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PROJECT INFORMATION

Project Director's Name*	Traci Birch
Organization*	Louisiana State University
Project Title*	Inland from the Coast: A multi-scalar approach to regional climate change responses
Reporting Period*	June 1, 2020 - May 31, 2021

Note to Grantees: In sections 1 to 5, we ask you to highlight your accomplishments (including outputs and outcomes) through this grant award. These sections of the final grant report will be made available to the public.

1. GOALS AND ACCOMPLISHMENTS

1.1 Please restate the goals and objectives of your project.*

The objectives stated in the project proposal include: 1) gathering and disseminating local ecological knowledge about landscape functionality; 2) providing high quality, accessible information on current and future environmental conditions to influence community decision-making; 3) evaluating past events to support adaptation responses, strategies, and best practices that are more emotionally and culturally sensitive; 4) defining community wellbeing priorities in coastal communities and inland migration destinations; 5) integrating ecological conditions and community wellbeing to foreground safety in planning and development decision-making; and 6) integrating climate adaptation design methods and best practices and other policy tools to increase the likelihood of effective implementation.

Outputs include: 1) calibrated and validated basin- and watershed-scale models for a coupled inland-coastal system, that can be used by community leaders and design professionals to provide decision support highlighting critical vulnerabilities and opportunities for adaptation at the community or neighborhood scale; 2) neighborhood-scale models that can improve safety and increase adaptive capacity at the local level; 3) profiles for current and future wellbeing in coastal and inland communities, including commonalities across regions; community outreach and educational resources including accessible web-based resources to help impacted communities become more resilient; 4) best practices for adaptive design and policy that incorporate ecological integrity and community wellbeing considerations; and 5) vision document positioning project findings particular to the Baton Rouge region in a regionally relevant context to maximize the transferability of this research to other regions and states.

The project identifies three distinct but interconnected research tracks:
• Regional Mapping and Hydrologic Modeling
• Defining and Measuring Community Well-being
• Design Application and Policy Framework

Four phases of work:
• Data Gathering and Assessment (month 1-9)
• Research Synthesis (month 9-18)
• Design Project Focus (month 18-39)
• Vision and Dissemination (requested through no-cost extension for month 36-48)

Goals for Phase 3: Design Process

Regional Mapping and Hydrologic Modeling
• Work with professional agencies and government to develop model interface for use in development decision-making

Defining and Measuring Community Well-being
• Toolbox for community health and wellbeing promotion – adaptation
• Preliminary cost/benefit analysis of potential social and environmental interventions

Design Application and Policy Framework
• Education on adaptation and wellbeing tools for government stakeholders, design professionals, developers, and community members

• Development of best practice models and methods
• Project-based design assistance in partnership with professional organizations
• Community workshop/design charrettes engaging public in process
• Draft of model ordinances that consider legal, environmental, and community health/wellbeing
• Fact sheets and/or FAQs on sector-specific research topics (e.g. elected officials, designers, floodplain managers, homeowners, etc.)

Goals for Phase 4: Vision & Dissemination

Regional Mapping and Hydrologic Modeling
• Completion of parameter work on land use & cover and river geometry for input into Amite River Basin Numerical Model
• Simulate coupled rainfall runoff and storm surge to better understand effects of large-scale landscape change on flood transitions zones
• Coordinate with design group on FUTURES modeling of past, present and future landscape conditions to identify opportunities for regional risk reduction
• Framework for transferability to other coastal-inland regions
• Peer review paper submissions
• Presentations at national conferences

Defining and Measuring Community Well-being
• Completion of truth testing for data sources used in pre- and post-flood Wellbeing Index
• Complete interface between Wellbeing Index and FUTURES modeling to better consider spatial and human dimensions when identifying opportunities for regional risk reduction
• Economic analysis of risk reduction measures related to FUTURES modeling scenarios
• Development of pilot mental health survey for future disasters
• Framework for transferability to other coastal-inland regions
• Peer review paper submissions
• Presentations at national conferences

Design Application and Policy Framework
• Complete community-based design products for Denham Springs and Baker, LA. Present to elected officials and citizens.
• Compile Ascension Parish and North Baton Rouge reports
• Regional FUTURES modeling of past, present and future conditions to identify opportunities for regional risk reduction

• Regional roundtable engaging resource managers, elected officials, planners, subject matter experts, and researchers around the topic of regional governance for flood risk reduction (full team)
• Development of model ordinances considering legal, environmental, and community health/wellbeing
• Creation of Amite Basin 'Vision' document pulling together modeling, wellbeing, design and policy research at the regional scale for future adaptation
• Framework for transferability to other coastal-inland regions
• Peer review paper submissions
• Presentations at national conferences

Reporting
• Collate final data and compile report for NAS

1.2 Describe the accomplishments of your project. You should include both the anticipated accomplishments that you outlined in your project proposal as well as any *unanticipated* accomplishments that have since occurred. Describe any activities you have conducted, programmatic progress made, or project benchmarks and milestones met.*

South Louisiana and the Amite River watershed are highly susceptible to flooding, which regularly occurs both through coastal storms impacts [e.g. Hurricane Katrina (2005), Isaac (2012)] and riverine flooding (e.g. 1983 and 2016 rain events). It was the most recent 2016 flooding that precipitated this research, with the explicit understanding that regional development patterns are unsustainable. To better understand how this coupled coastal-inland system functions, the team recognized that there was a need to better understand how the hydrologic, social, economic, and political conditions within the region have functioned over time. To address these gaps in knowledge, the research team set out with the following objectives: 1) gathering and disseminating local ecological knowledge about landscape functionality; 2) providing high quality, accessible information on current and future environmental conditions to influence community decision-making; 3) evaluating past events to support adaptation responses, strategies, and best practices that are more emotionally and culturally sensitive; 4) defining community wellbeing priorities in coastal communities and inland migration destinations; 5) integrating ecological conditions and community wellbeing to foreground safety in planning and development decision-making; and 6) integrating climate adaptation design methods and best practices and other policy tools to increase the likelihood of effective implementation. The following provides an overview of the anticipated and unanticipated accomplishments related to these objectives.

Modeling (Objectives 1 and 2): To accomplish objectives laid out in this proposal, was crucial to both

quantitatively and qualitatively assess past, present, and future conditions of landscape suitability for development. Note how the various modeling efforts worked toward this goal:

The focus of this research subgroup was to create hydrology, hydraulic and hydrodynamic models to look at: 1) whether changes to the Amite and Comite Rivers planform geometry (e.g., cutoffs and impacts from sand and gravel mining) changed the river hydraulics and flood inundations (Harris, 2020); 2) how development patterns (through changes in land use land cover and % impervious cover) changed runoff patterns throughout the basin and river hydraulics and flood inundations (Cowles, 2021); 3) integrating wellbeing and socio-economic data, through vulnerability and adaptive capacity metrics, with flood modeling (Guerin, 2021); and 4) how advances in compound flood modeling can be used to better define transition zones and flood risk to communities that may be impacted by combined riverine and coastal flooding.

The first two tasks, mentioned above, utilized archival datasets covering the Amite River Basin from the 1930s to present, with a goal of quantifying how historical anthropogenic changes impacted the hydrology and hydraulics. The hydrology and hydraulics for the research was conducted using a Louisiana Department of Transportation and Development (LA DOTD) funded model of the Amite River Basin developed by Dewberry, Inc. The Dewberry model is an integrated HEC-HMS (hydrology) and combined 1D/2D unsteady flow HEC-RAS (hydraulics) that was calibrated and calibrated by Dewberry for a range of actual storm events, including the August 2016 flood. Model properties (i.e., river planform geometry, % impervious) were modified based upon the historical datasets; the model was then re-run with the changes; and results were compared to the present day validated and calibrated model. The results from these tasks resulted in two MS thesis (Harris, 2020; Cowles, 2021) and will be summarized below.

Harris (2020) quantified relationships between the changes in the historical river planform and the resulting flow, stages, and subsequent flood depths. River lengths and sinuosity were measured from the 1930s to present, confirming there has been an overall 6 and 13% decrease in length and sinuosity of the Comite and Amite Rivers upstream of their confluence, respectively, from the 1930s to present. Planform geometries from four time period scenarios from the 1930’s to present were input into a combined 1D/2D unsteady flow HEC-RAS model, which was run using four spatially-variable rainfall events ranging from 1- to greater than 500-year return period flows to examine the significance on flood characteristics.

Analysis of the historical river geometry data show that the Amite and Comite Rivers have both experienced an overall decrease in length and sinuosity from the 1930s to present at varying spatial and

temporal degrees. The HEC-RAS model results show an overall increase in peak flow and stage magnitude corresponding to the overall decrease in river length and sinuosity, with slightly variable results for the intermediate time periods. The March 2016 event, a 2.8- to 6-yr flow event, appeared to show the greatest percent change in stage and flow across the rivers, given the magnitude of the event and the distribution of the rainfall. October 2017 and August 2016, 1.5-yr and greater than 500-yr return period flow events respectively, elicited the next greatest response in percent change in peak flow and stage. August 2017, a 1-year return period flow event, brought about little change in peak flow and stages due to the small magnitude and rainfall distribution not covering the reaches that experienced change.

