will shift to assessing technical considerations and best practices for house relocation within the context of Pinellas County through case study analysis and interviews with local built environment professionals, including house moving contractors, architects, preservationists, and city/county staff.

Solutions and Results

The solution to this gap in public education is currently in research and development. The end goal is a how-to guide on house relocation to complement and inform adaption plans released by city/county governments. With future plans to create a guide applicable throughout the state, an initial version will focus on best practices for Pinellas County's landscape, development patterns, and building traditions, including soils, construction materials, foundation types, architectural forms, and more. The preceding Texas-based research points to anticipated benefits, barriers, and lessons learned for house relocation in Florida. A primary benefit is removing a house and its inhabitants from flooding and other related climate-related risks. Additional benefits at the community scale include retaining market-based affordable housing in the form of modest, older homes; decreases in demolition and new construction waste through house reuse; and preservation of local culture through vernacular architecture and building traditions. A primary barrier is the high number of slab-on-grade houses in Florida, which are more technically challenging or not cost effective to relocate. Houses most easily relocated are wood-framed, pier-and-beam foundation single-family homes built before the proliferation of post-WWII slab-on-grade foundation homes. Additional barriers include underinformed assumptions about the high economic cost of house relocation in comparison to demolition and/or new construction; the limited number of construction contractors offering relocation services; and the prioritization of redevelopment speed over environmental, preservation, and other community-scale concerns. Lessons learned from the Texas-based research include engagement and collaboration strategies for working with city/county elected officials and staff to yield beneficial revisions in policy and land development code; and the potential to relocate and reuse houses intact or in pieces to create unique, place-specific architectural designs outside of flood-risk areas.

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Anticipatory Planning for Resilient Electric Vehicle Charging Services Under Coastal Hazards with Counterfactual Analytical Framework

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Background:
Transportation electrification aims to mitigate climate change and introduce challenges for infrastructure and facilities' adaptation management and planning. Concurrently, the challenges could be amplified by vulnerabilities arising from the growing intense climate and weather events, such as tropical cyclones. In particular, the resilience of public electric vehicle (EV) charging stations across scales to withstand, respond to, and recover from disruptions becomes imperative, given their role in channeling the mobility of residents under environmental shocks. The resilient functioning of the public EV charging "station-user" network can be hampered by physical damage to charging facilities and restricted resident access to charging services. EVs are vulnerable to damage from saltwater, making EV users highly susceptible to flooding hazards introduced by hurricanes. Thus, planning for long-term adaptation and resilience of urban facilities is essential.

However, many high-risk areas lack first-hand experiences of severe disturbances. These communities demand anticipatory information on EV charging network functionality under scenarios worse than real-world cases to guide future-oriented preparation. This project explores how EVCSs' infrastructural and built-environmental features, socio-economical characteristics of residential areas, and the supply-user network topological features affect the resilience of public EV charging access to users under disturbances of hurricane hazards in current and extreme scenarios.

Planning and Process
In this project, we specifically focused on the case study on the Tampa Bay area during the disturbances and recovery period of Hurricane Ian (2022). We introduced a Bipartite Network of EV charging stations and Users (BNEU) and conceptualized the mechanism by which tropical cyclone hazards disrupt the network and enlarge charging service gaps. The bipartite network depicted the EV charging station-user interactive network with two types of nodes and links in between. This framework engaged both EVCS and facility users, exploring features encompassing the EVCSs characteristics and network typology in terms of their correlation with resilient charging service flow. Then, we designed a counterfactual analytical framework and constructed worse-case scenarios based on Hurricane Ian to study unforeseen future hazards in the context of climate change. Relying on a multi-agent-based model, we simulated the charging behavior of users and captured the impact on the EV charging network under five categories of hurricane hazards.

Solutions and Results
The combined empirical and modeling methods have produced contextual results that reveal vulnerable components of BNEU in the Tampa Bay area to guide adaptation planning of EVCSs. Our findings reveal the correlative attributes of robust EVCSs, including frequent access by a broader range of users from remote areas, installation of fast charging ports, and location in areas with lower building heights. A distributed network topology has also been shown to be more effective than a compact network topology in enhancing the resilience of BNEU by providing sufficient alternatives for users. In addition, the identified challenges of inequitable public charging services available to older adults and low-income neighborhoods provide evidence of historical disparities in EV charging access for disadvantaged populations.

Using the provided counterfactual analysis framework, we simulated the resilience of the EV charging network under extreme scenarios and found that the expansion of hurricane hazards would increase the magnitude and duration of impacts on the BNEU, with an increase in the number of disrupted EVCS and facility user connections. Meanwhile, inequitable access to resilient charging services for low-income and older adults would be exacerbated as hurricane intensity increases.

The proposed BNEU framework and the MABM simulation procedure conceptualize the coupled impacts of tropical cyclone hazards on the functioning of BNEU, allowing a holistic assessment of resilience influencers under historical cases and further anticipated unexpected shocks. A comparison of the empirical and simulation analyses reveals insights into proactive preparation for low-probability high-cost extremes, which are essential for ensuring the long-term prosperity of BNEU. The proposed factual and counterfactual analytical framework is generalizable to coastal communities, in particular those with high risks of environmental hazards yet limited historical experience in anticipating unseen vulnerabilities. This project draws lessons from the resilience of BNEU to current shocks, informing strategic pathways of infrastructure planning toward resilient service flow. Looking forward, anticipatory scenario analysis could offer insights into the allocation of EVCSs, in response to the growing EV market and the pressing need for a resilient charging network.

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Resilient Jacksonville: An Interdisciplinary Strategy for a Resilient Future

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Background

The City of Jacksonville is the largest city in the continental United States with respect to land area and has over 1500 miles of shoreline. Jacksonville's position on the Atlantic Ocean and the St. Johns River makes it susceptible to sea level rise, tidal flooding, and fluvial flooding. Jacksonville is also susceptible to pluvial flooding, and the region is expected to experience 1.5-2x more extreme precipitation events by 2070, which will exacerbate stormwater issues. Major flooding during Hurricane Irma and Hurricane Matthew recently brought public attention to the issue of compound flooding in Jacksonville. The city is working to reduce flooding risks through its comprehensive Resilient Jacksonville Strategy.

Planning and Process

In 2023, the City of Jacksonville published its Resilient Jacksonville Strategy. The Strategy was developed by an interdisciplinary team and diverse stakeholders. The myriad expertise of the workgroup members led to a comprehensive Strategy that tackles resilience from many different perspectives. The entire process was guided by the best available science and data, including a robust vulnerability assessment and detailed spatial analysis. Community engagement was a critical component of the planning process, which garnered public support for the Strategy.

Solutions and Results

The Resilient Jacksonville Strategy includes 45 actions and 90 sub-actions that are intended to be implemented over the next 50 years. The Strategy addresses many different chronic stressors and acute shocks facing the City. Many of the actions outlined in the Strategy are focused on mitigating the impacts of flooding. For example, the City has committed to establishing a formal green infrastructure program, which will deploy green infrastructure solutions across the city to reduce flooding and provide other ecological benefits. The City is also working on a probabilistic compound flood model and real-time forecasting system that will be used to guide the implementation of actions in the Strategy, focusing work in the areas of greatest need.

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Regional Planning Councils Assist Inland Communities with Vulnerability Assessments and Adaptation Planning

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Background

Inland communities face unique challenges when analyzing and adapting to flooding. Initially, vulnerability assessments (VAs) for flooding in Florida primarily focused on coastal areas. However, Florida Statutes were later expanded to include inland communities, though the guidance for conducting VAs remained largely unchanged. This left inland communities struggling to adapt coastal methodologies to their specific needs. Recognizing the need for consistency, Regional Planning Councils (RPCs) began researching best practices for inland VAs.

One challenge involved analyzing rainfall-induced flooding using spatiotemporal analysis or existing hydrological and hydraulic modeling results. Unfortunately, these results were often unavailable for inland areas. Additionally, tidal flooding and storm surge analyses may not be relevant to inland counties, and if applicable, data acquisition can be challenging. While methodologies for analyzing compound flooding events (the combined effects of tidal, storm surge, and rainfall) are still under development, robust modeling is needed to account for these combined effects. Finally, inland adaptation planning necessitates a different set of tools compared to coastal planning. Several Regional Planning Councils have actively responded to these needs by developing consistent assessment and adaptation methods for inland communities.

Planning and Process

As this effort encompassed more than one project, the timeline spanned multiple years, beginning in 2022 and continuing to the present. To develop more effective adaptation plans for sea level rise and flooding that reflect the expertise and interests of the community's local stakeholders, the adaptation planning process encourages communities to consider their vulnerabilities and how each factor relates to these issues. Within the vulnerability assessment (VA) process, the RPCs engaged with various local and statewide partners, such as municipalities, counties, academic institutions, members of the scientific community, nonprofit community organizations, and the public, on multiple occasions over several months. Some RPCs utilized members of their existing Regional Resiliency Collaboratives for input and evaluation. This included introducing the Resilient Florida Grant Program requirements and explaining how VAs would be used to develop more effective adaptation plans for both short-term and long-term planning horizons in the context of a community's geographic location. It also included consultations with experts in different types of flooding analysis to select the most appropriate methodologies. Continued partnerships, outreach, and messaging efforts will ensure ongoing positive outcomes. Most importantly, the VA process empowers stakeholders to become informed and act.

Solutions and Results

Vulnerability Assessments help communities determine which natural, structural, and social assets will likely be impacted by future flooding and sea level rise. Since each region is very different, whether rural/urban, as one of the solutions to identify the potential problems of flooding and sea level rise, the RPCs are working on various interactive GIS maps showcasing modeled rainfall-induced flooding results against the different types of assets across their respective regions. The RPCs are also addressing specific inland concerns by adapting USGS stream gauge data to coordinate with NOAA tide gauge data to allow analysis of any potential storm surge and/or tidal inundation, combining data from neighboring coastal counties that may share water bodies, and creating buffers to represent boundary layers. The results are forthcoming and expected to ameliorate any differences between counties that share boundaries.

Many adaptation solutions could address the concerns with future flooding and sea level rise; the methodology the RPCs are focusing on is a collaborative statewide portal containing opportunities to mitigate these potential issues, whether in an inland or coastal community. The portal pulls from the best adaptation practices throughout Florida, the nation, and the world, and is broken into multiple categories, including green infrastructure, traditional stormwater infrastructure, and hybrid infrastructure. In addition to this, RPCs are also working with individual counties to develop adaptation plans that are specific to the most vulnerable assets within certain focus areas. These adaptation plans may utilize solutions from the statewide portal but also compare them using cost-benefit analysis and other types of analyses to determine which option is most suitable for any given asset.

One of the challenges the RPCs have been dealing with is developing a flood model that accurately represents flooding on all types of topography, such as flat, karst, and/or hilly, not just coastal. Another challenge is gathering the right stakeholders to review and critique the data created during the project. These data can be very technical, so creating a solution that works for all stakeholders is challenging, whether they are in the scientific community, a public works department, elected leaders, or the public.

One of the lessons learned throughout this process is that some of the State's greatest experts on subjects such as compound flooding are not necessarily working in concert, so the RPCs have taken the lead in arranging for a more cohesive process for this. As the RPCs continue to work on this set of related projects through 2025, additional challenges and solutions will continue to be identified, mitigated, and showcased for future communities to review our results and process.

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Wetland Evaluation Tool (WET): Driving Wetland Restoration in the Central Florida Water Initiative Area

Danielle Ivey *and* ***Paul N. Gray***
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Background
The Central Florida Water Initiative region surrounds the Orlando metroplex and includes three Water Management Districts. Rapid population growth is exacerbating concerns over flooding, water supply and scarcity, agriculture and habitat loss, and general human habitability. Climate change makes these issues more pressing. Strategically conserving and restoring historic wetland basins can help alleviate all these concerns by providing safe places to put water during wet events, retaining water longer into the dry season, creating habitat and aesthetic values, and providing landowners an extra source of income. Storing more water in the headwater regions of the three Water Management Districts also can abate harmful downstream impacts of over-drainage and nutrient pollution. Creating partnerships with private and public landowners is essential to harness these benefits. To forward these efforts, Audubon developed a GIS tool to identify locations with the greatest opportunities, named the Wetland Evaluation Tool (WET).