Cowles (2021) utilized historical land use and land cover data to examine the spatial and temporal changes in rainfall runoff and flooding. Rapid development in recent decades has led to an increase of impervious surfaces in Baton Rouge and surrounding areas, encroaching on floodplains and wetlands. To model the effects of these historical changes, simulations were run in a HEC-HMS and coupled 1D/2D HEC-RAS model of the Amite River Basin for a variety of storms and land cover scenarios. The impacts of increasing surface imperviousness were more prominent at smaller spatial scales, where there has been significant development, and differences were more pronounced for smaller storms. At the basin scale, differences in flooding due to impervious cover changes were found to be somewhat limited, particularly along the main rivers and streams and for the larger, less frequent events. Given the low impact of increasing impervious cover on flooding caused by the August 2016 storm and other large storms, this work indicates that flood mitigation efforts in the Amite River Basin and similarly flood-prone areas are likely best suited to large-scale projects like the Comite Diversion Canal and Darlington Dam, as well as smaller-scale interventions to manage the impacts caused by higher frequency, lower intensity storms that are often controlled by backwater conditions.

For the 3rd task, Guerin (2021) looked at incorporating community vulnerability into existing flood risk approaches. Currently, identification of flood risk to flooding is limited and only includes economic (dollar damages) and public safety impacts and does not consider the phase dependency of the system, i.e., pre-, during- and post-storm, both critical shortcomings for more broadly assessing community risk and developing comprehensive plans and mitigation strategies. This work developed a framework based on a Flood-Vulnerability Index (FVI) approach and then demonstrated its usefulness, at the census tract level of detail, for three parishes in the Amite River Basin (East Baton Rouge, Livingston and Ascension) based on the August 2016 flood. The calculated FVI’s indicators are multidimensional and phase dependent: “Pre-Flood” Susceptibility Indicator (FSIPF); “During-Flood” Exposure Indicator (FEIDI); and “Post-Flood” Adaptive Capacity Indicator (FACIPF). The social and economic component of FSI, and FACI, were both computed using well-being variables developed as part of this project). FSIep was created using the

Flood Hazard Index (FHI) methodology developed by Kazakis et al., (2015); which serves to identify flood prone zones based on the community's hydrological, morphological and land-use, land-cover (LULC) characteristics. FEI was developed utilizing a structure inventory, included in Dewberry's Amite River Basin Numerical model, and direct economic loss shapefiles, produced for HEC-FIA (Flood Impact Analysis) model. These two shapefiles were spatially joined using only matching attributes between the two shapefiles.

Results from this work showed two primary trends. First, the shift from high pre-storm FVI values, indicating greater levels of susceptibility, in the East Baton Rouge Parish census tracts to high during-storm FVI values, indicating larger levels of exposure, in Livingston and Ascension Parishes that were inundated by floodwaters from the Amite and Comite Rivers. Furthermore, going from during-flood to during-recovery phase FVI, the number of highly vulnerable census tract areas increased within Ascension Parish and Livingston Parish along the southern end of the Amite River Basin. Given the severity and extent of the August 2016 event, this was not unexpected, but does highlight the ability of this approach to capture the spatial and temporal aspects of community vulnerability. While this demonstration used only a single event, future work could utilize this framework with probabilistic storm events to develop Flood Risk Indices. Finally, the framework allows for a very comprehensive and wide-ranging set of data types and sources, scaling and weighting techniques, and data aggregation methods. While the methodology and results in this work are limited by the availability of datasets and certain assumptions for scaling and weighting, the framework provides opportunities to identify data gaps and incorporation of more rigorous and meaningful statistics to identify and quantify Flood Vulnerability more accurately.

The 4th task, looking at the physics of compound flooding and identification of flood transition zones work resulted in multiple publications and this project partially supported two LSU PhD dissertations (Gao, 2021; Santigao-Collazo, 2021) and a number of journal publications (e.g., Bilskie & Hagen, 2018; Santiago-Collazo et al, 2019; Bilskie et al, 2021).

Low-gradient coastal watersheds are susceptible to flooding caused by various flows such as rainfall, tides, and storm surge. Compound flooding occurs when at least two of these mechanisms happen simultaneously or in close succession. Different inundation models, observed data, and/or a combination of these are coupled through varying techniques involving one-way, loosely, tightly, or fully coupled approaches to assess compound flooding. Modeling and identification of flow paths and inundation levels in these low-slope systems is even more challenging due to the impacts that the presence of anthropogenic and natural vertical features that can have significant. Ideally, accurate digital elevation models (DEM), now available at sub-10 meter resolutions, would be directly represented in the numerical

model discretized model grid (mesh). However, the computational expense of doing so is typically much too high and impractical. Therefore, significant elevation barriers such as roadbeds, levees, railroads, and natural ridges that conduct, impede or otherwise influence surface-water flow propagation, referred to throughout this dissertation as ‘vertical features,’ must be identified and considered in the development of an unstructured mesh. This project partially supported development of an algorithm, named PyVF, that automates the extraction of vertical features based on only two parameters, a differential elevation threshold and a local feature radius. In Gao (2021), the algorithm is applied to a state-of-the-art DEM at 1-m resolution to test the robustness of the algorithm for the automatic extraction of potential vertical features. Furthermore, the extracted potential vertical features are downscaled according to specified constant or variable sizing function, for use in unstructured mesh generation with fixation of vertical features, including direct assignment of DEM cell elevation, in the mesh. Of importance to this and future work, PyVF is also well-suited for overland flow/flood modeling, such as the HEC-RAS model mentioned previously.

While only partially supported by this work, some related work should be mentioned that shaped this and future work on historical and future landscapes. A series of hurricane storm surge models for past, present, and future landscapes of coastal were developed and used to examine the evolution of surge characteristics through the simulation of water levels and waves forced by a suite of historic hurricane events. These historic landscapes extend back to 1850 and include 1890, 1930, 1970, 1990, and 2010. Similarly, landscape projections have been made for the years 2030, 2050, 2070, 2090, and 2110, and the evolution of storm surge and waves has been examined. It was found that past changes in the landscape and surge characteristics are a consequence of local land river management and future changes will be driven by future relative sea level change. Some example publications of this work, include: Siverd et al. 2019a; Siverd et al. 2019b; and Siverd et al., 2020.

To understand the combination of rainfall runoff and hurricane storm surge a methodology was developed and applied to include surface water runoff in a surge model. A “what if?” case combining Gustav-like hurricane surge with ponded water from the historic 2016 Baton Rouge flood demonstrated the increase in peak and time-series total water levels when both events occur in close succession. Furthermore, the capability to add rainfall rates as a source term directly into the ADCIRC storm surge model (rain-on-mesh) was implemented. A major outcome of this work was a demonstration of flood transition zones and a method to delineate the zones (Bilskie & Hagen, 2018). An additional outcome of this effort is a recognition that combining rainfall runoff and storm surge flooding independently, as is traditionally done, results in an overestimation of the total water level.

Santiago-Collazo (2021), a PhD dissertation, primarily focused on the physics of compound flooding. In that research, a one-dimensional (1-D), fully coupled compound inundation model was developed based

on the Shallow Water equations. This model approach simultaneously simulates the free water surface variations in the ocean domain (i.e., tide and storm surge modeling), rainfall-runoff in the watershed's upland region (i.e., hydrology modeling), and compound flooding within a defined coastal transition zone. To test this compound inundation model, various 1-D transects, representing idealized low-gradient coastal watersheds, were applied under various forcing conditions (rainfall-runoff/tides/storm surge combinations) that vary in magnitude, time, and space. These flooding scenarios include antecedent rainfall conditions in the watershed region and tropical cyclone-driven storm surge. The primary goal was to evaluate each flooding mechanism and the associated hydrodynamic responses to aid in the identification of generalized coastal transition zones and enhance the production of flood maps for varying regions in the coastal watershed. The compound flood hazard zones' migration were evaluated for past, present, and future (c. 1890 – 2090) conditions of the Mississippi River Delta Plain using an existing two-dimensional (2-D) compound inundation model. This effort, as well as the previously mentioned research, provide a basis by which flood risk can be more rigorously assessed at the coastal land margin.

Finally, the methods described above were applied to better understand the effects of large-scale landscape changes on flood transitions zones across coastal Louisiana with focus on the NAS/RWJ study region. Bilskie et al., (2021) addressed the potential impacts of antecedent rainfall-runoff, tropical cyclone (TC)-driven rainfall, and TC-driven surge on total water levels and its influence in delineating a coastal flood transition zone for two distinct coastal basins in southeastern Louisiana (Barataria and Lake Maurepas watersheds). Note that the Lake Maurepas watershed is at the lower part of the Amite River Basin. Rainfall-runoff from antecedent and TC-driven rainfall along with storm surge was simulated using a new rain-on-mesh module incorporated into the ADCIRC code. Antecedent rainfall conditions were obtained for 21 landfalling TC events spanning 1948–2008 via rain stations. A parametric, TC-driven, rainfall model was used for precipitation associated with the TC. Twelve synthetic storms of varying meteorological intensity (low, medium, and high) and total rainfall were utilized for each watershed and provided model forcing for coastal inundation simulations. First, it was found that antecedent rainfall (pre-TC landfall) is influential up to 3 days pre-landfall. Second, results show that antecedent and TC-driven rainfall increase simulated peak water levels within each basin, with antecedent rainfall dominating inundation across the basin's upper portions. Third, the delineated flood zones of coastal, transition, and hydrologic show stark differences between the two basins.