Planning and Process
WET uses four GIS layers to rank project potential: land use, soils, hydrography and elevation. We restricted projects to 400 acres or larger for cost efficiency. The WET formula had a maximum score of 60 points for project potential, and WET identified 224 locations that scored 53 points or higher. Eleven other layers provide additional information on potential project sites, including number of parcels and assessed value of properties. Many of the potential sites that the WET formula identified already are in restoration (Apopka marshes, Kissimmee headwater lakes) giving proof of concept that the tool is calibrated properly. Though most of these sites are not under restoration currently. Not only does WET identify suitable places for water projects, it also identifies risky locations for development. Audubon is also using this tool to identify areas that may experience chronic flooding and learning how well WET might provide options for mitigation.

Solutions and Results
Audubon hired a wetland restoration specialist in 2023 to present the tool to local governments, agencies, water management districts, NGOs, private landowners and other potential partners with a goal of fostering projects. Audubon has been presenting the tool to potential partners, receiving feedback and coordinating on funding opportunities. Funding can come from many sources including wetland restoration easements (e.g., NRCS), Payments for Environmental Services (e.g., SFWMD's PES program), resiliency grants, local governments, and other sources. This version of the tool is the "beta" version, that will be upgraded as we become more familiar with the strengths and weaknesses of the formulas and layers. More urban local governments identified the need for smaller polygon sizes due to space limitations. In heavily urbanized areas there is potential for flood mitigation and recharge projects especially where redevelopment and revitalization are planned. Open and conservation areas also have the potential for water projects. We have found some counties already working on the identified polygons, providing proof of concept that our tool is calibrated to pick up the most suitable areas. We have joined them in pursuing the projects picked up by our tool. Working with government staff to find areas that will assist in restoring wetland hydroperiods and help abate localized flooding is key. Rapid land use changes also require constantly updating GIS layers.

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Determining the Operational Flow Discharge for Flooding and Sediment Export Controls via Sediment Transport Modeling in South Florida's Canals

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Background

Watershed development, in terms of human activities linked to urbanization and agriculture, has been associated with greater stormwater runoff and sediment yield. Physiographic and climatic conditions, along with the degrees and types of development, favor the generation of flooding events in Florida. In addition to irrigation, drainage, navigation, and recreation, canals across this state have served as systems for flood control. Despite operated upstream gates in canal systems are capable to regulate discharge, human-induced sediments can be accumulated and then exported to coastal downstream environment. Since projections of climate change suggest the exacerbation of extreme storm events in Florida, it is imperative to determine the threshold of flow discharge for which canals can be operated for controlling both flooding and sediment transport. Therefore, the research objective of this study is to project the operational range of flow discharge, for which flooding can be controlled without exporting sediment to the coastal downstream habitat.

Planning and Process

From selected canals in Florida (e.g., Tamiami Canal, L-29), this study projects the amount of sediment generated and discharged at the upstream gates by developing the Revised Universal Soil Loss (RUSLE) model via Geographic Information System (GIS). This model integrates the data of soil erosion factors associated with rainfall, soil properties, land cover, topography, and support practices. Data sources for modelling each soil erosion factor include Digital Elevation Models (DEM), web soil survey from US Department of Agriculture (USDA), and National Land Cover Dataset (NLCD). Then, the total amount of sediment transported from upstream to downstream canals is projected via the 1D Sediment Transport Model. Input parameters of this model include: (i) canal width, (ii) slope, (iii) flow discharge, (iv) intermittency (i.e., fraction of time above the flow discharge), (v) canal bed grain size, and (vi) total annual average sediment fed upstream of the gate. Data sources for input parameters of the 1D Sediment Transport Model include recorded flow discharge data at the upstream gate canals from DBHYDRO. Finally, this study performs a sensitivity analysis via multiple simulations under different flow discharge and intermittency scenarios, elucidating which operational conditions of the upstream gate canals suit better for controlling flooding condition and mitigating the transport of sediment.

Solutions and Results

Results from the integration of the RUSLE-based GIS with the 1D Sediment Transport Models project the amount of sediment transported under different operational conditions at the upstream gates of studied canals. These different operational conditions are simulated under various flow discharge and intermittency scenarios. Findings from this investigation provide insights on how to improve the management of canal systems for not only flooding, but also for pollution control.

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Future Development and Water Quality for the Pensacola and Perdido Bays Estuary Program

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Background

Continued population growth in the Pensacola Bay watershed challenges the ability to make improvements in water quality, as forest cover is replaced by developed land and nonpoint sources dominate the pollutant load to waterways. Mid-range population growth projections for Escambia and Santa Rosa counties (including all incorporated areas) are for 90,000 new residents from 2023 - 2040. This project created maps of the two counties displaying multiple land use scenarios -- the baseline, trend using current patterns, and an alternative scenario that implements more compact development patterns and land conservation.

For each of the three scenarios, the stormwater volumes and water pollutant load for sediments and nutrients were modeled, demonstrating the reduced pollutant loads from more compact development patterns. With input from local stakeholders, an accompanying report includes recommendations for Land Development Code and Comprehensive Plan changes that local governments can use to facilitate better land-use patterns that preserve forest cover while creating high-quality communities for new residents.

Planning and Process

The project was conducted from October 2023 through May 2024. Project partners included the Pensacola Perdido Bay Estuary Program (funder), Healthy Gulf, 1000 Friends of Florida, and the UF Center for Landscape Conservation Planning. Local stakeholders among city and county governments also provided project feedback and review.

The project expanded on population and development estimates originally established in the 2040/2070 Project https://1000fof.org/county/ for Escambia and Santa Rosa Counties. The 2040/2070 project estimates population values based on historical trends, then applies these values to a model that estimates where development will occur using historical expansion trends ('trend' development), and introduces an alternative, more compact development pattern ('alternative' development). The additional data included updated estimates from the most current actual population counts and applied development modeling used in the original project. In addition to updated population and development modeling, pollution loading calculations were completed using Event Mean Concentration (EMC) methods and compared the difference between current development, 'trend' development, and 'alternative' development.

Benefits of alternative development scenarios highlight efficiencies in infrastructure such as stormwater, wastewater and other services. Benefits are also achieved through reduced impervious surfaces, allowing for more infiltration which reduces flooding as well as pollutant runoff impacts.

Solutions and Results

Future population projections for 2040 were based on data obtained from the Bureau of Economic and Business Research (BEBR). Gross development densities were calculated based on existing development patterns and were extrapolated to demonstrate 'trend' growth patterns for the future population projections. These calculations indicated population growth of 9% in Escambia County and 24% in Santa Rosa County and would require development of nearly 5,000 additional acres of land for Escambia County, and over 15k acres for Santa Rosa County. These acreage conversions would most likely come from natural lands such as forest and silviculture, resulting in significant losses of pervious area as well as habitat and ecosystem impacts. In contrast, development which follows the more compact, alternative scenario converts a little over 2k acres for Escambia County and a little more than 10k acres for Santa Rosa County.

Furthermore, pollutant load estimates for the trend scenario using the EMC method show total nitrogen (TN) increases to be 63k+ lb./yr for Escambia County, and 46k+ lb./yr for Santa Rosa County, and total phosphorus (TP) increases of 11k+ lb./yr and 8k+ lb./yr respectively. Compared to increases in pollutant load runoff for alternative development scenarios of 12k+ lb./yr and 9k+ lb./yr TN for Escambia and Santa Rosa (respectively), and 2k+ lb./yr and 1.5k+ lb./yr TP for Escambia and Santa Rosa (respectively).

In addition to compact development scenarios providing benefits through greater pervious surfaces and less pollutant loading in runoff waters, there are also ways to direct development that can further help reduce flood impacts. Encouraging development away from wetlands, floodplains or known flood zones allows these naturally wet-inclined habitats to serve their natural function and keeps elevated water volumes away from the built environment.

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Building Resilience to Coastal Flooding Through Living Shorelines: Lessons from the Resilient Pasco Project

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Background

Phase 5 (Living Shorelines Plan) of the Resilient Pasco Project emerged in response to the worsening challenges presented by coastal flooding in Pasco County, Florida, exacerbated by events like Hurricane Idalia (2023) and the ongoing threat of sea level rise. Pasco County, situated along the Gulf of Mexico, is facing increasing vulnerability to storm surge events and coastal erosion, threatening both ecological habitats and local communities. In response to these challenges, the Resilient Pasco Project set out to develop conceptual living shoreline plans for three public parks owned and maintained by Pasco County. The project was motivated by issues applicable to coastal erosion, storm surge, historical impacts to natural habitats, and environmental degradation caused by human activity. These conditions were observed over time at Anclote River Park, Key Vista Nature Park, and Robert K. Rees Memorial Park. In response to these challenges, a multidisciplinary team—comprised of local government officials, environmental scientists, coastal engineers, planners, and surveyors—worked together to develop conceptual living shoreline plans for these three sites. The primary objective was to bolster coastal resilience to flooding and strengthen the adaptive capacity of Pasco County to both climate change and sea level rise.

Planning and Process

The Living Shorelines Plan phase of the Resilient Pasco Project followed a phased approach set within a six month timeline. The phase commenced with initial site visits, background investigations, surveys of each site location, including subaquatic vegetation surveys, and gathering essential data to inform the development of comprehensive conceptual plans. One of the key highlights of the process was the emphasis placed on coastal wave analyses—applicable to both current and future flooding—and additional environmental considerations integral to shaping the final plans. By incorporating a detailed understanding of coastal dynamics, the conceptual plans sought to strike a balance between effective shoreline stabilization and the preservation of the natural environment. Environmental scientists led the field investigations, data collection process, and development of the final plans. Coastal and water resources engineers provided expert insights into historical, current, and projected storm surge dynamics for each site. Surveyors developed detailed surveys for each site, documenting both geographic features and local government-maintained structures. Pasco County staff ensured that local knowledge was integrated into the development of the final conceptual design plans.

Solutions & Results

Pasco County’s Living Shorelines Plan explored various solutions to address shoreline erosion and enhance coastal resilience. These solutions were tailored to each site's specific conditions and challenges identified during the planning phase. Some of the explored solutions included the use of natural materials like oyster bags, planting of vegetation such as mangroves and seagrasses, installation of erosion control structures, and shoreline stabilization techniques.

At Anclote River Park, oyster bags were strategically placed in the conceptual design plans along the shoreline to dissipate wave energy and promote sediment accumulation. Key Vista Nature Park conceptual plans included similar interventions, including the planting of mangroves and installation of erosion control measures. These design choices will help to mitigate erosion and stabilize the shoreline, providing habitat for various coastal species. Robert K. Rees Memorial Park faced challenges due to the deteriorating seawall and erosion issues. To address these challenges, a combination of shoreline stabilization techniques, including the reinforcement of the seawall and planting of vegetation, was included in the conceptual plans.

Phase 5 of the Resilient Pasco Project, beyond the development of conceptual plans, involved other planning activities, including: identifying policy recommendations for promoting living shorelines through Pasco County's comprehensive plan and code of ordinances; publishing a homeowner's guide to living shorelines to promote public awareness; and publishing a digital story map to educate stakeholders about the planning process navigated to develop the conceptual plans.

Challenges encountered during the project included limited funding, design constraints caused by regulatory and permitting requirements, and geographic constraints presented by subaquatic vegetation and other natural habitats. The entire budget for this phase was slightly more than $86K, leading to constraints in the design process because of a limited budget to work with. The design team reconsidered specific strategies because of permitting challenges that would ultimately be encountered in the implementation phase. Finally, specific solutions were limited because of geographic constraints caused by limited space between the Gulf of Mexico and shoreline. Collaboration between Pasco County and the design team assisted in overcoming these challenges, where extensive QA/QC procedures were implemented to verify that the final plans were achievable, permittable, and resilient.