Wellbeing (Objectives 3 and 4): Focus of this research subgroup was to: 1) create a wellbeing profile across the Amite River inland-coastal watershed that considered commonalities and unique community characteristics; 2) provide new evidence on risk factors that threaten wellbeing and undermine community health and resilience; 3) provide comparisons among impacted subgroups to expand the

understanding of risk and protective factors after multiple disaster exposures; 4) create educational and outreach materials for historically underrepresented and underserved populations, and guidelines for future translational work; and 5) build a framework for community wellbeing and resiliency transferable to other regions. This multi-disciplinary approach and team worked closely with the other two teams (modeling and design) to incorporate feedback loops with other researchers and community members to produce results that are useful and accessible to all stakeholders. Further, these data were developed with the intent that their outcomes could document the dynamic change in related to prolonged disaster exposures in a way that is useful to planners and design professionals focused on community resilience work. To this end, the wellbeing team conducted: 1) archival and best practice research, 2) focus group and scenario building workshops, 3) a mental health survey, and 4) created a regional wellbeing index. The following provides an overview of the anticipated and unanticipated accomplishments related to these outcomes:

Archival and best practice research: The team (Colten, Mukherji, Chan) completed a review of parish-level flood-management policies (e.g. comprehensive/master plans, zoning ordinances, floodplain and subdivision management regulations, etc.) with a focus on how communities adjusted their regulations between the 1983 and 2016 floods, to better understand how communities make themselves more resilient in the face of risk. Further, this subgroup examined public meeting proceedings and initial adjustments to similar policies and regulations between the 2016 flood (until 2019) to determine if there are different outcomes during the period in which most communities are most likely to undertake change. In both cases, the realization was that for the most part, communities do little to change their regulatory framework even when they have firsthand knowledge of their risk – favoring instead to believe that this is a once-in-a-lifetime event – despite similar repetitive impacts. After this grant started, the State of Louisiana has implemented the Louisiana Watershed Initiative, which is intended to serve as the coordinating program for floodplain management in the State, and to work to drive regional management in a way that reduces risk over time. The announcement and development of this program brought to the forefront (for the IFC team) the need to move beyond modeling (which is a key priority for LWI) and create workable models for watershed-scale governance if this program is to be successful. An unanticipated aspect of the IFC work was to conduct a review of river-basin scale flood management practices across the U.S. (2020), with the thought that this could further highlight nuance within the IFC project, but also better understand how this work may influence regional change in the future.

Focus groups/Scenario building workshops: This subgroup (Colten, Mosby, Mukherji) completed four (4) focus group discussions with local flood management experts in East Baton Rouge, Livingston, and Ascension parishes. These meetings took place early in the process, and sought out local concerns with flood risk and management that might not readily appear in hydrologic data and identified local priorities

for flood management. Further, this subgroup also completed three (3) scenario-building workshops in East Baton Rouge and Livingston parishes, and convened a group at the watershed-scale. The team used the US Dept. of Interior Scenario Building framework, which provides a set of conditions and actions relevant to participants (e.g. implementing green infrastructure, building new large-scale drainage canals, etc.), and then engages decision makers to identify key intervention points where they can focus attention, develop alternatives, and ultimately identify opportunities for reducing the negative impacts of an unfolding event. These exercises allowed local flood management experts to consider the range of flood mitigation strategies and helped identify options that they thought were feasible and preferable. Rather than scientific expertise, knowledge gathered was sought from everyday life and experience (which often includes considerations such as local political will or community preferences, a valuable source of information that is often overlooked in major environmental management projects.

Mental health survey: Symptoms of anxiety, depression, and post-traumatic stress in directly impacted communities are frequently observed after exposure to natural disasters, yet estimating elevations in symptom count data has proven difficult to obtain at a population-based level because 1) there was little baseline data, and 2) programs implemented immediately after the flood were short-lived and underfunded. This fact was not fully understood, and required a response not anticipated at the outset of this research. To overcome this problem, the team (Cherry, Birch) created an online survey to assess self-reported symptoms of anxiety, depression, and post-traumatic stress associated with the 2016 flood, and to better understand compounded impacts. The survey, which included 506 individuals (M age = 45.44 years, SD = 17.07 years, age range: 18–86 years), was conducted approximately 24- to 36-months after the 2016 flood. Questions were contained in six modules: Module 1 assessed sociodemographic characteristics of the sample; Modules 2 and 3 assessed flood experience (including property loss, displacement, and prior severe weather exposures) and stressors (including moving out of flooded homes, filing for assistance with FEMA, dealing with insurance claims, the rebuilding process, cleaning and discarding possessions, locating people to do repairs, dealing with permits). Modules 4, 5 and 6 assessed mental health history, current mental health symptoms (post-traumatic stress, depression, anxiety), and self-rated health, respectively. These data show elevations in symptoms of post-traumatic stress, depression, and anxiety in respondents with flood damage to their homes compared to those who were exposed to the flood but did not have water enter their homes. Recovery stress and total recovery events were positively correlated with for all three symptom types. Identified predictors of elevated symptoms of post-traumatic stress, depression, and anxiety (age, gender, current flood status). Prior flood experience did not predict current mental health symptoms. These findings have important implications for the assessment of mental and behavioral health challenges after severe weather events.

Wellbeing Index: As noted, the geographic area chosen for this research was based on the pattern of

existing challenges common to coupled inland-coastal regions across the Gulf Coast and the Southeast US coastal region. The region is characterized by low elevation and slope, making it susceptible to frequent flooding. Due to low elevations and proximity to water, many of these areas remained undeveloped or were used as agricultural lands for generations – either through necessity or regulation. However, between 1980 and 2016 the area expanded and added 231,000 additional people, an increase of nearly 50%. Ascension and Livingston Parishes saw their populations more than double as the region grew outward away from the City of Baton Rouge toward the Amite River floodplain. Meanwhile, the urban core, and in particular communities of color, were left to deal with underperforming infrastructure and lack of investment. The floods of 2016 exposed the fact that 25-years of suburban development had greatly increased risk, without corresponding increases in risk reduction measures. Most construction is slab-on-grade, and approximately 91% of all of those who flooded were uninsured. The team recognized that these place-based risk factors - and others such as (but not limited to) repetitive flood impacts, access to parks – are detrimental to quality of life and wellbeing but are not easily captured in social vulnerability indices. To address these shortcomings, the team (Moles, Birch, Chan, Zhu, Yang et al.) developed and implemented an innovative index of community wellbeing to 1) establish baseline conditions for wellbeing in the region, and 2) quantify the human impact of the 2016 flooding for residents in the region. Index indicators included a range of data sources (e.g. US Census, USDA, FEMA, Louisiana Dept. of Education, LA Dept. of Transportation, etc.) categorized into four core categorizations that provide a foundation for better understanding regional wellbeing: community stress, economic health, environmental health (built and natural environments), and public health and safety. Comparisons of the pre- and post-2016 flood data using the index were an important accomplishment, as there were marked and verifiable shifts in the region, which have implications for policy, planning, and recovery strategies that mitigate adversity after flooding and other severe weather events. The baseline information was used across the group – by the design team and the modeling team – to better understand how place-based risk factors might be incorporated into a range of development decisions (e.g. infrastructure and post-disaster recovery investment). In particular, we know that all communities struggle with recovery – but that struggle is varied spatially. The long-term goal of this work is to quantify these differences in a way that can improve pre- and post-disaster recovery processes. Challenges included the availability of data, the age of data available, and a dearth of data related to physical and mental health, which we intend to address through future research.

Design and Policy (Objectives 5 and 6): The foundation for the Inland from the Coast (IFC) recognized that reducing flood risk and improving health, wellbeing, and quality of life must be approached at multiple scales simultaneously in order to be effective. With this understanding, the project operated at three scales: neighborhood, city, and parish (county). While interrelated, historically they have not been treated as such and are often studied and planned for individually. The team also recognized that design

and planning professionals with knowledge of the local context and culture offer a bridge and technical capacity to communities that can measurably improve community resilience; which also builds future professional capacity to address local priorities. Connecting research and practice required prolonged and sustained engagement of stakeholders - locally-engaged practitioners, academics , government agencies, and vulnerable populations – all with the commitment to long-term community resilience. While professionals can serve as an effective bridge, applying new concepts (e.g., coastal-inland flood modeling, wellbeing research, design best practices) within communities (especially following a disaster) also requires trust-building and recognition of past injustices, which can be enhanced by the knowledge academics bring to the table. These understandings – the need to work at multiple scales, the need to engage a range of stakeholders, and the need to build trust within communities - served as the cornerstone for all community-based IFC work.

This research subgroup included faculty from three universities (LSU, University of New Orleans, and Florida State), Louisiana Sea Grant, and engaged students from each of these institutions from the disciplines of architecture, landscape architecture, planning, geography, and law. Faculty and students built partnerships with design professionals affiliated with the American Institute of Architects (AIA), American Society of Landscape Architects (ASLA), American Society of Civil Engineers (ASCE), and American Planning Association (APA); regional policy makers, and community members who participated in education events and design workshops, applying enhanced flood understanding and community wellbeing priorities at the design project level. The outputs of this research subgroup included: 1) Professional education and collaboration, 2) community-based design guidelines that address community wellbeing and resilience priorities, and 3) legal and policy research to assist communities struggling with how to implement resilience efforts. The following provides an overview of the anticipated and unanticipated accomplishments related to these outcomes:

Professional education and collaboration: The adage goes, “those who can, do; those who can’t teach.” A primary tenet of this grant is that there is a need to close the gap between those who do and those who teach to improve resilience and outcomes in the Amite River watershed. To connect design, planning, and policy development projects with university-based research, The IFC team developed a series of education and information gathering opportunities to build a relationship with local chapters of national professional design, planning and engineering organizations. In total, there were six mid-day sessions (“Lunch-n-Learns”), certified to provide professionals with needed continuing education credits, that engaged local talent in key questions related to this research. Year one included two events to introduce professionals (architects, landscape architects, planers, and engineers) to the three themes of the grant (i.e. modeling, wellbeing, design), evolving local issues and opportunities, and most importantly to gather feedback from professionals about their interest and concerns moving forward (92 participants).