Lessons learned from the project include the importance of adaptive management and ongoing monitoring to evaluate the effectiveness of implemented solutions and make necessary adjustments. Building strong partnerships and collaborations with diverse stakeholders is essential for addressing complex coastal challenges and leveraging resources effectively. Public outreach and education are crucial for garnering community support and participation in coastal resilience initiatives.

Key advances included the development of innovative techniques and plans for shoreline stabilization and habitat restoration using natural materials and ecosystem-based approaches. Next steps in the planning process for Pasco County will be focused on translating the conceptual plans from planning and design to implementation. Resulting from the project were detailed permitting considerations that will assist local officials through the regulatory and construction phases of these proposed living shoreline projects. Leveraging a combination of funding sources will play a critical role.

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Smart Watersheds: Changing the Way We Think About Water Management

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Background

Stormwater, particularly urban runoff, is one of the leading contributors to water pollution and plays a significant role in exacerbating flooding and erosion issues. Conventional stormwater ponds are designed and built to hold a predetermined amount of runoff, but these ponds release partially treated stormwater during and immediately after rain events. With large storms, conventional ponds can overflow and flood the surrounding area with untreated stormwater, impacting communities and the environment.

The latest innovation in stormwater technology that is currently being deployed in Florida incorporates live weather forecast data to automatically operate equipment and lower the pond water level before a storm arrives. These active, intelligent stormwater management systems are utilizing Continuous Monitoring and Adaptive Control (CMAC) technology. While the sun is still shining, a "smart pond" can automatically release treated water into the environment and thereby increase its flood storage capacity and water quality performance.

Planning and Process

This presentation will introduce the next generation of stormwater management, highlighting a groundbreaking project led by The Nature Conservancy (TNC). In collaboration with National Stormwater Trust (NST) and leading software developers, TNC is developing the world's first Smart Watershed Network Management (SWNM) model. By integrating Artificial Intelligence (AI), Machine Learning (ML), and adaptive control technologies, this initiative aims to reshape our understanding of watersheds and manage them as interconnected systems for improved environmental outcomes. The project focuses on the Indian River Lagoon, where the SWNM model will be used to transition stormwater management from passive systems to CMAC-enabled smart ponds with data-driven decision support. By expanding stormwater management from individual ponds to a coordinated network within a watershed, this initiative sets the stage for Florida's first smart watershed.

Solutions and Results

The demonstration project offers an opportunity to validate TNC's theory of SWNM, which is based on over 10 years of data and analysis showing the enhanced environmental benefits of CMAC-enabled smart ponds. Using AI and ML support, a collection of smart ponds integrated within a common network can dynamically communicate and adapt to changing conditions across a watershed. This allows for improved site-level decisions about stormwater storage and discharge while still complying with regulatory and site constraints at the individual pond level. Coordinated operations, informed by real-time data sharing, will result in better hydrologic and hydraulic performance, benefiting both the local watershed and downstream water bodies.

The presentation will introduce the technical details of the SWNM model and will showcase the environmental and flood reduction benefits of a smart watershed, supporting changes in policy and permitting for widespread deployment across Florida. The long-term success of this initiative will contribute to restoring the Indian River Lagoon and lay the groundwork for a new paradigm in stormwater management statewide.

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Climate Resilient Green Stormwater Infrastructure in Southeast Florida

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Background
Southeast Florida is facing substantial climatic and environmental challenges due to its unique climate and geography. The region's low elevation and proximity to the ocean makes it vulnerable to flooding, especially as rising sea levels and increasing storm intensity, driven by climate change, exacerbate the situation. Additionally, rapid urban development has significantly reduced natural permeable surfaces, which historically absorbed rainwater and minimized runoff. Accumulation of non-point source pollutants in stormwater runoff has also deteriorated water quality in waterways (canals), Biscayne Bay, and coastal waters. Furthermore, the urban heat island (UHI) effect has become more pronounced. These challenges have spurred a renewed focus on implementing sustainable and resilient water management solutions. Green Stormwater Infrastructure (GSI), which includes natural-engineered practices such as rain gardens and bioswales, is increasingly being recognized for its potential to reduce runoff volume, control pollutant loads, and mitigate UHI effects.

The primary objective of this research is to conduct comprehensive field instrumentation and monitoring of GSI practices across urban areas in Southeast Florida and quantify the efficiency of GSIs in terms of pollutant load and runoff volume reduction and UHI mitigation. Furthermore, the study assesses GSI impacts on groundwater quality, specifically focusing on pollution and hydraulic mounding phenomena.

Planning and Process
This study introduces, a comprehensive monitoring plan designed to assess the long-term performance of different GSIs across various urban development areas in Miami, FL. The first location, Ocean Bank Arena site, comprises a network of exfiltration trenches and a rain garden situated in an 8-acre site on the Modesto A. Maidique Campus (MMC) of Florida International University (FIU) in Miami, FL. The second site, known as "Factory Town", a 6.5-acre post-industrial redevelopment site in Hialeah, FL, features a rain garden and a bioswale. Finally, the third site, situated within a commercial zone in Coral Gables, features an exfiltration trench and an array of urban trees.

To investigate the performance of GSIs, we employed a wireless sensor network containing different on-site sensors to measure water levels, soil moisture, soil temperature, air temperature, humidity, wind speed, wind direction, and rainfall. Additionally, we collect samples of soil, stormwater runoff, and groundwater for laboratory analysis to evaluate the efficacy of different GSI types in improving water quality, reducing runoff volume, and mitigating UHI effects. Details of the monitoring design, preliminary data, and associated analyses are presented herein.

Solutions & Results
Green Stormwater Infrastructures (GSIs) are recognized as effective solutions for managing stormwater and mitigating floods. By integrating natural processes into the built environment, GSI can help restore the hydrological balance and provide crucial ecosystem services. By gathering and analyzing data through this comprehensive GSI field monitoring program for the first time in South Florida, this study provides critical insights into the flood control and ecosystem benefits of GSIs as well as the potential groundwater-related challenges posed by them, thereby informing urban costal sustainability and resilience in the region. The preliminary data and analyses provided valuable insights into how different GSI types function under local conditions, allowing us to refine their design and implementation strategies. Early results indicate a reduction in pollutant loads and more balanced groundwater recharge, which are crucial for flood mitigation and water quality improvement. The analysis of temperature and humidity levels also plays a crucial role in demonstrating UHI reduction in these areas. This aspect of the study will provide vital data on how GSIs contribute to moderating local climates, thereby enhancing living conditions and environmental sustainability in urban environments.

This initiative required close collaboration with management organizations and other stakeholders to identify the most suitable monitoring sites. Although logistical challenges arose in setting up the wireless network across diverse and sometimes challenging terrains, these were mitigated through effective teamwork and resource-sharing. Despite the successes, there were challenges in achieving uniform data collection due to equipment malfunctions and variations in terrain. These were addressed by replacing sensors and developing redundancy in the network design to minimize data gaps. The project also highlighted the importance of regular maintenance and calibration of monitoring equipment for consistent results. However, the data-driven insights gained have proven valuable for developing effective coastal resilience strategies. This monitoring approach is expected to lead to advances in optimizing GSI designs for local conditions, enabling researchers, practitioners, and policymakers to effectively integrate nature-based systems, in concert with gray infrastructure, into urban coastal resilience plans.

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Evaluation of Soil Hydraulic Conductivity in Green Stormwater Infrastructure in Miami, Florida

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Background

Saturated Hydraulic Conductivity (Ksat) is a fundamental parameter influencing the efficacy of climate-resilient Green Stormwater Infrastructure (GSI) for flood control and ecosystem services. It measures the soil's permeability and its ability to conduct water when saturated, providing essential insights for optimizing GSI designs. High Ksat values promote efficient infiltration, reducing surface runoff and mitigating urban flooding. Additionally, appropriate Ksat levels enhance natural filtration processes, leading to improved water quality, while supporting native vegetation and biodiversity, vital for ecosystem services like habitat provision and urban heat island mitigation. Optimizing Ksat enables cities to develop GSI systems that adapt to climate change, ensuring flood control, and sustainability. The objective of this study is to conduct detailed, systematic assessments of Ksat at designated GSI sites. The study area, Ocean Bank Arena, is an 8-acre site located on the Modesto A. Maidique Campus (MMC) of Florida International University (FIU) and includes a network of exfiltration trenches overlain by a rain garden for collecting stormwater runoff from the Ocean Bank Arena site and its adjacent streets and sidewalks. This comprehensive temporal and spatial analysis is critical for optimizing the design and maintenance of GSIs for effective stormwater management and other ecosystem services in urban areas.

Planning and Process

Measuring Ksat in the field is challenging due to temporal and spatial variability and measurement errors. We have conducted Ksat measurements in the field using two modern infiltrometers, the Modified Phillip Dunne (MPD) and Saturo, to analyze temporal and spatial variations in field Ksat values. This involves taking monthly Ksat measurements in the field to track any annual, seasonal, or monthly variations. Additionally, to explore potential diurnal fluctuations, multiple Ksat measurements are performed on selected days throughout the year to assess possible impacts of diurnal temperature changes on Ksat. This dual approach allows us to capture both seasonal and daily fluctuations in soil Ksat, providing a comprehensive understanding of how Ksat values vary with environmental conditions. Spatially, we varied the testing locations within the GSI system to capture Ksat variations influenced by different soil characteristics. Given that Ksat values can change significantly based on soil texture, organic matter content, and compaction levels, the testing provided crucial insights into localized soil hydraulic characteristics. By using both the MPD and SATURO infiltrometers, we ensured data accuracy through comparison and correlation of results from both instruments, allowing us to validate measurements in the context of local conditions. This dual-equipment approach enhanced our understanding of Ksat variability and its implications for effective stormwater management. Additionally, we are expanding our focus to include Ksat tests on soil samples in laboratory experiments. This comprehensive approach will provide a more robust understanding of soil hydraulic characteristics and enhance our ability to accurately assess and manage stormwater infiltration using the best practices identified through these comparative analyses.

Solutions and Results

Test results from both MPD and the Saturo revealed high Ksat values at both study sites. The Ksat values observed ranged from 10 cm/h to over 50 cm/h. These high Ksat values indicate the high permeability of the soil, which is highly advantageous for water percolation but raises concerns about groundwater pollution due to the shallow groundwater level in the study region. The consistently high Ksat values support the primary goal of the GSIs in the study site, which is to enhance infiltration and improve stormwater runoff volume reduction management. Further research is underway to investigate the water quality effects of GSIs through the installation of a network of groundwater observation wells and water quality sampling and analysis. We also conducted multiple tests on a single day to check the variations of Ksat with the change in microclimate conditions like temperature & humidity. Daily testing at the site showed a consistent trend between the MPD and Saturo measurements. The MPDs consistently recorded relative values in comparison to the Saturo, even when the location and timing of the tests were altered. Despite diurnal changes in environmental conditions such as temperature, our analysis so far has revealed no significant diurnal changes in Ksat values. However, spatial variation had a notable impact on the results. Even variations of just 4 to 5 feet in testing locations led to considerable changes in Ksat values. This suggests that spatial heterogeneity in soil characteristics can significantly influence the measured permeability, underlining the importance of considering spatial distribution when assessing soil hydraulic properties in green stormwater infrastructure projects.

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Lessons Learned from Local Governments and Resources from the Environmental Finance Center: Strategies for Accessing Federal and State Funding for Flooding Adaptation

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Background

The Southeast Chapter of the National Climate Assessment ("NCA5"; USGCRP, 2023) reports, with high confidence, that climate change threatens the economic stability of the region. Flooding is particularly disruptive in the Southeast, with various sources and broad implications. High tide flooding alone is anticipated to increase fivefold based on the NCA5. Flooding adaptation is imperative to Florida communities yet funding for such projects can often be difficult to secure, especially for disadvantaged communities. Although a multitude of funding opportunities exist, the diversity of opportunities and strategies available can be difficult for communities to navigate. Various programs offered through the Departments of Transportation, Energy, and Housing and Urban Development, the Environmental Protection and Federal Emergency Management Agencies and many others can be creatively used to supplement local budgets and invest in flooding adaptation. Three local governments will share their process, lessons learned, and experience accessing federal funding for flooding adaptation. The Southeast Sustainability Directors Network, an EPA Region 4 Multimedia Environmental Finance Center, is working with local governments to develop and share strategies to leverage federal funds for flooding adaptation.