Year two included three events focused on the following topics: 1) engaging local professionals in discussing the use of fill in local building practices [an issue important to rapidly growing communities (e.g. Ascension Parish) and one that potentially exacerbates flooding](65 participants); 2) Speed Design for emerging professionals focused on the intersections of community infrastructure and wellbeing (which helped develop strategies for Baker)(30 participants); and 3) the appropriate phasing and design of green infrastructure and multi-use spaces after a buyout program (provided context for Denham Springs)(18 participants). Finally, in year three the team held a session that focused on the ways hydrologic modeling can aid architects, landscape architects, planners, and civil engineers in making community development decisions (35 participants). It should also be noted that a core team of six design professionals also participated in the community-based design processes. Further, IFC researchers met monthly with leaders from the local professional chapters to discuss strategy and how to effectively engage professionals in ongoing research. While this was a foundation of the grant, an unanticipated outcome was the sustained the interest of the professional community, which has helped to build bridges not just to the communities, but also between the Coastal Sustainability Studio and professional organizations. This has translated to further partnerships and funding opportunities for CSS.

Community-based design: The design and policy team - working closely with federal, state and local stakeholders - selected project sites at the neighborhood, city, and parish scales to develop strategies that reduce flood risk and improve health, wellbeing, and quality of life within the watershed. It is important to note that each of these communities was directly impacted by the 2016 floods, and had already been working with agencies such as FEMA and the Louisiana Office of Community Development to develop recovery strategies. The research team did not propose new processes, but rather worked with each community to further the concepts they had already identified and prioritized, and to build resilience and wellbeing into the framing. Partner communities include the cities of Baker and Denham Springs, the Plank Road neighborhoods in the City of Baton Rouge, and Ascension Parish. In each case, these are communities already doing the hard work, and asking the hard questions around how to make themselves more sustainable in the future. The research team used this opportunity to build relationships and bring capacity to these communities in a way that encourages positive change at each of the identified scales.

The work in Baker, Denham Springs, and Plank Road included prolonged community participation and design processes that yielded a range of rendered projects, policy recommendations, and funding strategies intended to move closer to implementation of resilience and wellbeing projects (See attached community design reports). Engagement strategies were designed to first elicit the community’s definition of their own wellbeing based on local socio-cultural values and priorities. These concepts then served as the foundation for design work. For example, in the City of Baker a series of meetings with

local residents helped researchers and design professionals understand that the suburban development pattern, complete with large yards, big trees, and quiet neighborhoods where friends and neighbors can gather was the foundation for why many live in the community. Further, residents wanted more opportunities to walk through their neighborhoods and use public spaces to see friends and family. In developing flood mitigation strategies, the team focused on building stormwater management strategies into existing parks to make them more functional and efficient; to provide new greenway connections along bayous which can also provide additional water storage; and upgrade existing corridors with pervious paving and amenities to make bike and pedestrian travel safer. While these strategies aren't unique to Baker, the framing around the communities desired characteristics for wellness allow community members to see themselves in strategies that are often difficult to embrace. Design work included direct engagement between IFC researchers and residents that resulted in design guidelines; as well as a series of semester-long classes that coordinated architecture, landscape architecture, and civil engineering students to allow for 'deep dives' into specific project sites and issues facing each community. In each community, a person emerged who acted as a liaison between ongoing community planning processes and the IFC research team. These community partners were critical in 1) identifying key stakeholders who participated in interviews, steering committee meetings, and scenario-building workshops; and 2) building trust between power brokers within the community, such as elected officials, agency representatives and business leaders.

From the outset, the research team recognized the need to consider the entire watershed as a system in order to affect significant change. As noted, after this grant started before the State established the Louisiana Watershed Initiative (LWI) as a framework for reducing flood risk. A key element missing from this program is design, which will be key to developing large-scale multi-functional flood control/infrastructure investments. To this end, IFC partnered with the Louisiana Office of Community Development to further delve into the concept of designing a watershed. The design subgroup (Harmon, Mosby, Trahan) created scenarios of possible future development through a platform called FUTure Urban-Regional Environment Simulation (FUTURES). These scenarios envisioned a range of development trajectories (e.g. compact growth, sprawl, nodal expansion), which were layered with risk assessments from the hydrologic modeling team and conditions drawn from the wellbeing index. These complex scenarios were then presented as the foundation for a regional-scale (i.e. Amite River watershed) design charrette and roundtable. The initial design charrette engaged 32 professionals (e.g. architects, landscape architects, and planners) divided into four teams and focused on the following questions, which were drawn from the participant brief: To date, the Louisiana Watershed Initiative has generated significant data, ideas, and support. But where do we go from here? How can we turn data into visions, policies, and investment? How does this overall strategy lead to projects that: 1) Increase community health and well-being, 2) Build sustainable economies across the region, and 3) Lead to long-term

resilience in the face of climate change? The design component asked local and national experts to envision greater Baton Rouge, and the larger Amite River Basin, over the next 20+ years. In particular, the design work was framed around common concepts that emerged from the work with individual communities: Living with water, designing for active living, and connecting communities. The initial effort yielded a range of watershed-wide design schemes that were then presented to 95 decision makers, including elected officials, government agency and non-profit representatives for review and further discussion. While this work is still being synthesized into a regional vision report, it represents one of the first efforts in the state to think at this scale.

Legal research: The Louisiana Sea Grant Law and Policy Program staff provided support to the design and wellbeing teams throughout the term of the research. In particular, this subgroup (Wilkins, Pace, Daigle) compiled legal research topics such as (but not limited to) the following, which either stood alone or were included in the reports supplied to communities: 1) Review of state flood disclosure requirement for property sales and conducted a comparative analysis with other states. 2) Review of prior flood related litigation including Boudreaux case and MR-GO lawsuits (including pitfalls of relying on litigation to collect damages) 3) Conducted legal research into policy and case law on issues related to health and well-being for the gap analysis. 4) Conducted legal research into the development permitting process and floodplain management codes for Baton Rouge and the surrounding areas in preparation for drafting model regulations later in the grant. 5) Monitored planning commission agendas in areas of interest encompassed by this grant. 6) Monitored ongoing litigation related to 2016 floods. 7) Monitored changes to the National Flood Insurance Program. 8) Participated in American Society of Flood Plain Managers higher education committee 9) Continued (on-going) legal research into cases address flooding, recovery, property rights, takings claims, local government liability.

The Law and Policy team worked most closely with Ascension Parish Planning Department, who requested legal (versus ‘design’) assistance to study the impact of fill (i.e. dredged materials to raise properties above BFE) in new subdivision developments on pre-existing neighborhoods. In addition to legal research, the team attended public meetings to better understand the public’s perspective on this topic – which became very political during the period IFC researchers were participating. The team compiled legal opinions and briefs on concepts such as the following: 1) the consequences of failing to adopt the floodway in accordance with National Flood Insurance Program (e.g. removal from the program, consequences with mortgage lenders, etc.), 2) new “floodway” designations on FEMA flood maps, and 3) maintenance of new and existing retention ponds created from fill borrow pits. The Law and Policy team also met with students in the hydrologic design and landscape architecture classes to discuss how NFIP standards work, program shortcomings, and how program rules influence local development.

2. Outputs

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

** denotes required fields*

2. OUTPUTS

Outputs are tangible or measurable deliverables, products, data, or publications produced during the project period.

2.1. Please indicate the number of students (K-12, undergraduate, or graduate), postdoctoral scholars, citizen scientists, or other trainees involved in the project. *

Please enter 0 if none were involved.

K-12 students	0
Undergraduate students	261
Graduate students	127
Postdoctoral scholars	3
Citizen Scientists	16
Other Trainees	347

2.1a. Other Trainees *

Please describe who are the "other trainees" involved in your project.

As noted, a major component of this research was to engage design, engineering and planning professionals in a total of six accredited education events (e.g. Lunch and learns, design charrettes) where they earned needed continuing education credits and we were able to disseminate and/or glean information from them on key aspects of the work.

2.2. Has your project generated any data and/or information products? *

Generation of data includes transformations of existing data sets and generation of data from existing resources (e.g., maps and images). Information products include publications, models, software, code, curricula, and digital resources.

(Check all that apply.)

Responses Selected:

Data
Information Products

2.3. Briefly describe how you fulfilled the approved Data Management Plan and, if applicable, any changes from the approved plan. *

Due to the complex nature of the work conducted, the range and formats of quantitative data collected and employed was broad, including but not limited to: Environmental and ecological, climatic, hydrologic and hydraulic, infrastructural, digital elevation models (DEM), flood inundation, risk assessment, land use, demographic, current and historical policy documents, insurance, mental and public health, and socio-cultural information. Data formats included: tabular data sets, relational databases, geospatial and visual data such as maps, simulations and related data. Data obtained from a wide range of partners at the federal, state and local levels, and from publicly available databases, including databases available through United States Geological Survey (USGS), National Oceanographic and Atmospheric Administration (NOAA), United States Army Corps of Engineers (USACE), US Census Bureau, and the Federal Emergency Management Agency (FEMA) and/or the corresponding state agencies. During its use, data underwent quality assurance/control to the greatest extent possible to improve model, index, and

design outcomes.

Qualitative data was obtained by PIs from key community leaders and citizens through interviews, focus groups, and community forums. In addition to the approved Data Management Plan, the team conducted online surveys of local residents to better understand mental health issues and challenges related to impacts of the 2016 floods and past experiences with disasters. All qualitative data collection methods were reviewed and approved by the LSU IRB Office to guarantee the highest standards for human subject data collection, and only IRB-approved PIs had access to these files. Focus group data (Colten) was analyzed for major themes and shared with coastal scientists for integration into modeling activities. Interview and community meeting data (Birch) was compiled and synthesized for use in design and planning processes/outputs. Mental health survey data (Cherry) was analyzed to understand trends in comparison to past storms and other regions.

In accordance with LSU policies pertaining to data management, human subject data (e.g. audio recordings, transcriptions, notes, excel spreadsheets and survey results) was (when applicable) de-identified and is being stored on LSU’s password protected shared drive (LSU Box) and the LSU CSS secured network, which is accessible only to authorized faculty and staff. All files saved to the LSU shared storage drive and networks are backed up continuously. Data and text materials are being stored on the shared drive indefinitely. Three years after the conclusion of the award, the project data on the LSU CSS network will be documented, referenced and archived for long-term use in a secure LSU storage format. If required, Microsoft Word and PDF files will be transformed to more stable software formats and data will be moved to updated storage platforms for long-term management. The PIs (Birch & Willson) will work with team members to post public-intended data, metadata, and final products on the LSU Coastal Sustainability Studio's website (resiliency.lsu.edu/) and the LSU Digital Commons (digitalcommons.lsu.edu) within one year of the conclusion of this grant and will be in the standard formats for that repository (in accordance with LSU and Gulf Research Program policies for data sharing). The LSU Digital Commons is a digital collection of LSU's research, scholarship, and creative work. Using an open access platform, this repository allows for the preservation of documents as well as dissemination of information and data to a global audience. The materials will remain on this repository for the entire length of time that it is functioning. The data acquired and preserved in the context of this proposal will be further governed by LSU’s policies pertaining to intellectual property, record retention, and data management. Modeling data, including DEMs, GIS files, gage data, model inputs, etc, are all permanently stored and backed-up using LSU’s password protected systems – LSU Box, LSU OneDrive and LSU Center for Computational Technology servers.

If your project has generated data, please download the Excel worksheet entitled GRP Data Management Reporting. Use the "Data Report" tab in the worksheet to create an inventory of data sets that you produced and to verify deposit in a curation facility. Upon completion, please upload the worksheet to your task list. If you need guidance on how to complete the Data Report, please e-mail gulfgrants@nas.edu. A member of GRP's data management staff will reach out to you.

If your project has produced publications, websites or data portals, GIS applications, models or simulations, software packages or digital tools, code, curricula, or other interactive media, please download the Excel worksheet entitled GRP Information Management Reporting. Use the "Information Products Report" tab in the worksheet to create an inventory of these products and to verify deposit in a curation facility. Upon completion, please upload the worksheet to your task list. If you need guidance on how to complete the Information Products Report, please e-mail gulfgrants@nas.edu. A member of GRP's data management staff will reach out to you.

2.4. Aside from data and information products, what other tangible or measurable deliverables or products (e.g., workshops, trainings, and outreach events) were produced during the project period? *

Upon completion of this form, you may upload supplemental material that represent the tangible or measurable deliverables or products to complement this narrative report.

Baker, LA: Five public meetings (3 steering committee meetings and 2 public design charrettes)
Denham Springs, LA: Three public meetings (2 steering committee meetings focused on downtown and railroad park, and 1 public outreach effort at the 2019 Denham Springs Fall Fest)
Plank Road: Three public meetings (1 public outreach effort at the 2019 Martin Luther King Festival, 2 presentations to Build Baton Rouge and
Ascension: Participation in three public meetings organized by Parish officials
Scenario Building: Three scenario building workshops
Regional Workshop: One four-day watershed-scale design charrette (engaging design professionals), one one-day presentation of design work to decision makers (e.g. elected officials, agency and non-profit representatives)
Professional Engagement (Lunch and Learns): Six accredited professional engagement events

3. Data Management

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

* *denotes required fields*

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3. DATA MANAGEMENT

In this section, please provide a response to each question to complement the **Data Report** in the GRP Data Reporting Excel worksheet.

3.1 If you listed multiple data sets in the data reporting table, please briefly describe how these data sets relate to one another. *

These are discrete data sets. Most are data sets developed by students in partnership with faculty, each of which fed into the coastal and riverine modeling efforts. In addition, the dataset (Moles) includes indicator data for the Wellbeing index.

3.2. Please provide a list of additional documentation to describe the data listed in the reporting table (e.g., code books, lab manuals, workflow procedures). Enter none if you did not produce any additional documentation to describe the data. *

NA

3.3. Beyond depositing data and metadata in a repository, what other activities have you undertaken or will undertake to ensure that others (e.g., researchers, decision makers, and the public) can easily discover project data? What other activities have you undertaken to ensure that others can access and re-use these data in the future? *

Modeling: H&H and ADCIRC models and datasets have been stored on password protected sites. However, the theses, papers, reports, etc. are all publicly available with contact information. Wellbeing: This information has already been shared with a range of potential future partners (e.g. Blue Cross Blue Shield, the LA Department of Health and Hospitals). Further, this work will engage new research partners and funding sources as US Census data is released and the potential for temporal change to be monitored increases. The theses, papers, reports, and book chapters etc. related to this topic are all publicly available with contact information. Design: Outputs of this work include studio books and community design reports, all of which were printed and given to the communities for their use in implementation and funding requests.

3.4. Are any data products you produced sensitive, confidential, and/or proprietary? *

Yes

3.4a (yes). Were these sensitive, confidential, and/or proprietary data products described in the data management plan of the approved project plan? *

No

3.4b (no). For the sensitive, confidential, and /or proprietary data products that were not described in the data management plan of the approved project plan, please describe why they must remain confidential. Please note if (and when) you plan to make these data publicly available in the future or if they must remain confidential indefinitely. *

In addition to the approved Data Management Plan, the team conducted online surveys of local residents (565) to better understand mental health issues and challenges related to impacts of the 2016 floods, and compounded traumas and experiences with disasters (e.g. Hurricanes Katrina and Rita, etc). All qualitative data collection methods were reviewed and approved by the LSU IRB Office to guarantee the highest standards for human subject data collection, and only IRB-approved PIs had access to these files. Due to the sensitive nature of the data, the raw responses must remain confidential. Further, these respondents are also being engaged again for a five-year post-disaster survey and thus are still active research participants. However, the structure and overall results of the mental health survey have been published and disseminated.

3.4c (no). Please describe any other changes to your plan for managing restricted access to and re-use of confidential data since the approval of the project plan that are not captured in Question 3.4b (no). Briefly describe the new plans and procedures. If there are no other changes that are not captured in Question 3.4b (no), please state that in the text box.*

NA

4. Information Products

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

* *denotes required fields*

4. INFORMATION PRODUCTS

In this section, please provide a response to each question to complement the **Information Products Report** in the **GRP Information Products Management** Excel worksheet.

4.1. Please select the type(s) of information products that your project produced. *

Responses Selected:

1. Scholarly publications, reports or monographs, workshop summaries, or conference proceedings
2. Websites or data portals
5. Models or simulations

Scholarly publications, reports or monographs, workshop summaries, or conference proceedings *

Please provide a list of citations for project publication, reports and monographs, workshop summaries, and conference proceedings.

Conference Presentations:

Bilskie, M.V., S.C. Hagen, D.C. Del Angel, D. Yoskowitz, D.L. Passeri. “Climate Change Impacts Along the northern US Gulf Coast,” American Geophysical Union Fall 2019 Meeting, San Francisco, CA.

Birch, T. “Deep-seeded and uprooted: Colorblind resiliency planning as gentrification.” American Association of Geographers Annual Meeting. Washington, DC. April 4-7, 2019.

Birch, T. (Invited) “Inland from the Coast: A multi-scalar approach to regional climate change responses.” Robert Wood Johnson Sharing Knowledge to Build a Culture of Health Conference. Woodlands, TX. March 7-8, 2019.

Birch, T. “Inland from the Coast: Making the case for regional climate change responses.” Democracy in Retreat? Master Planning in a Warming World. New Orleans, LA. March 28-30, 2019.

Birch, T. (Invited) “Inland from the Coast: Measuring Well-being as a Guide for Community Development.” Challenges of Natural Resource Economics & Policy. New Orleans, LA. May 20, 2019.

Birch, T. (Invited) "Inland from the Coast: Measuring Wellbeing as a Guide for Community Development." American Institute of Architects, Louisiana Chapter, Baton Rouge, LA. September 2019.

Birch, T., Nelson, M., Ehrenfeucht, R., Lambeth, T., Williams, J. "Climate Justice and Adaptive Migration Planning in South Louisiana," American Collegiate Schools of Planning 59th Annual Conference, Greenville, SC. October 2019.

Birch, T. "Regional Resilience: Building adaptive capacity and community wellbeing across Louisiana’s dynamic coastal-inland continuum," Coastal and Estuarine Research Foundation Biennal Conference, Mobile, AL. November 2019.

Birch, T., Kitsinger, A., Passe, U., Barrera, S. L. "Rethinking Borders and Boundaries in the Cities along the Mississippi River Watershed," 108th Annual Meeting - American Collegiate Schools of Architecture, San Diego, CA. March 2020.