USGCRP, 2023: Fifth National Climate Assessment. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023

Planning and Process

The Southeast Sustainability Directors Network (SSDN) is a collaborative community addressing sustainability challenges unique to the South. With members from over 120 local and tribal governments across 10 states - including more than 35 members in Florida, the peer-to-peer network shares best practices and scales sustainable solutions to mitigate climate change. SSDN is a Multimedia Environmental Finance Center (EFC) that assists communities in EPA Region 4 on sustainability issues such as energy efficiency, renewable energy, mobility, water and waste, with a focus on equity-centered approaches. The team also supports DOE's Energy Transitions Initiative Partnership Project for communities located in the Gulf of Mexico. SSDN also assists local governments and community-based organizations with applying for federal funding to address climate change and equity via philanthropic efforts.

Solutions and Results

There are dozens of opportunities offered from both federal and state governments to address flooding. An overview of several state and federal options is listed in the table below. The portfolio of technical assistance (TA) continues to increase to support President Biden's Investing in America agenda. This assistance is delivered in large part by non-federal entities, such as SSDN. Historically, many communities did not have access to the resources necessary to successfully compete for and implement federal funding. The enhanced TA offering is intended to close this access gap. Many grant opportunities are now paired with TA - see the *Investing in America Technical Assistance Guide*, Sept. 2023, https://www.whitehouse.gov/wp-content/uploads/2023/09/IIA-Technical-Assistance-Guide-September-2023-v091223.pdf

Table 1: Selected Funding Opportunities

Agency	Program	Description
EPA	Superfund Technical Assistance Grant (TAG) Program	TAG helps communities participate in Superfund cleanup decision-making. It provides funding to community groups to contract their own technical advisor to interpret and explain technical reports, site conditions, and EPA's proposed cleanup proposals and decisions. https://www.epa.gov/superfund/technical-assistance-grant-tag-program
EPA	Water Infrastructure Finance and Innovation Act (WIFIA) Program Loans	The WIFIA program offers long-term, low-cost loans for eligible water infrastructure projects, including the repair, rehabilitation, and replacement of aging infrastructure and conveyance systems. https://www.epa.gov/wifia
EPA	Clean Water State Revolving Fund	CWSRF funding can help address water quality issues caused by stormwater runoff through the financing of gray and green infrastructure solutions https://www.epa.gov/cwsrf/clean-water-state-revolving-fund-cwsrf-stormwater
EPA	Clean Water Act §319 Program	Grants for local governments, including county and municipal governments, special districts, water management districts, public universities/colleges and national estuary programs to reduce nonpoint source pollution from land use activities and address low impact development for stormwater. https://floridadep.gov/wra/NonpointSourceGrants
EPA	Tribal Set-Aside Program of the Drinking Water Infrastructure Grant (DWSRF)	Community water systems and non-profit, non-community water systems that serve a tribal population are eligible to have projects funded, in whole or in part, with the Drinking Water Infrastructure Grant Tribal Set-Aside (DWIG-TSA) funds. https://www.epa.gov/tribaldrinkingwater/tribal-set-aside-program-drinking-water-infrastructure-grant
DOT	Safe Streets and Roads for All	SS4A is a discretionary program that funds regional, local, and Tribal initiatives through grants to prevent roadway deaths and serious injuries. https://www.transportation.gov/grants/SS4A
USDA	Environmental Quality Incentives Program	EQIP is a voluntary program for agricultural producers to plan and implement conservation practices that improve soil, water, plant, animal, air, and related natural resources on agricultural land and non-industrial private forestland https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/
USDA	Single Family Housing Repair Loans and Grants	Also known as the Section 504 Home Repair program, this provides loans to very-low-income homeowners or grants to elderly very-low-income homeowners for private water well and septic system repair and replacement. The loans or grants can be used to repair, improve, or modernize homes, or remove health and safety hazards. https://www.usda.gov/programs-services/single-family-housing-repair-loans-grants
HUD	CDBG-Mitigation (CDBG-Mit)	The CDBG-MIT enables grantees to implement their FEMA Hazard Mitigation Plans (HMP) with planning and other pre-disaster activities. https://www.hudexchange.info/programs/cdbg-mit/
FEMA	Flood Mitigation Assistance	FMA grants are used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. https://www.fema.gov/grants/mitigation/learn/flood-mitigation-assistance
FEMA	Building Resilient Infrastructure and Communities Grant	BRIC supports states, local communities, tribes and territories to undertake hazard mitigation projects, reducing risks from disasters and natural hazards https://www.fema.gov/grants/mitigation/learn/building-resilient-infrastructure-communities
Florida DEP	Resilient Florida	Resilient Florida provides an opportunity for counties, municipalities, and special districts to receive assistance to analyze and plan for vulnerabilities, as well as implement projects for adaptation and mitigation to address the impacts of flooding and sea level rise. https://floridadep.gov/ResilientFlorida

Adapted from SSDN's Grant Opportunity Database: https://bit.ly/32G63DP

The federal funding offerings can be daunting to negotiate, especially in unprecedented releases such as the Infrastructure Reduction Act and the Bipartisan Infrastructure Law. Florida local governments are taking advantage of several strategies, including collaborative partnerships, tapping into technical assistance, and combining several funding sources.

Note: The results of a survey of SSDN's Florida members will be available shortly.

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Siting for Future Seas – Examples of Stormwater Pump Station Siting to Prepare for Future Drainage System Adaptation

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Background
Over the coming decades, many gravity-based coastal storm drainage systems will require pumping due to sea-level rise. The construction of stormwater pump stations and force mains will ensure proper conveyance of drainage to their outfalls. In some areas, implementing stormwater pump stations are required in the short term to prevent extensive flooding. In other areas, however, the need for pumping is recognized, but may be delayed due to reduced risk and/or lesser consequence and the significant cost required. When and where to implement pumping has become a cause for concern. Challenges include increasingly limited right-of-way, increased construction costs, and pumping reliability. This presentation offers two (2) case studies that demonstrate the siting and eventual transition from gravity drainage to the implementation of pumping systems.

Planning and Process
HDR is involved with the planning and design of a multitude of stormwater projects across coastal communities in Florida. The projects to be discussed in this presentation involve the siting of stormwater pump station systems for future implementation to reduce the risk of flooding. Both projects were designed in 2023 and are intended for construction in late 2024. Both projects offer examples of how informed planning today can improve adaptation measures in the future.

Solutions and Results
In St. Augustine, Florida, a drainage improvement project at the Castillo de San Marcos national monument for the National Parks Service began as a simple pipe replacement. Vitrified clay pipes had become infested with crabs and were failing below the heavily trafficked area. Consideration of future sea-level rise conditions modified the current design approach to realign the drainage system to a single outfall, which would better accommodate a future stormwater pump station to be constructed. This siting effort facilitated future adaptation measures at a notable site to reduce future construction efforts/costs and minimize impacts to this historic memorial.

In Key West, another project involved siting of a stormwater pump station that will discharge to an injection well system to improve the resiliency of critical roads within the community and meet level-of-service requirements in 2045 and beyond. The approach for this project involved detailed hydraulic modeling of the existing system, which demonstrated that capacity limitations on the drainage trunk line would require major pipe replacements if a pump station was located outside of the “critical zone”. The model identified various areas where a future pump station could be located without large scale, costly replacements in existing infrastructure.

The purpose of this presentation will be to inform the audience of the stormwater challenges that coastal communities are facing regarding stormwater drainage and flooding impacts; describe various siting recommendations and best management practices; and to showcase project examples on how these recommendations informed future adaptation plans and streamlined future implementation.

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Incorporating Flood Vulnerability into Bridge Rehabilitation Planning, Case Study: Miami-Dade County, Florida

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Background

In the United States over 40% of the bridges have surpassed their intended lifespan, and about 25% require significant repair or complete replacement. This situation has evolved over time due to several factors, including insufficient investment in infrastructure upgrades and replacements. Additionally, the frequency and intensity of extreme weather events, such as floods is exacerbating the challenges faced by aging infrastructure. Nearly 21,000 bridges are vulnerable during such events, particularly scours, causing about 52% of failures. Scour, washing out streambed or bank material due to flowing water, poses a significant threat to bridge stability. Traditionally, the need for rehabilitation has been determined based on the bridge structural conditions and traffic loads. However, there is a need to consider additional factors where complexities arise, especially in urban areas. This research implemented a Spatial Multi-Criteria Decision Analysis to prioritize bridge rehabilitation projects in urban areas, considering flood vulnerability, social equity, and environmental justice considerations alongside traditional structural and traffic conditions. The practicality of the framework is demonstrated through its application in Miami-Dade County, Florida. This bridge prioritization process helps in investments by targeting resources towards the most vulnerable structures during extreme weather events, enhances public safety, and optimizes financial.

Planning and Process

Data relevant to the study was collated from national and regional/state datasets, comprising five major groups: physical, social, environmental, traffic, and structural data. Each group was further divided into subcategories. The collected data were analyzed to examine the spatial distribution patterns across the urban development areas of Miami-Dade County. The study area was segmented into a grid of cells, with each cell representing a specific location. Each data type within the main and subcategories was assigned a numerical vulnerability score from 1 (very low) to 5 (very high). In the study, two methods were utilized to assign weights to the various criteria for integrating and analyzing the data under each main criterion: clustering and the Simple Additive Weighting (SAW) method. Clustering was identifying patterns and similarities within the data. The SAW method integrated data under each main criterion, providing a quantified representation of vulnerability. This method facilitated the aggregation of different data types by assigning weights to each criterion based on their relative importance, as determined through consultations with experts and stakeholder feedback. Finally, the flood vulnerability maps developed through the MCDA process were validated using flood event data from social media and the national data records (311 data reports).

Solutions & Results

The study presents a vulnerability-based prioritization of bridges in a specified area under three scenarios. Scenario 1 focused solely on traffic and structural conditions, revealing that 61% of bridges had medium to very high (M to VH) vulnerability, with higher vulnerabilities on the east side of the area. Scenario 2 added flood vulnerability to the assessment, increasing the priority of central north bridges and resulting in 72% of bridges categorized as M to VH vulnerability. Scenario 3 incorporated Socio-Environmental and Equity Justice criteria, highlighting a more equitable assessment with 65% of bridges identified as vulnerable, showing changes in priority levels but maintaining the highest vulnerability in the eastern and southern parts. The study emphasizes the significance of including criteria like land use, income levels, and commute time, which impact the prioritization results, while criteria like rainfall and AQI have less influence. A case study on bridges along Interstate 95 (I-95) showed how vulnerabilities fluctuate across the three scenarios, with Scenario 2 emphasizing flood-prone areas and Scenario 3 considering social and environmental impacts. This fine-scale analysis evaluates each bridge individually, supporting transportation decision-makers (DMs) in comprehensive and equitable planning and funding allocation. The framework is based on readily available data, which enhances its applicability across different geographic locations. Its structured yet flexible design allows DMs to modify criteria based on specific regional requirements, ensuring adaptability to evolving priorities and new data sources. Decision-makers can customize the weight of criteria to reflect local conditions and preferences. Despite its strengths, one limitation is the reliance on the quality and resolution of input data for flood vulnerability assessments. If the observed flood data used in the analysis is incomplete or inaccurate, it may lead to less reliable vulnerability assessments and prioritization outcomes. Future research should aim to develop a web-based tool and integrate more dynamic data sources to refine and extend the framework's applicability. State Departments of Transportation and agencies like FEMA can leverage these findings to better understand flood risks and prioritize bridge rehabilitation projects, thereby enhancing public safety and infrastructure functionality.

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Near Real-Time Flood Mapping Using Satellite Images and Deep Learning, Case study: Miami-Dade County, FL

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Background
The increasing frequency and severity of urban flooding requires mapping flood extents methods. Urbanization, increased impervious surfaces, coupled with extreme rainfall, heightens the risk of pluvial flooding (cause by rainfall). The impacted entities typically include local residents, businesses, and governments who face disruptions and significant recovery. Traditional flood prediction, rely on hydrological models, often fail to deliver timely and accurate forecasts, especially in near real-time (NRT) conditions. These methods are dependent on high computational calculations, difficulties in model calibration, and extended simulation durations. Recent advancements include satellite imagery and machine learning (ML) can improve flood mappings. However, challenges persist, especially with the temporal resolution of satellite images hindering the responsiveness of flood mapping. Another challenge is that most studies concentrate on major flood events and overlook critical factors such as rainfall, they either disregard it completely or depend solely on annual average rainfall. To address these limitations and challenges, this research focused on predicting NRT pluvial flood extents in urban areas within Miami-Dade County, Florida, using a combination of Convolutional Neural Networks (specifically U-Net) and diverse datasets. Specifically demonstrated within the urban settings of Miami-Dade County due to its highly susceptible to flooding due to its geographical and climatic conditions.

Planning and Process
This study utilized three primary types of data: 1) flood influencing data (including Digital Elevation Models or DEM, Hydrologic Soil Group or HSG, imperviousness, and rainfall), 2) high-resolution Sentinel-1 Synthetic Aperture Radar (SAR) satellite imagery, and 3) flood event reports from local records (311-flood data reports) and social media. This is followed by the implementation of the U-Net model, a CNN architecture tailored for image segmentation, which effectively differentiates flooded from non-flooded areas. The U-Net architecture was designed for image segmentation and employed alongside a comprehensive dataset consisting of all available Sentinel-1 imagery, rainfall data from 2014-2023, and other geospatial data such as Digital Elevation Model (DEM), Hydrologic Soil Group (HSG), and imperviousness. The model effectively utilized the VV polarization mode of Sentinel-1 imagery to detect water bodies, with validation and ground truthing against historical flood events ensuring accuracy and real-world applicability. The model was trained and tested on a dataset split into 70% for training and 30% for testing, augmented to enhance robustness and ensure diverse flood pattern recognition. Historical flood events were also used for validation, ensuring the model's applicability and effectiveness in real-world scenarios.

Solutions and Results
The study's results demonstrate the effectiveness of the satellite imagery and the U-Net model in predicting and mapping NRT pluvial flood extents. The U-Net model, trained over 100 epochs, displayed impressive learning dynamics, with convergence of training and testing accuracy suggesting strong generalization capabilities. This is further evidenced by a high AUC of 0.93%, and precise performance metrics such as a training precision of 97.03% and recall of 88.62%. Ground truthing further validated the model with an accuracy of 84.05%, using data from a range of flood conditions, highlighting the model's operational reliability and its potential for enhancing NRT flood response strategies. One limitation noted was the potential mismatch between the timing of rainfall and the observed flooded areas in satellite images. Given the six-day imaging cycle of Sentinel-1, flooded areas might not correspond exactly to rainfall on the day images were captured. Addressing this, it is suggested that a detailed analysis of rainfall distribution over time could enhance the model’s accuracy, for example by integrating hourly weather station data to better correlate with short-term rainfall patterns. Despite this limitation, the use

of daily rainfall data reduced computational demands while maintaining sufficient accuracy for NRT applications. The model's NRT flood extent results are vital for emergency response, evacuation planning, and urban infrastructure management. As updates become available, new Sentinel-1 images and updated geospatial data can be integrated to keep the model current, making it a valuable tool for ongoing flood risk management in urban environments.

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Shelter From the Storm(s): The Association of State Floodplain Managers (ASFPM) and the ASFPM No Adverse Impacts (NAI) Legal Guide

Gerald Murphy[1], *Thomas Ruppert*[2]
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Background

Summarize the background of the situation, problem or challenge being addressed. What happened to lead to the situation? Was it the result of a disaster event or a change over time? Where did it occur? Who/what was impacted? What entities were involved in responding to the challenge?

We'll Ask: What are the roles and responsibilities of state and local government in a changing climate that is increasing our opportunities to flood. Most Americans live in coastal states, and the major populations of coastal states are located near the coasts. As climate changes, the intensity of coastal inundation and flooding, without weather disasters, will result in irreparable property damage and (too often, sadly) loss of life. Local governments are generally the first, most critical, and consistent responder in the aftermath of weather disasters. This close community relationship underscores the public need for all levels of government—to be stewards of the communities' floodplains. To support professional floodplain stewardship staff and their lawyers in their efforts to intelligently steward their communities' floodplain to avoid ill-advised development, ASFPM has developed the No Adverse Impacts (NAI) Legal Guide. Too often local efforts to protect the greater communities' general health, safety, and welfare seem thwarted by threats of infringing on private property rights and 5th Amendment "takings." Such threats should never deter good faith efforts to higher standards for community health, safety, and welfare. Let's reduce the risk.

Planning and Process

Describe the timeline for the project, the process used to plan and develop solutions, the stakeholder groups who were involved. How was the community engaged during the planning and implementation process? How was the multidisciplinary team composed, and how did this influence project outcomes?

The Project kicked-off with a conversation at the ASFPM Conference in Raleigh 2021. The overarching concern was local governments considering higher regulatory standards for coastal and floodplain construction, abandonments, and other ways to avoid future disaster liability.

Solutions and Results

Describe what solutions were implemented to address the problem. What were the results? You may wish to elaborate on costs, challenges you encountered, and beneficial collaborations. Please share lessons learned—both positive and negative—that may help others address similar challenges in the future. What key advances or innovations are resulting, or are expected, from this project?

It is the authors' great hope that the effort resulting in the NAI Legal Guide will empower local government attorneys and their clients to adopt and enforce higher, no adverse impact, and more forward-looking floodplain development standards for the greater protection of their citizens.

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Campus Flood Assessment through a Web-interphase Powered by AI: Understanding Student Perception of Risk During Flooding Events

***Mobina Noorani**, Kaleb Smith, Karla Saldaña Ochoa*
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Background
Flood disasters have significantly increased due to climate change, demanding action from educational institutions. Moreover, coastal regions are experiencing more frequent, small-scale flooding due to rising sea levels. Florida has faced four major hurricanes in the past decade, causing over $120 billion in damages. Despite these risks, higher education research typically focuses on sustainability or reducing carbon footprints. University students are particularly vulnerable to flooding due to various risks on campus that their institutions sometimes overlook. Therefore, this project aimed to systematically understand student street-level flood risk perception using a web interface powered by AI. The Web-Interface cohesively displays a pre-processed dataset of built environment information (georeferenced maps, satellite images, and street view images) collected from 30 university campuses along the Gulf of Mexico. The web-interface guides the user in describing their perception of risk and the contributing factors at a particular campus. These data were gathered during a Spring 2024 workshop with participants aged 19 to 40. Key concerns from students included risks from trees falling due to wind and flood damage, especially onto houses and cars. Additionally, students felt unsafe on campus, underscoring the importance of improving campus infrastructure and safety measures.

Planning and Process
The project comprises three stages: **a) Creating a Database of Campus-Built Environmental Data:** Using the Open Street Map API, we extracted road networks within a 5km radius of each campus. A grid of 12.5 meters was created based on the roads' axes, generating a list of coordinates for data collection. We gathered images from Street View, flood maps, density maps, and Digital Elevation Models. Only campuses with at least 80% street view image coverage were selected to ensure comprehensive data. We collected 675,486 images from 30 universities, including 96,498 satellite images, 192,996 street view images, 96,498 flood maps, 96,498 density maps, and 96,498 DEM maps. On average, each campus had 3,721 geo-coordinates. **b) Developing a Web-Interface:** The web-interface includes two main inputs: a survey to capture student perceptions of flood risk and geographic coordinates linked to the imagery dataset from each campus. Aerial imagery was used to provide context, while street view images helped collect student risk perceptions. **c) Data Analysis:** With over 205 student interactions on the web interface, we analyzed survey responses to identify primary concerns in the built environment during flooding events. This analysis aims to inform practices that can prevent such scenarios in the future.

Solutions and Results
To develop the web-interface, we employ a unique approach. We organize our dataset using an unsupervised clustering algorithm – Self Organizing Map (SOM)– to reduce the number of examples shown to the participants and make them the most representative. We used a pre-trained CNN (VGG-16) for feature extraction on the street view images and applied a dimensionality reduction algorithm, T-SNE, to reduce the features from 4096 to two dimensions. These smaller feature vectors are then fed into the SOM to help organize the images into more representative clusters. This approach helped create a grid of the most representative campus environments that can be used to organize similar campus facilities through built environment imagery.

The web-interface shows a trained SOM that visualizes the street view images closest to the Best Matching Unit (BMU) per cell. Clicking on an image takes the user to another window where the image enlarges, and all other information from the site is shown. The website displays a street-view image side-by-side with the same image with objects automatically identified by an algorithm called Inception-ResNet-v2. This neural network combines Inception and ResNet architectures to achieve high object detection accuracy. To adapt to the literature review on flood risk in urban environments, we filter the categories from the objects included in the Inception-ResNet-v2 algorithm to fit into one of the following categories, which have been previously validated by other studies using GSV[1], [2], [3]:

- Sill Height: Window
- Building Typology: Building, Office building, Skyscraper, House, Tower.
- Street: Streetlight, Traffic light, Traffic sign, Stop sign.
- Structure Attached to Adjacent Building: Porch, Stairs, Door, Window, Door handle.
- Overall Building Condition
- Vehicles: Land vehicle, Truck, Bus, Car, Van, Train

To capture the perception of risk, we asked the following questions after the students reviewed all the built environment information:

- "Does this image look like it is on a college or university campus?"
- "Which objects might be at risk during a hurricane?"
- "Are there any additional objects not detected that might be at risk during a hurricane?"
- "If you walk in this place, do you feel safe?"

Their answers were recorded to be further analyzed using word clouds and heatmaps, providing valuable insights into the common concerns and themes within the dataset. The result shows that most students felt unsafe walking in certain areas, as evidenced by street-level images. Additionally, students mentioned that these street-view images did not resemble typical campuses. The analysis highlighted frequently mentioned terms such as "tree," "fall," "damage," and "wind," indicating a substantial focus on the risks associated with trees, particularly their potential to fall and cause damage during windy conditions. Similarly, the analysis of user input items and descriptions showed frequent terms like "risk," "flood," "car," and "house," suggesting significant concerns about flooding risks and their impact on vehicles and residential properties. These insights emphasize the need for effective flood risk management strategies to protect critical assets like houses and cars from potential flood damage. This detailed analysis helps identify priority areas for risk assessment and mitigation efforts.

Costs and Challenges:
The project cost was mostly data collection, storage, and CPU ($12,000). A SEED Grant from the University of Florida founded the project. Not all locations had Street-view images. Additionally, not all locations were labeled. Future work will focus on completing the labeling process and expanding the study to include additional campuses and training deep learning models.

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Flooding Adaptation in South Florida: Building Community Resiliency and Reducing Flood Risks Through Structural and Nonstructural Strategies

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SFWMD Resiliency efforts focus on assessing the impacts of sea level rise and extreme rainfall, among other evolving conditions, and how they affect communities' quality of life. These efforts include advancing scientific data and research – through the Water and Climate Resilience Metrics – to ensure resiliency planning and implementation projects are founded on the best available science and robust technical analyses.

Flood Resiliency Studies – such as the Flood Protection Level of Service Program and the C&SF Flood Resiliency Study – utilize the latest Hydrologic and Hydraulic tool support the assessment of adaptation strategies to ensure the regional flood control system provides the desired level of flood protection today and will continue to do so in the future. The SFWMD Sea Level Rise and Flood Resiliency Plan compiles a comprehensive list of priority resiliency projects and recommended flood adaptation strategies with the goal of reducing risks and increasing community and ecosystem resiliency in South Florida.