Birch, T. “Climate Justice and Adaptive Migration in Coastal Louisiana.” American Association of Geographers, Denver, CO. (Virtual) April 2020.

Birch, T. “Teaching Delta Urbanism in the Anthropocene: Educating to reduce risk and enhance wellbeing across Louisiana’s dynamic coastal-inland continuum." American Collegiate Schools of Architecture Teachers Conference. (Virtual) June 2021.

Birch, T. “Reimagining the watershed: Speculative Design for Envisioning Sustainable Water Systems.” State of the Coast: Investing in our Future. New Orleans, LA. June 2021. (Virtual, postponed from 2020)

Colten, C. “The eclipse of memory in the Amite River Basin,” American Association of Geographers Annual Conference. Washington, DC. April 7, 2019

Colten, C. “The eclipse of memory in the Amite River Basin,” 6th National Forum on Socioeconomic Research in Coastal Systems. New Orleans, LA. May 20, 2019.

Colten, C. “The eclipse of Memory in the Amite River Basin,” World Congress on Environmental History, Florianopolis, Brazil, July 24, 2019.

Colten, C. “Fixed Borders and Fluid Environments: Incompatible Boundaries in Coastal Louisiana,” American Geographical Society, Geography 2050 Conference, New York, NY, November 22, 2019.

Colten, C. “Fixed Boundaries—Changing Environments in the Amite River Basin,” Shanghai University, visiting distinguished scholar guest lecture, October 2019.

Colten, C., & Mukerji, R. “Scenario Building Workshops: Adapting a Strategic Science Technique to Qualitative Purposes in the Amite River Basin,” accepted for presentation at the American Association of Geographers annual meeting in Denver, Colorado, (Virtual) April 2020.

Cowles, A. “Impacts of land-use change on flooding in the Amite River Basin, Louisiana. LSU.” Department of Civil & Environmental Engineering Graduate Student Conference. Baton Rouge, LA. April 5, 2019.

Cowles, A., Willson, C., Twilley, R. “Effects of land-use change (1938–2018) on surface runoff and flooding in the Amite River Basin, Louisiana, USA using coupled 1D/2D HEC-RAS–HECHMS.” [Poster]. American Geophysical Union 2019 Fall Meeting, December 11, 2019, San Francisco, CA, United States. https://doi.org/10.1002/essoar.10501755.1

Daigle, M. “Where will the water go?” Challenges of Natural Resource Economics & Policy. New Orleans, LA. May 20, 2019.

DeLorme, D.E., Hagen, S.C., S.H. Stephens, R. Collini, K. Wowk, “Challenges and Opportunities for Building Coastal Resiliency through Convergence Research,” American Geophysical Union Fall 2019 Meeting, San Francisco, CA, December 9-13, 2019.

Eubanks, K. “Historic changes in the Amite River Basin stream network length and sinuosity.” LSU Department of Civil & Environmental Engineering Graduate Student Conference. Baton Rouge, LA. April 5, 2019.

Eubanks, K. E. “Changes in Planform Geometry in the Amite River Basin, Louisiana, USA, and the Impact on Flood Routing.” American Geophysical Union Fall Meeting 2019, San Francisco, CA.

Fagan, G. C. “Stormwater management in Louisiana: Cross-jurisdictional planning needed.” Challenges of Natural Resource Economics & Policy. New Orleans, LA. May 20, 2019.

Gao, S., Bilskie, M., Hagen, S., & Braud, D. “Hydrologic simulation and assessment of remote sensing products of the 2016 Louisiana flood in the Amite River Basin.” 2018 State of the Coast. New Orleans, LA. May 30 – June 1, 2018.

Gao, S., Bilskie, M., Hagen, S., Santiago-Collazo, F. “Increasing resilience to current and future flooding through the integration of hydrologic and storm surge models.” American Geophysical Union Fall 2018 Meeting. Washington, DC.

Gao, S., M.V. Bilskie, S.C. Hagen, “A Python program for Extracting Significant Vertical Features from LiDAR-DEM to improve Unstructured Finite Element Meshes,” American Geophysical Union Fall 2019 Meeting, San Francisco, CA.

Hagen, S. “The Mississippi River Delta Plain as a basis for understanding low gradient coastal land margin systems and how we may engineer our response to climate change.” 6th International Conference on Estuaries & Coasts. Caen, France. August 20, 2018.

Hagen, S.C., D.E. DeLorme, Z. Wilson-Kennedy, “Pursuing Convergence Research and Training in the Living Laboratory of Louisiana and throughout the Gulf of Mexico,” American Geophysical Union Fall 2019 Meeting, San Francisco, CA.

Hagen, S.C. (Invited) “Towards convergent research outcomes at the coastal land margin,” SECASC Regional Science Symposium, New Orleans, LA, November 13, 2019.

Hagen, S.C., “Towards convergent research outcomes at the coastal land margin,” IAHR World Congress, Panama City, Panama, September 1-6, 2019.

Harris, K.E., C.S. Willson, K.M. Konsoer, R.R. Twilley, 2020, “Spatially and Temporally Varying Changes in Planform Geometry in the Amite River Basin, Louisiana, USA and the Impact on Flood Routing”, AWRA 2020 Virtual Geospatial Water Technology Conference: Complex Systems, August 5, 2020.

Moles, A, & Zhu, H. “Measuring individual community capacity, resilience, and recovery in three Louisiana coastal parishes.” American Association of Geographers Annual Meeting. Washington, DC. April 4, 2019.

Moles, A. (Panel participant) “Coastal hazard response, mitigation and resilience.” Challenges of Natural

Resource Economics & Policy, the 6th National Forum on Socioeconomic Research in Coastal Systems. New Orleans, LA. May 20, 2019.

Mosby, K., & Birch, T. "Inland from the coast: Measuring wellbeing as a guide for community development". Community Research Conference. Aug. 9, 2019. New Orleans, LA.

Mosby, K. "Designing resilient communities in an era of climate change: The multi-scalar connection between government policies, local development practices, and community wellbeing". State of the Coast. Investing in our Future. June 2021. New Orleans, LA.

Mukerji, R. “Changing geographies of flood mitigation policies: A case study of Central, LA.” 6th National Forum on Socioeconomic Research in Coastal Systems. New Orleans, LA. May 20, 2019.

Mukerji, R. “Changing Geographies of Flood Mitigation Policies: A Case Study of Central Louisiana,” [Poster] Southwest Division of the American Association of Geographers in Fort Worth, Texas, October 2019. (First Place Prize Winner).

Mukerji, R. "Qualitative Approaches to Understanding Changing Geographies of Flood Mitigation Policies," Annual Meeting of the Association of American Geographers in Denver, CO, (Virtual) April 6, 2020.

Pace, N. “Floodplain management: Law and policy concerns.” American Planning Association Louisiana Chapter Annual Conference. May 24, 2019.

Willson, C.S., “Inland from the Coast: An Update on the H&H Modeling.” American Society of Civil Engineers Baton Rouge Branch Luncheon, June 29, 2020.

Zhu, H., & Moles, A. “Measuring individual community capacity, resilience and recovery relative to population age in three Louisiana coastal parishes.” [Poster] 15th Annual LSU Life Course and Aging Center 2019 Spring Symposium.

Presentations Cancelled due to COVID-19 restrictions:

Cherry, K. E. (Invited). “Older Adults in Louisiana: Observations and Conversations after a Disaster.” Tulane University School of Public Health, New Orleans, LA. March 13, 2020.

Colten, C. “Fixed Boundaries –Changing Environments in the Amite River Basin,” invited guest lecture,

Eberhard Karls Universität, Tübingen, Germany, May 2020.

Mosby, K. (2020). "Building community resilience to climate change". [Poster] American Planning Association National Conference: Discover Inspiration. April 2020. Houston, TX.

Publications:

Bilskie, M. & S. Hagen (2018). Defining Flood Zone Transitions in Low-Gradient Coastal Regions." Geophysical Research Letters. 45(6). 2761-2770. https://doi.org/10.1002/2018GL077524

Bilskie MV, Zhao H, Resio D, Atkinson J, Cobell Z and Hagen SC (2021) "Enhancing Flood Hazard Assessments in Coastal Louisiana Through Coupled Hydrologic and Surge Processes." Front. Water 3:609231.doi: 10.3389/frwa.2021.609231

Birch, T, & Carney, J. (2019). "Delta Urbanism: Aligning adaptation with the protection and restoration paradigm in coastal Louisiana." Technology|Architecture + Design, 3(1), 102-114.

Birch, T, & Carney, J. (2019). "Regional Resilience: Building adaptive capacity and community wellbeing across Louisiana's dynamic coastal-inland continuum." In S. Laska (Ed.), Louisiana's Response to Extreme Weather: A Test Case for Coastal Resilience. New York, NY: Springer International.

Birch, T., Henry, I. and Nelson, M. (2021). "Disasters and the Built Environment: Understanding the Potential and Pitfalls of Urban Planning in Post-Disaster Recovery." In K. Cherry and A. Gibson (Eds), The Intersection of Trauma and Disaster Behavioral Health. New York, NY: Springer.

Cherry, K., Calamia, M., Birch, T. and Moles, A. (2020). "Assessing Mental Health after a Disaster: Flood Exposure, Recovery Stressors, and Prior Flood Experience." In K. Cherry and A. Gibson (Eds), The Intersection of Trauma and Disaster Behavioral Health, Springer.