The SFWMD is also making significant infrastructure adaptation investments that are needed to continue to successfully implement its mission of safeguarding and restoring South Florida's water resources and ecosystems, protecting communities from flooding, and ensuring an adequate water supply for all South Florida's needs. These efforts are in collaboration and cooperation with regional, state and federal agencies, local and tribal governments, non-governmental entities, universities, and citizens throughout Central and Southern Florida. Working to ensure the region's water resources and ecosystems resiliency, now and in the future, is part of everything the district does.

Dr. Maran is the Chief of District Resiliency for South Florida Water Management District. In her role, she is responsible for coordinating resilience efforts across federal, state, regional and local agencies, advancing scientific research to ensure resilience planning and projects are founded on the best available science; and developing and implementing comprehensive resiliency projects in South Florida.

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Creating Climate Ready Development: Implementing Integrated Policy and Programs to Build Affordable and Resilient Housing

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Background

Housing is the foundation of our communities and economies. Shortages, aging housing stock and increasing climate disasters are exacerbating community instability. Yet in many jurisdictions, housing planning is not well integrated into climate planning and adaptation strategies driven by infrastructure. Without proactive state policies and economic programs, local governments are challenged to implement pre-disaster mitigation efforts to reduce impacts to communities and housing.

There is a huge need to transform predevelopment and RE development design and financial planning strategies to integrate green and resilient principles into affordable housing. According to the Enterprise Community Foundation, buildings are responsible for nearly 40% of emissions globally.

Green and resilient affordable housing construction in Florida lags due to concerns about the cost impacts, knowledge of standards and access to experts. To reach the state's ambitious affordable housing goals, Florida needs to increase the number of experienced developers and local contractors that are trained and certified in affordable housing and climate resilient building practices. Planning is needed to create integrated business networks and local workforce development plans and increase the representation of women, black and Hispanic professionals.

Planning and Process

In 2024, the Florida Housing Coalition began working on three strategies to address these issues: 1) form partnerships with leading organizations to create the Green and Resilient Accelerator program that will build housing capacity. 2) Encourage resilient design of homes that are affordable and can be built rapidly post-disaster; and 3) support policy and incentives to increase resilient development above the Florida Building Code that meets affordability parameters and is attractive to insurers.

The new partnerships formed in 2024 include the Florida Green Building Coalition, AIA-Florida, Solar Energy Loan Fund. The groups are working to develop joint training programs focused on affordable housing developers.

The Coalition recognizes that the location of a home or apartment building is one of the most significant factors in supporting quality of life and safety. Extreme weather, environmental conditions, and surrounding infrastructure can dramatically impact neighborhoods and increase housing risks and insurance costs. It is crucial for affordable housing developers to assess a prospective site to identify hazards and possible improvement costs, before purchasing the land or designing the property. More work and collaboration is needed on this.

Solutions and Results

- The Coalition developed a new resilient site selection guide for developers, with funding from Fannie Mae. After this guide, the Coalition partnered with the Emerald Coast Regional Council and Texas A&M Texas Watershed Community Partners who created the CHARM tool on comprehensive project supported by the Gulf of Mexico Alliance. This program is creating new resources which will assist local governments and consultants in optimizing public lands and creating data-driven priorities to site new housing development in safer locations. These resources will be available in late 2024 or early 2025.

- In May, the Coalition was awarded a grant by the Robert Woods Johnson Foundation to assess the cost and feasibility of building apartments to IBHS FORTIFIED standards for Multifamily properties. The project has 2 developer partners with 3 properties that will be built in 2025 that are supporting the case studies. AON is modelling the risks and avoided risks for these properties under the different standards. This project will also engage insurers, developers and housing finance thought leaders through virtual roundtables in the Fall to solicit input on financing mechanisms, insurance and resilient construction standards.

- In 2025, FHC plans to develop partnerships with expert organizations to address flood resistant materials and design for at risk areas, modular components and develop recommendations for elevation which can reduce risks and potentially improve insurance. Other recommendations will include optimizing site development to increase permeability, green spaces, stormwater management and low impact development strategies that support resident well-being and reduce onsite flood risks.

- Other efforts will include engaging universities, elected officials and housing decision makers.

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Preparing Port Canaveral for 2070: The Port Canaveral Vulnerability Assessment and Adaptation Plan

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[2]Jacobs

Background
Port Canaveral is a combined cruise, cargo, and naval port in Brevard County. The Port is the world's busiest cruise port, with more than 6.8 million passengers and 7.1 million tons of cargo passing through in 2023. The Port's coastal location is exposed to coastal hazards including sea level rise and hurricanes, and exposure is expected to increase due to climate change. Port leadership recognized the inherent challenges facing the Port and in 2022 enlisted Jacobs to conduct a vulnerability assessment and develop an Adaptation Action Plan. The purpose of this project was to identify the vulnerability of Port critical infrastructure to flood and other natural hazards and develop a plan to help the Port protect its assets and maintain reliable and safe operations.

Planning and Process
Jacobs conducted a vulnerability assessment to understand the effects of natural hazards and dependencies on Port operations and sustainment. Jacobs evaluated asset exposure and sensitivity to a variety of natural and climate related hazards to gain an understanding of asset vulnerability over time. Jacobs then evaluated the likelihood and consequence of hazards impacting vulnerable infrastructure. The result was an understanding of facility vulnerability and risk for natural hazards including flooding and high winds.

In addition to the vulnerability analysis, stakeholder engagement was conducted for both internal Port stakeholders and external stakeholders who support Port operations. At the beginning of the project, the project team convened a Study Advisory Council comprised of CPA staff (engineering, information technology, public safety, operations, and real estate) to provide information and advice based on local knowledge and historical context. A stakeholder engagement workshop was conducted with the Port's safety tenants and partners, including the Brevard County Sheriff's Office, Fire Rescue, and the U.S. Coast Guard to keep stakeholders informed of the process and incorporate safety and emergency response into the adaptation plan.

Solutions and Results
The Port and Jacobs developed an adaptation strategy that functions as a living document. The Adaptation Plan contains both a suite of adaptation strategies that can reduce the Port's risk to natural hazards and a roadmap for implementing the recommended projects. The plan identifies that the Port has a good foundation to enhance its resilience against natural hazards.

The adaptation strategies are a mixture of physical projects and policy or design standard initiatives. The physical projects were developed with the intent of reducing risk at critical facilities, including the cruise terminals, critical access roads, and shorelines. Each action contains a project definition and planning level cost estimates. Policy recommendations include forward-looking design guidelines and enhanced capital project prioritization to promote near term implementation of the adaptation projects into the Port's capital improvement planning process.

As a result of this project, the Port has already begun advancing recommended projects including incorporating future conditions into its designs. For example, new parking garages are being designed and built at higher elevations to reduce exposure to future flood events. The new Cruise Terminal 4 is being designed with passive and active flood defenses, ensuring the Port is a climate-change ready facility of the future.

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The New ASTM Property Resilience Assessment Guides Risk Mitigation Investments in Florida

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Background
While the ASTM Property Resilience Assessment (PRA) Guide is forthcoming, it is in use around the Country by owners of commercial and industrial real estate to: (1) identify current hazards and future climate impacts that are present at a property; (2) estimate the vulnerability of the property and the significance of the potential damage/losses; and, (3) determine if feasible resilience measures exist and if they are cost-beneficial with a positive ROI.

This presentation will describe an actual PRA that took place for a South Florida hotel/resort and how the process led to the implementation of flood risk mitigation investments. The entities involved in the project were: the hotel/resort owners, environmental consultants, RiskFootprint™ scientists, flood prevention experts, vendors of flood barriers, and various architects and engineers.

Planning and Process
The project took place over several years. The first step was to answer the hotel/resort owner's question: "Given past flooding and hurricanes and given the location and climate change and sea level rise, should we keep the investments here or should we sell the properties and buy or build somewhere else." This question was answered by researching and preparing a community resilience study that looked at both the city, county, state, and federal resilience status at the present time and plans for the future. Once a decision was made that the owner would continue to do business at the existing locations, the second question was: where the major vulnerabilities to flooding, storm surges, heavy rainfall, and sea level rise were located. This was modeled using various existing open source and proprietary models. Depths in structures were determined at various event severity levels. With this information, values-at-risk were estimated, and feasible flood protections were identified with rough order of magnitude costs. The stakeholders that were involved included those parties listed above in Section One. The local government was also involved to help identify various applicable building code provisions for the renovations.

Solutions and Results
The solutions that were implemented included: dry floodproofing, wet floodproofing, removable flood barrier system, raising MEP equipment, floodproofing elevators and pool equipment and chemical storage, etc. The result was a hotel/resort that is much more resilient than previously. It is anticipated that there may be flooding in the subgrade with larger storms, but the water will not come into contact with critical equipment or infrastructure and can be pumped out when the storm subsides.

One lesson learned is that the PRA process is meant to be a screening tool to help commercial and industrial property owners better understand their risks and risk mitigation alternatives. The PRA process, without more, could be used to develop, for example, in a 5-year Capex/Opex Plan. Sometimes, however, owners may want to move quickly or even "leapfrog" into actual design level engineering and implementation of risk mitigation recommendations. The vendors need to anticipate this contractually and make sure that the owners understand that different contracts and different experts will likely be required to move to the design phase and implementation.

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Living in a Material World: Support for the Use of Natural and Alternative Materials in Living Shorelines

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Background
Living shorelines (LS) construction often integrates engineered structures such as breakwaters, retaining walls, and collars made of concrete, plastics, and metals meant to enhance restoration speed and augment physical engineering services; however, the environmental impacts of these conventional materials are typically not a substantial component of design considerations. Life cycle analysis (LCA) involves evaluating each period of an object's existence, including manufacturing, transportation, utilization, and degradation, to understand its cumulative effect on the environment. Recent work has begun to consider the implications of material use in specific restoration applications, but there is currently an absence of a systematic, comparative LCA for these materials, limiting an informed justification for the transition from conventional to alternative materials. This is particularly important in LS construction and coastal restoration where project goals typically include maximizing benefits while minimizing negative impacts and demonstrating sustainable environmental ethics. Incorporating the full life cycle of materials via LCA demonstrates the breadth of variation in impact between artificial and natural materials, providing a more complete review of the cumulative costs of their use and providing an understanding of these materials necessary to minimize the adverse environmental impacts of LS development.

Planning and Process
This literature review manuscript involved a systematic review between 2020 and 2022 of peer-reviewed articles, industry documents, and engineering datasheets to understand the prevalence and usage of conventional and alternative coastal restoration materials and their life-cycle environmental impacts. This work was conducted in collaboration with researchers at UF across the engineering department and in IFAS to better understand material characteristics and applications in practice. Case studies were also collected from a range of locations to provide positive and negative examples of material selection consequences for various ecosystems and community groups.

Solutions and Results
We found that while conventional construction materials are the primary choice for restoration designers and managers because they are readily available, have an inexpensive purchase price, and exhibit predictable properties, the adverse environmental impacts from the life cycle process of each material, including production, transportation, installation, and degradation, should be accounted for in material selection criteria and warrants the evaluation of less impactful alternative materials. Natural and reduced-impact alternative materials such as rock, plant fibers, and biodegradable plastics can serve as viable alternatives with comparable availability and functionality while incurring reduced carbon, chemical, and particulate impacts. Our study reveals where there is a need for more detailed and standardized information on the life cycle of various materials in the coastal environment owing in part to the variation in material performance as a function of project aims and environmental conditions. Nonetheless, there are clear benefits to choosing alternative over conventional materials in many cases for both immediate project needs and overall coastal restoration goals, and our findings support the development of a new paradigm where material life cycle impacts are given more weight in the design process.

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Modeling Future Land Cover Changes and Quantifying Carbon Storage and Sequestration: An Integration of the InVEST Model and MOLUSCE Plugin

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Background
Land cover (LC) patterns shaped by human activities and natural processes have significantly changed over recent decades, particularly in coastal regions. These alterations, driven by factors such as urban expansion, deforestation, and climate change, have resulted in the degradation of coastal ecosystems, which are essential for carbon sequestration. The disruption of these ecosystems has exacerbated carbon emissions in coastal areas, contributing to rising atmospheric carbon dioxide levels. This situation is not the result of a singular disaster event but rather a gradual change over time, reflecting the cumulative impact of environmental shifts.