Colten, C. (2017). "Floods Collide with Sprawl in Louisiana's Amite River Basin." Focus on Geography. DOI: 10.21690/foge/2017.60.2f

Colten, C. & A. Grismore (2018). "Can Public Policy Perpetuate the Memory of Disasters?" RCC Perspectives 3, 43-52.

Colten, C. (2020)." The eclipse of memory in the Amite River Basin." Open Rivers: Rethinking Water,

Place & Community, no.16

Colten, C. (2020). “Eroding Memories and Erecting Risk on the Amite River." Open Rivers 16 https://editions.lib.umn.edu/openrivers/article/amite-river/

Colten, C. (2021).” As Inland Becomes Coastal: Shifting Equity and Flood Risk in the Amite River Basin (USA).” Global Environment

Moles, A., Birch, T., Chan, Y., and Yang, D. (2020). “Community Vulnerabilities and Wellbeing after Disaster.” In K. Cherry and A. Gibson (Eds), The Intersection of Trauma and Disaster Behavioral Health, Springer.

Mosby, K., Birch, T., Moles, A., and Cherry, K. (2020). “Disasters.” In L. Kaye (Ed), Handbook of Rural Aging, Routledge/Taylor and Francis.

Pace, Niki L. (2018) “Unaware, Unprepared, and Unexpectedly Flooded: Improving Louisiana's Capacity to Respond to Flood Hazards,” 6 LSU J. of Energy L. & Resources Available at: https://digitalcommons.law.lsu.edu/jelr/vol6/iss1/7

Santiago-Collazo, F., M.V. Bilskie, S.C. Hagen, (2019) “A Comprehensive Review of Compound Inundation Models in Low-Gradient Coastal Watersheds.” Environmental Modelling and Software, Vol. 119, pp. 166-181, https://doi.org/10.1016/j.envsoft.2019.06.002

Reports:

Hammons, H. Jacobson, T., Nguyen, N., Peterson, E., Shah, T., Stich, X., Wright, A., & Harmon, B. (2019). "The Hungry River: Designing a Future for the Amite River’s Former Sand and Gravel Mines." Baton Rouge, LA: LSU CSS.

Black, J., Han, P., Hippensteel, C., Ji, X., Lott, S., Xu, M., Zhang, Y., and Harmon, B. (2019). "Spring Up! Denham Springs Master Plan." Baton Rouge, LA: LSU CSS.

Birch, T., Mosby, K. & Trahan, R. (2021) "Healthy & Resilient Baker." Baton Rouge, LA: LSU CSS

Birch, T., Mosby, K. & Trahan, R. (2021) "Denham Springs Resilience". Baton Rouge, LA: LSU CSS

Serrano, N. & Birch, T. (2021) "Plank Road" Baton Rouge, LA: LSU CSS

Theses/Dissertations:

Chan, Y. L. (2018). "An Index for Measuring Community Resilience to Flooding in Baton Rouge, Louisiana." Louisiana State University, Baton Rouge, USA. (Available: https://digitalcommons.lsu.edu/gradschool_theses/4666/)

Cowles, A. (2021). "The Effects of Historical Land-use Change on Surface Runoff and Flooding in the Amite River Basin, Baton Rouge, Louisiana USA Using Coupled 1D/2D HEC-RAS-HEC-HMS Hydrological Modeling." Louisiana State University, Baton Rouge, USA. (Available: https://digitalcommons.lsu.edu/gradschool_theses/5325/)

Harris (nee Eubanks), K. E. (2020). "Historical Changes in Planform Geometry of the Amite and Comite Rivers and Implications on Flood Routing" (2020). LSU Master's Theses. 5211. (Available: https://digitalcommons.lsu.edu/gradschool_theses/5211)

Gao, S. (2021) "Vertical Feature Delineation for Flood Hazard Assessments at the Coastal Land Margin" (2021). LSU Doctoral Dissertations. 5598. (Available: https://digitalcommons.lsu.edu/gradschool_dissertations/5598)

Guerin, A. (2021) "A conceptual framework for phase-dependent, composite flood risk index (FRI) curves based on the relationship between temporal probability of flood occurring (PH) and flood vulnerability index (FVI) along with maps of FVI within the Amite River Basin based on the August 2016 Flood." (2021). LSU Master's Theses. 5424. (Available: https://digitalcommons.lsu.edu/gradschool_theses/5424)

Mukerji, R. (2020). Changing Geographies of Flood Mitigation Policies: A Case Study of Central, Louisiana. Louisiana State University, Baton Rouge, USA. (Available: https://digitalcommons.lsu.edu/gradschool_theses/5084/)

Santiago-Collazo, Felix Luis, "Simulation of Compound Flood Events in Low-Gradient Coastal Watershed" (2021). LSU Doctoral Dissertations. 5577. (Available: https://digitalcommons.lsu.edu/gradschool_dissertations/5577)

Websites or data portals *

Please provide a list of project websites and data portals (including the website URL).

LSU CSS manages the websites css.lsu.edu and www.resiliency.lsu.edu, which both include information about this project and showcases documents and events related to the grant. Further, information related to master's theses and dissertations funded through this grant are stored at digitalcommons.lsu.edu.

How long beyond the grant period will you maintain the project website/data portal and its contents? Please describe plans to archive the website/data portal and its contents after regular maintenance concludes.*

Three years after the conclusion of the award, the project data on the LSU CSS network will be documented, referenced and archived for long-term use in a secure LSU storage format. If required, Microsoft Word and PDF files will be transformed to more stable software formats and data will be moved to updated storage platforms for long-term management. The PI (Birch) will work with team members to post public-intended data, metadata, and final products on the LSU Coastal Sustainability Studio's website (css.lsu.edu and resiliency.lsu.edu/) and the LSU Digital Commons (digitalcommons.lsu.edu) within one year of the conclusion of this grant and will be in the standard formats for that repository (in accordance with LSU and Gulf Research Program policies for data sharing). The LSU Digital Commons is a digital collection of LSU's research, scholarship, and creative work. Using an open access platform, this repository allows for the preservation of documents as well as dissemination of information and data to a global audience. The materials will remain on this repository for the entire length of time that it is functioning. The data acquired and preserved in the context of this proposal will be further governed by LSU’s policies pertaining to intellectual property, record retention, and data management.

Curricula for education and training, GIS applications, Models or simulations, Software packages or digital tools, or other interactive media, and Other *

If you produced any additional documentation to describe information products, please provide a list of this documentation (e.g., model or simulation documentation, software manuals, source code annotation).

NA

4.2. Beyond depositing information products in a repository, what other activities have you undertaken or will undertake to ensure that others (e.g., researchers, decision makers, and the public) can easily discover and access the listed information products? *

Engineering: H&H and ADCIRC models and datasets have been stored on password protected sites. However, the theses, papers, reports, etc. are all publicly available with contact information.
Community Wellbeing: The Wellbeing Index and accompanying datasets have been securely stored on password protected sites. Further, this work will serve as the foundation for future work once the 2020 US Census data is available – which will bring in additional researchers in who can/will work with the existing datasets and index outputs. As noted, while raw data is protected as per IRB protocols, the Mental Health Survey is currently being used as foundation for 5-year post-disaster studies. Further, PIs are working with the State of Louisiana and other mental health providers to determine possibilities of a large-scale dissemination of the survey in the event of future impacts. In both cases, the theses, papers, book chapters, and reports are all publicly available with contact information.
Design Outputs: The community-based design work produced throughout this grant was done in partnership with elected officials, community members, and organizations in each of the corresponding communities (e.g. Baker, Denham, Ascension, Plank Road, Amite River Watershed). All studio classes presented their work to the communities at the end of each semester, and several produced reports at the end which were digitized and printed for dissemination for use by the communities. Further, long-term design work which was conducted by CSS directly with community members (rather than as part of a class) was also put into reports and presentations that were given to communities for future use. This work was always intended to build on recovery work already being undertaken by the communities, and to provide a foundation for them to make implementation funding requests. To date we have books/reports presented to Baker, Denham Springs, and Ascension Parish. The work in the Plank Road corridor is currently being completed, as is the synthesis of the regional watershed. Both of these partners [i.e. Build Baton Rouge (Plank Road), and the Capital Regional Planning Commission and LA Office of Community Development will receive the final report and a presentation of the final work.

4.3. Are any of the information products you produced confidential, proprietary, or subject to special license agreements? *

No

5. Project Outcomes

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

** denotes required fields*

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5. PROJECT OUTCOMES

Outcomes refer to the **impact(s), consequence(s), result(s), or effect(s)** that occur from carrying out the activities or outputs of the project. Outcomes may be environmental, behavioral, health-related, or programmatic. Example outcomes include, but are not limited to: increased learning, knowledge, skills, and motivation; policy changes; actions taken by a group as a result of information generated by your project.

5.1. Please describe the outcomes achieved during your project and how they were assessed. For this question, we are interested in learning about the immediate short-term outcomes that have already occurred during or as a result of your project. Do not include long-term outcomes you foresee your work contributing to beyond the end of the project. *

Engineering: Two of the numerical modeling studies (Harris, 2020; Cowles, 2021) demonstrated the impacts (or non-impacts) that changes in river planform geometry and land use and land cover had on runoff and flooding. Results have been presented at conferences and reviewed by MS thesis committee members. Results from these studies show that, while significant historical changes have occurred, the impact of these changes depends on the magnitude and frequency of a storm event. Work done by Guerin (2021) highlights the spatial and temporal variability of flood vulnerability and the critical need to incorporate more than just economics into the calculation of risk. The compound flooding and transition zone work has demonstrated that the interaction between river and coastal flooding is not a linear complex and that future work on identifying flood risk will require new modeling approaches and more research on joint river and coastal storm probabilities.