The challenge of preserving and restoring coastal ecosystems has drawn the attention of environmental organizations, governmental agencies, and research institutions. Collaborative efforts are underway to address the problem, with entities such as the U.S. Army Corps of Engineers and local governments working to restore degraded habitats and enhance carbon sequestration capacities. This approach aims to mitigate the long-term environmental impact, ensuring the resilience of coastal ecosystems and reducing global carbon emissions. This project examines restoration efforts in Northern Chesapeake Bay, particularly at Aberdeen Proving Ground, Maryland. By integrating sea level rise (SLR) impacts and quantifying carbon sequestration under various scenarios, the research promotes ecosystem restoration for public benefit.

Planning and Process
The project is part of a five-year, U.S. Department of Defense-funded initiative focused on implementing nature-based solutions, specifically living shorelines, to enhance coastal resilience. Currently in its third year, the project aims to construct living shorelines while addressing land use and land cover changes, as well as quantifying the ecosystem services gained or lost in the context of climate change, specifically carbon storage and sequestration. The planning process involved a comprehensive assessment of vulnerable coastal areas and included a multidisciplinary team of engineers, climate scientists, and landscape architects. This diverse expertise enabled the development of integrated solutions that address both environmental and military priorities.

Community engagement has been a key component throughout the project, with local stakeholders actively involved in planning workshops and feedback sessions. These efforts have ensured that the solutions are not only scientifically sound but also aligned with the needs and concerns of the surrounding community. The inclusion of military representatives and local government officials further strengthened the project's ability to balance ecological restoration with defense infrastructure requirements. By incorporating both scientific rigor and community input, the project is on track to deliver long-lasting environmental and socio-economic benefits.

Solutions and Results
This study uses the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) modeling tool with the Modules of Land Use Change Evaluation (MOLUSCE) plugin in QGIS to advance landscape ecosystem service measurement and scenario-based tradeoff comparisons, including LC change patterns, carbon storage, and sequestration. MOLUSCE employs historical LULC data, validated against current data, and integrates influencing variables through artificial neural networks, multi-layer perceptron, and cellular automata, enabling accurate future LULC predictions. This approach advances the accuracy of ecosystem service assessments and supports effective decision-making in landscape management.

Results show that by 2061, carbon storage without SLR scenarios is projected at 4,059,393 Mg C, with a sequestration of -54,087 Mg C. With SLR, storage decreases to 3,894,973 Mg C, resulting in a sequestration of -218,507 Mg C, equivalent to $11 million in net present value (NPV) loss and the annual emissions of 47,500 passenger vehicles. The NPV loss of carbon will reach a deficit of $2.74 million and 11 million by 2061 without and with SLR, respectively. These findings underscore the need for prioritizing restoration efforts and emphasize the importance of proactive interventions by landscape architects, ecologists, and scientists to mitigate climate change in coastal areas. This approach is transferrable for modeling future LULC and predicting carbon storage and sequestration to predict priority areas for restoration.

This research highlights that the disappearance of land significantly reduces the ability of coastal ecosystems to store carbon, a key element in combating climate change. As a result, it is imperative to establish and execute robust strategies to curtail land degradation and safeguard both carbon sequestration capacity and the ecosystems' broader ecological and economic benefits. Approaches such as living shorelines and thin layer placement (TLP) have gained recognition as practical methods for strengthening coastal resilience and protecting these vital environments. In addition, this study developed a conceptual design to pinpoint and prioritize the most at-risk areas within the study region.

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Outfitting the Florida Panhandle in Community Water Level Sensors

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Background

The panhandle of Florida is home to numerous estuaries, rivers, bays, springs, and globally rare coastal dune lakes. Like all of Florida, the area is experiencing unchecked growth, and the natural resources are struggling to keep up. As a result, there has been an increase in flooding in areas not historically prone to these issues, as well as issues in underserved communities that have been suffering from flooding for decades. With the increase in weather events such as hurricanes, other storm events due to climate change, and saltwater intrusion along our coast, our communities need tools and education to adapt to these new impacts and become more resilient. The Southeast Coastal Ocean Observing Regional Association (SECOORA) has developed a network of states along the Southeast coast that have installed water level sensors in communities to monitor flooding. However, there were none in the Florida panhandle. The goal was to place up to 20 water level sensors throughout a 7-county area in the panhandle of Florida where there were no sensors prior to 2023.

Planning and Process

For projects like this to be successful, "boots-on-the-ground" are desirable to have a connection to the communities where the sensors will be placed. Therefore, SECOORA reached out to Florida Sea Grant to partner in the effort for the Florida panhandle. A regional Florida Sea Grant Outreach Coordinator was hired to work with local Florida Sea Grant Agents, UF/IFAS Extension Agents, local authorities, and communities to identify appropriate sites to deploy water level sensors based on geographic location, accessibility, current and projected flood susceptibility based upon precipitation-based flooding, and compounding effects of sea level rise. Many of the sites are public boat ramps. Once sites have been identified and approved, sensors are installed by partners from Florida Atlantic University. The Outreach Coordinator then works with the surrounding community to encourage use of the corresponding online dashboard to provide useful data and information that can help inform local citizens and emergency managers and improve the overall safety and resilience of the community.

Solutions and Results

UF/IFAS and Florida Sea Grant Extension Agents partnered with the Southeast Coastal Ocean Observing Regional Association and Florida Atlantic University to install 10 water level sensors in the Florida panhandle. Counties included in the project were Okaloosa, Walton, Bay, and Gulf. Four more sensors are anticipated to be installed in December 2024 in Santa Rosa and Escambia counties. This effort now ensures that the Florida panhandle is included in the regional network of southeastern US community-based water level monitoring systems designed to engage communities by gathering data, monitoring flooding events, and increasing resilience. The sensors collect water level data, air temperature, wind speed, humidity, and precipitation, all displayed on a public facing online dashboard. Communities, once trained to use the dashboard, can use this data to make decisions. Community meetings have been held and engagement surrounding the sensors has been positive. Educational templates are being developed for use at community meetings as additional sensors are deployed and additional community meetings are scheduled. SECOORA is working on updating their public facing dashboard based on feedback to make the data derived from the water level sensors more user friendly and easier to interpret. Suggestions, such as the addition of time stamped video or photos on the dashboard at the water sensor sites are one innovation in the works. Data from the dashboard is also beneficial to the nascent estuary programs in the panhandle helping them to fill in data gaps as they pursue funding to preserve and protect the large panhandle estuaries.

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Cedar Key ShOREs – A Model for Co-Designing Nature-Based Solutions in a Small Coastal Town

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Background

Coastal communities are increasingly vulnerable to the impacts of climate change, including sea level rise (SLR), accelerated coastal erosion, and more extreme rainfall. The City of Cedar Key, Florida, USA, is a small municipality with particularly high exposure to climate hazards. Cedar Key is situated on the open Gulf of Mexico coast in a region with the 4th fastest SLR acceleration rate in the nation. Cedar Key is experiencing rapid shoreline erosion rates, and stormwater infrastructure is increasingly inundated with salt water. These hazards challenge low-lying neighborhoods that are important to coastal and inland residents (e.g., aquaculture workforce, lower-income visitors, and shore-based anglers), small business owners, and residents of public housing. Local leaders are aware of the need to act and know that this diverse cross-section of community members must be continually engaged. To this end, our interdisciplinary (Agricultural, Biological, and Geomatics Sciences; Built Environment Resilience; Geo and Stormwater Solutions; Soil, Water, and Ecosystem Sciences; Landscape Architecture; Construction Management; Civil and Coastal Engineering) team partnered with Cedar Key on a National Academies Gulf Research Program planning grant titled Cedar Key ShOREs (Shoreline Options for Resilience and Equity), followed by Phase 2 funding for a detailed design process (ongoing).

Planning and Process

The project involved a series of engagement strategies aimed at 1) collecting baseline opinions, 2) educating community members about climate risks they face and the options available to reduce risks, 3) building consensus around nature-based solution (NBS) options to apply locally, and 4) creating opportunities for community feedback to be heard throughout the process. We adopted a mixed-method approach for the data collection and analysis, including a survey, interviews, and workshops. Our team was divided into three main sub-teams, Shoreline team, Stormwater team, and Community Engagement team. All three sub-teams worked closely with community members and the government in the City of Cedar Key. In Phase 1, community workshops enabled the team to test out different conceptual design options in an open forum, where interdisciplinary experts were able to engage with community members. The make-up of the team – bringing diverse knowledge – and willingness to discuss informally with local residents created a foundation of trust. In Phase 2, the work has moved into a detailed design phase, and the 3 sub-groups are relying on their different skill sets to move the project forward.

Solutions and Results

In early 2023 we conducted an intercept survey to explore how residents of Cedar Key/Levy County and visitors perceived the town, the hazards related to SLR and stormwater, and their perception of different NBS. Survey responses (n=179) demonstrated environmentally aligned attitudes and a clear desire to protect shoreline and low-lying areas. We also found statistically significant correlations between effectiveness and aesthetics for almost all the infrastructure options, and many of these correlations were strong to very strong, especially for the stormwater infrastructure options. This means that the more beautiful or visually green the option is, the more effective it is perceived to be, even if the green look doesn't add anything from an engineering perspective. In addition, participants supported and trusted science-based solutions and wanted to learn more about NBS. We incorporated the insights from the survey responses into a facilitated series of co-design workshops that resulted in community-vetted conceptual designs for a comprehensive, nature-based watershed project that features green stormwater infrastructure and a large-scale living shoreline. The City has already implemented some of the immediately actionable options using local funds. We also collected “Shore Stories” from participants at the final workshop of Phase 1. These stories spoke to the very human reasons behind why addressing climate risks using NBS is important to community members. In Phase 2, we are co-designing engineering plans that incorporate NBS, including GSI and living shorelines, as part of a shoreline protection and stormwater management strategy that can serve as a model to other communities. Because we know that some barriers to the implementation of the proposed solutions were possible, we continue building local relationships and trying to understand the hopes, fears, and motivations of residents. To this end, we conducted interviews with twelve households in early 2024 to discuss the stormwater solutions they would like to see on (and around) their properties in more depth. We have community focus groups upcoming in May 2024 and community workshops to feedback on the design process at key completion points (30/60/90%). Through education, consensus-building, and participatory planning, the project empowers the community to understand and mitigate risks associated with sea level rise, coastal erosion, and extreme rainfall. In addition, by documenting the planning and design process, as well as the outcomes and community feedback, the project provides valuable insights that can inform similar initiatives elsewhere, thereby expanding the collective capacity to address climate change impacts. Moreover, the project promotes inclusive decision-making processes by involving a diverse cross-section of community members in planning and design activities. By incorporating input from various stakeholders, including low-income residents, small business owners, and public housing residents, the project ensures that the solutions proposed are equitable and address the needs of all community members. Finally, the project has the potential to influence local and regional policies related to coastal resilience and climate adaptation. By demonstrating the feasibility and effectiveness of nature-based solutions, the project may inspire policy changes that incentivize or require the integration of these approaches into coastal development and infrastructure planning.

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Data-Driven Spatial Planning for Coastal Flood Adaptation of Social Infrastructure

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Background

Climate change and environmental shocks like flooding have introduced uncertainty and challenges to economic development and community resilience, particularly impacting coastal communities. The anticipated increase in the frequency and intensity of weather extremes will likely stress these communities, affecting their built environments, local economies, and residents. The community infrastructure system, which includes both built and social infrastructure, is increasingly strained as it adapts to environmental changes. Community-based small businesses (CSBs), which are locally owned and operated, are vital for providing goods, services, and resources while functioning as social infrastructure promoting social connections. They bear the brunt of disruptions and are particularly sensitive to natural hazards. Despite their indispensable functions, CSBs are vulnerable to coastal floods due to characteristics that affect their resilience in business continuity and service restoration. Community-based exogenous factors can facilitate the resilience of CSBs. Notably, the built environment and the spatial contexts in which CSBs and customers are embedded influence the extent of disruption caused by flood hazards and the resourcefulness of CSBs in the recovery process. Given their dependence on user visitation to maintain functionality and promote community welfare, adaptive planning for CSBs requires thoroughly considering both the spatial context and their users.

Planning and Process

In this project, we expect to engage the local community and stakeholders (including CSB owners and planners) through focus groups and interviews to conduct a proof-of-concept evaluation of the proposed CSB spatial planning framework. We are currently at the end of Project Year 1 and have created a quantitative index that benchmarked the CSB catchment vulnerability of coastal communities in Florida, relying on the big-mobility data of CSB customers. We will specifically engage with a coastal city located in the Gulf region in Florida, affected by Hurricane Ian severely in 2022, for example, the City of Cape Coral (Lee County). The city has urgent needs and a high interest in the resilient spatial planning of CSB. As commercial centers such as CSB clusters are increasingly disrupted or at risk of climate events, there will be a need to examine new cluster locations as part of broader managed retreat initiatives. At the end of Project Year 3, we will engage planners and local chambers of commerce or similar economic development organizations.

Solutions and Results

In the first stage of this project, we constructed a CSB-Catchment Vulnerability Index (CCVI) that aggregates the vulnerability of CSB catchments based on access. The CCVI consists of two subindices: the Social Vulnerability Index (SVI), which assesses the socio-economic vulnerability of customers, and the Hazard Vulnerability Index (HVI), which evaluates the level of exposure to hazards within their catchment areas. Using the CCVI, we mapped CSBs' demand-side vulnerability in all 17 coastal metropolitan areas across Florida, identifying the spatial, community, and sectoral disparities in CSB catchment vulnerabilities. Our analysis of the CCVI spatial distribution unveiled a phenomenon we term the "Coastal Fringe Trap." In this scenario, CSBs located on the coastal fringe are more likely to serve socially vulnerable populations despite facing lower hazard risks. This trap may be further exacerbated by unintentional climate adaptation approaches, which could gentrify coastal areas and worsen the vulnerability gap. Given the changing climate and the expanded scope of coastal hazards, CSBs in this overlooked area may face increased risks of exposure to hazards, thereby exacerbating demand-side vulnerability. This finding contributes to the intersection of spatial planning and economic development by highlighting the need to balance economic benefits with vulnerability concerns. A comparative analysis of the CCVI across communities and sectors reveals the major metrics that contribute to place-based distinctions. It also identifies three types of demand-side vulnerability among CSBs in different sectors. The CCVI provides local and regional planners with generalizable and comparable metrics, identifying vulnerable spatial areas, key local industrial sectors, and specific root causes. Recognizing the dual role of CSBs as both social infrastructure for communities and economic entities, we suggest planning strategies that not only address customer vulnerability for CSBs but also facilitate resilient CSB service to vulnerable neighborhoods.

This project pioneers the quantification of the demand-side vulnerability of CSBs by integrating access-based catchment areas. We advocate for a shift in vulnerability assessment focus from CSB-centered structural and internal strength to catchment-centered attributes. Recognizing the distinctions among the industrial sectors of CSBs, we emphasized their different roles as social infrastructure or economic entities. We explored the adaptation demand not only by providing targeted support to CSBs but also by utilizing them as a strategy for mitigating challenges. A comprehensive understanding of multi-scale disparities in CSB vulnerabilities is fundamental for anticipating their resilience to environmental shocks and enhancing overall community planning for climate adaptation.

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Revitalizing McCoys Creek: Restoring Both Community and Waterway

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Background

The long-neglected McCoy's Creek in Jacksonville, Florida is a channelized and degraded urban creek that frequently overtopped its banks. Nuisance flooding has long been an issue in the Riverside neighborhood. The frequency of flooding along the adjacent McCoy's Creek Boulevard had reached a point far exceeding the level of service for the roadway and frequently interfering with residents' ability to travel safely. Initial proposals to address the situation only included the removal of McCoy's Creek Boulevard and did nothing to address the neighborhood connectivity that would be lost, the root cause of the creeks flooding, or the environmental health of the creek. The removal of the Boulevard would have significant impacts to the neighborhood's urban fabric and connectivity, but the neighborhood also had limited open space and almost no access to the creek itself. Groundwork Jacksonville realized an opportunity for comprehensive community investment and seized the opportunity to take a holistic approach to planning, combining the efforts to address flooding with a plan to restore the creek and create a new park corridor with the integration of the Emerald Trail network.

Planning and Process

In 2018, Groundwork Jacksonville was able to leverage private and grant funding to commission *The McCoy's Creek Visioning Study*. Groundwork Jacksonville hired an integrated design team, including SCAPE Landscape Architecture and Wood Engineering (now WSP), and working with the community, stakeholders, and the City of Jacksonville developed a vision for restoring the stream corridor that would not only address the chronic and extreme flooding issues but would provide open space and recreational opportunities and repair the degraded stream corridor. The McCoy's Creek Visioning process was guided by key goals established through outreach, engagement, and dialogue with the surrounding residents and other stakeholders. These goals were: restore ecological and hydrological function (natural channel design), reduce flooding, and create a community asset. Though a series of interactive events including the annual "Creekfest" with neighborhood residents, local partners, and other stakeholders the team developed a vision and framework plan for flood management and open space rooted in the hydrologic and ecologic restoration of the creek. The plan and accompanying analysis, specifically the cost benefit findings, enabled the City to refocus funding to include natural channel design.

Solutions and Results

The multi-year McCoys Creek Restoration, currently in construction, will reduce chronic and extreme flooding, restore native ecosystems, and expand open space and recreational opportunities in the community of North Riverside in Jacksonville, FL. The risk-reduction, health, recreational, and other community benefits of completed sections are already being experienced by the community. McCoy's Creek Restoration is transforming a flood-prone urban waterway in the heart of Jacksonville into an ecological and recreational amenity and destination open space for the surrounding neighborhood. Implementation of the plan is still in progress, but the surrounding neighborhood is already able to enjoy the benefits and amenities of the completed segments.

Key aspects of the project include:

- The removal of a low-lying roadway to expand the floodplain and restore natural meander and riffles and pools of the creek, restoring more natural hydrology while increasing food storage capacity.
- Retaining and enhancing access and connectivity throughout the neighborhood by improving newly created street ends, maintaining existing vehicular street crossings, and adding a robust accessible trail network through the neighborhood.
- Adding two miles of pedestrian and bike trails and park amenities to the neighborhood.
- Making the creek itself physically and visually accessible to the neighborhood.

The plan was adaptive and cumulative in a way that allowed the use of multiple funding sources and flexible implementation pathways. Over the years, Groundwork Jacksonville has been able to leverage aspects of the planning to seek out alternate funding sources for other areas of the Creek, as well as further recreational and ecological improvements. This has enabled the City and Groundwork to fund the construction of the place and performance they envisioned rather than build a project that was funded. This has also enabled them to phase the project, getting the first phase of the creek under construction within 4 years of completing the master plan while other phases were being designed. This approach meant that residents are already enjoying the benefits of less frequent flooding, new trails and open space, and access to the creek while still working out the design and implementation of more challenging stretches of the creek. Delivering tangible benefits quickly has helped maintain enthusiasm and even grown support and investment in the projects and other urban stream restoration + flood reduction + recreation projects in Jacksonville.

This work has expanded what began as a single purpose and reactive flood mitigation effort into a resilient new park and restored creek corridor in the heart of Jacksonville. This on-going cooperative partnership between the City of Jacksonville and Groundwork Jacksonville is a case study of the vital need for a comprehensive and integrated planning approach to urban flood management and resilience.

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Coastal Storm Protection Model

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Background

The background of the situation is that Florida's surface water and wetlands are facing challenges such as water pollution, flooding, and storm surges due to factors like precipitation, sea level rise, and human activities. These challenges have led to the deterioration of water quality and the health of wetlands.

Entities involved in responding to these challenges include local and regional governments, environmental organizations, and scientific institutions. The Center for Landscape Conservation Planning at the University of Florida is one such institution that has been working to inform agencies about land protection priorities. They have developed the CLIP 5.0 Surface Water Restoration dataset, which focuses on enhancing and preserving surface water quality and quantity in significant areas across the state.

This dataset integrates various data layers to prioritize land acquisition and restoration efforts, including connected wetlands, buffers, flood storage preservation, conservation status, and water quality impairments. The goal is to protect surface water resources and identify critical areas for conservation and restoration. The model's foundation is adaptable and can be used to address different water quality issues.

Planning and Process

The timeline for planning and developing solutions for surface water restoration in Florida's coastal areas can be traced back to the development of the Critical Lands and Waters Identification Project (CLIP). CLIP was originally developed to assist the Century Commission for a Sustainable Florida and the Florida Fish and Wildlife Conservation Commission's Cooperative Conservation Blueprint (CCB). It has since evolved to serve as a scientific resource for the U.S. Fish and Wildlife Service's Peninsular Florida Landscape Conservation Cooperative (PFLCC).

The process used to plan and develop solutions involves the use of Geographic Information Systems (GIS) datasets on significant natural resources in Florida. These datasets are used to identify critical ecosystems and establish statewide natural resource priorities. CLIP version 4.0 was developed with a hierarchical structure, comprising 20 fundamental natural resource data layers categorized into six Resource Categories: Biodiversity, Landscape, Surface Water, Groundwater, Water Restoration, and Marine resources.

CLIP 5.0 Surface Water Restoration focuses on enhancing and preserving surface water quality and quantity. It specifically targets areas where restoration or conservation efforts can reduce non-point source water pollution and enhance flood resilience. The analysis utilizes a comprehensive methodology to assess the risks posed by storm surges in Florida.

Solutions and Results

The solutions implemented to address the problem of identifying surface water restoration priorities in Florida include the development of the recent CLIP 5.0 Surface Water Restoration Dataset and the use of comprehensive methodologies to assess storm surge risks. The dataset incorporates various layers of data, such as wetlands, floodplains, buffers, water quality impairments, landscape development indices, and conservation metrics, to identify and prioritize critical areas for restoration. The dataset also emphasizes the importance of multiple core data layers in prioritizing land acquisition to protect significant surface waters with high water quality and natural floodplains.

Additionally, the use of land cover data, water data, and the National Hydrography Dataset helped generate crucial data layers for understanding stormwater impacts along the coastline to provide valuable insights to decision-makers and raise awareness about the potential dangers of storm surges along Florida's coastline.

At the core of the analysis lies the connected features mask layer, which includes all relevant characteristics associated with Florida's surface water network. The use of land cover data, both at a generalized level and with more detailed classifications, helps pinpoint suitable regions for conservation or restoration efforts. The "restorable" land cover classification is subdivided into restorable wetlands and uplands, based on a combination of hydric soils and land cover layers. While land cover data has limitations, it generally provides accurate data for statewide suitability models. The initial model utilized FNAI/FWC Cooperative Land Cover (CLC), while the latest employed Water Management District (WMD) land cover data, offering more detailed classifications. Vector data was initially used for land cover analysis but converted to raster for creating masks and prioritization models. Further differentiation of natural and restorable land cover into wetlands/uplands facilitated wetland restoration site identification. Critical zones for maintaining surface water quality include connected wetlands and upland buffers adjacent to surface waters and wetlands. These vegetated areas act as natural filters, enhancing water quality by trapping sediment and absorbing nutrients before they reach surface waters.

The analysis identifies and ranks areas with potential for natural land conservation and restoration, considering factors like restorable wetlands and uplands, flood storage preservation, conservation status, and water quality impairments. The approach also recognizes the importance of vegetated buffers and floodplains in enhancing water quality and floodwater storage.

In conclusion, the model's foundation, identifying connected wetlands, floodplains, and buffer zones, is crucial for addressing water quality issues and can be adapted to serve various objectives. This approach is ideal for entities aiming to acquire conservation lands or establish conservation easements. However, it may not suit every management objective, and adaptation is necessary based on specific needs.

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