Community Wellbeing: After the floods of 2016, it became clear that the communities sitting in the coastal/riverine transition zone (e.g. Baton Rouge, Houston, Easter North Carolina, etc.) are often poorly served by risk reduction tools available to communities (e.g. flood insurance, floodplain

zoning/regulations, etc.). In the Amite River Watershed, researchers understood early on that 91% of all impacted by recent flooding were without flood insurance. We also understood that suburban expansion into floodplains was not unique to this region, but a common practice nationwide that is poorly understood and rarely planned for. This index was developed in response to the fact that traditional social vulnerability indices a) heavily skew results based on race and economics, which b) fails to recognize that disaster impacts are hard to quantify but can severely weaken local communities. During the development and application of the Wellbeing Index, we were better able to document regional interconnections and complexity with regard to risk and recovery. The geographic setting, mix of community types, public & mental health data, and historical weather-related impacts provided us with a number of insights into community wellbeing as it relates to place. Of importance was the need to quantify community characteristics such as proximity to open space, public health histories, access/purchase of flood insurance, and other characteristics often overlooked because they don't present in typical forms (e.g. U.S. Census data), but which are critical to community wellbeing and risk reduction. In each case, the index provided a useful baseline for overall wellbeing – which wasn't preciously understood. The index provides a picture of community capacity, parish capacity, and coastal Louisiana as a whole, which is useful knowledge for both pre- and post-disaster planning purposes. Reducing risk and building resilience is often site-specific, and this work is helping to support partnership building and protocols for meeting the physical and emotional needs of community members which are being supported by outcomes of this work.

Mental Health Survey: We have documented both community-level and individual-level stressors that are directly tied to the devastating flood of 2016.

Watershed Scenario Building: We have documented the long-term struggle between basin-scale and parish-level administration of floods, and how the inability to manage at the basin scale fosters inter-parish conflicts and displaces risk from the upper basin toward the lower basin. This work also documented the preference for economic development over safe development. Local authorities have been reluctant to implement zoning or land-use policies that deflect development in areas with flood risks. Finally, we have documented the prevailing orientation of riparian risk reduction in local flood mitigation policies and the lapse among governing parish and state officials to insert climate change adaptation in flood management policies – with the exception of East Baton Rouge's drainage master plan.

Design: In each community, we have documented how communities define their own wellbeing, and developed design and planning approaches that embody these principles. This work has already translated to additional funding and extended partnerships between LSU and community members. For

example, CSS has received a National Endowment for the Arts (NEA) Our Town grant to work with the Baton Rouge Recreation Department and the Walls Project to further develop ideas developed in the North Baton Rouge/Plank Road corridor.

5.2. We're interested in hearing not just the results of your project but what are their implications for or contributions to:

- **offshore energy system safety,**
- **environmental protection and stewardship, and/or**
- **health and community resilience**

Please describe what you consider to be the most remarkable accomplishment or finding of your project. What can others learn from your accomplishment and finding? How do you see it fitting in with your greater field of study or community of practice? *

Engineering: [Most remarkable finding] While there have been (in some cases significant) impacts from changes in the Amite and Comite Rivers geometry and land use/cover (development) patterns, they most likely did not result in an increase in flooding due to the August 2016 storm. The increased risk as a result of this scale of event is due to development in the flood plain. In addition, smaller, more frequent rainfall events and any resulting flooding can be primarily attributed to development patterns. Therefore, it seems that at least three flood risk reduction approaches need to be implemented: large-scale infrastructure that can help mitigate the lower probability (less frequent) rainfall events; development outside of historic and current flood plains; and localized efforts to retain and/or slow down the runoff from areas that have been highly developed.

Mental Health Survey: [Most remarkable finding] The results of our online survey indicated that prior flood experience was unrelated to current symptoms of post-traumatic stress, depression, and anxiety. Implications for health and community resilience. Given the frequency of catastrophic disasters and increased likelihood of these events to reoccur in certain geographic areas, continued research on the psychosocial impacts of flood exposure over time is a valuable direction for future research. Further, our findings imply that multiple repeated assessments of mental health symptoms over time would be valuable. With multiple assessments that span a two-year interval or greater, researchers could describe trajectories of change and better inform the long-term threats to mental health at the population level in the years after severe weather events.

Wellbeing Index: More urbanized areas have much more extreme positive or negative scores on index

values. The rural areas are more moderate in all aspects of wellbeing. While there was a lot of movement out of the urban center for cheaper land and less traffic, the trade off is a loss of amenities and ease of transportation of all kinds. All communities seem to balance out their challenges in one aspect of wellbeing with a high level of wellbeing in some other area.
Interestingly, aging populations were correlated with higher wellbeing in the urban MSA. They were more likely to live in wealthier areas which likely added to the stability of the community financially, as well as them being less likely to be transient. An aging population in the rural areas was more likely to be correlated with lower community wellbeing, especially financial health.

Watershed Scenario Building: [Most remarkable finding] Local government officials, in the focus groups and scenario building workshops, indicated that they were distrustful of both the state and other units of government and attributed flooding to external administrative units (parish, state, or federal). This is a huge social/political issue that is not addressed in most basic hydrological modeling that guides flood risk assessment and mitigation planning.

Community Design: [Most remarkable accomplishment] Prior to the Inland from the Coast (IFC) project, LSU had played a limited role in the processes and outcomes of community-based planning in the Amite River basin. Generally, prior projects were site specific, and engaged local residents and professionals in a very limited capacity. IFC engaged multi-scalar communities (i.e. neighborhoods, towns, and regional entities), hundreds of residents, elected officials, design professionals, and agency experts in a broad discussion of what it means to design for wellbeing, live with water in a flood-prone area, and invest in project that produce multiple benefits for residents based on their vision for the future. This project produced a set of community-vetted recommendations for reducing risk and enhancing quality of life based on best practices, an enhanced understanding of local conditions, and resident-inspired innovation. Inland from the Coast united input from subject matter experts representing multiple academic disciplines (science, engineering, design, and social sciences) and residents who shared their lived community experiences. By elevating the voices of residents and engaging them throughout the research process, the project produced unique, community-specific planning ideas that can improve health and wellbeing in each of these communities.

Overall: The most remarkable accomplishment of the Inland from the Coast project is the highly effective team building model developed, resulting in 1) lasting multi-disciplinary research relationships, 2) the development of sustained university-community partnerships, and 3) the introduction of transdisciplinary research frameworks to graduate and undergraduate students, who will one day contribute and/or lead in their fields. This project directly funded 15 researchers across 9 disciplines, and engaged numerous others across the university in community-based research supported by IFC. This group came together as

a disparate group, and came away as a much more coordinated partnership with a better understanding of each other's approaches to research, strengths, and how these could come together to accomplish complex goals. For example, we knew early on that there was a dearth of mental health data to help drive the development of the index, and provide a framework for community design. The development of the mental health survey needed to include questions about baseline mental health issues (led by PI Cherry), but address the relationship of mental health to place (with input from Birch, Colten, Nelson), and produce results that could translate to policy (with input from Daigle, Pace, Wilkins). This approach embodied how the team worked together through the grant to make sure we were integrating knowledge and expertise to achieve our goals. This approach extended beyond the research team to the students as well. IFC supported 34 graduate and 4 undergraduate students from 9 disciplines and 3 universities, as well as 8 LSU summer interns from outside the university. Throughout the grant, these students worked closely together in the CSS studio to collectively address complex issues and tasks. Students worked in multi-disciplinary groups to prepare for and assist in the process of community engagement; analyze regional environmental, social and political conditions; and develop design recommendations for future implementation. Students also worked across disciplines to submit to competitive design competitions, and to complete their own academic work. Examples include, geography and landscape architecture students teaching their architecture and engineering peers how to use and interpret GIS; coastal engineering students teaching their architecture peers about hydrology and modeling; and geography and law students presenting their work to design students so they might better understand how design recommendations might translate into implementation policy. In addition to the students working together in the same space (versus being separate in their respective departments), they also met weekly to give presentations, ask questions of each other, and to announce upcoming events that would be beneficial to the larger group.

6. Communication

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

* *denotes required fields*

Note to Grantees: In Section 6, we seek input from you to help us evaluate the Gulf Research Program's funding strategy. This section will not be made available to the public.

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6. Information to Inform GRP Evaluations

6.1. Sharing the difficulties you encountered helps us learn from your experience. Describe any challenges you encountered in your project and how you addressed or overcame them. Challenges are inherent to conducting any complex project. These may include (but are not limited to): unexpected staffing changes, changes in the community you are working in, appearance of a new technology or dataset in the field you are working in, challenges accessing a field site, policy or regulatory changes that affect the issue you are addressing, low recruitment rates, delays in setting up services, or other problems in implementing and conducting your project. *

Modeling (Willson, Hagen): 1) development and availability of the Amite River Basin Numerical Model (ARBNM), used by three of the graduate students, took a bit longer than expected (not surprising due to the complexity of the model). Because we did not want to have any "competing" models, our plan was to use the ARBNM. However, the delay did allow us to do more quantitative work on the historical data. 2) Attempting to incorporate some of the wellbeing data into the Flood Vulnerability Indices was challenging, particularly since COVID-19 made it very challenging to meet in person and spend time working through the types and quality of data. That said, the interactions with the Health and Wellbeing group was very good and productive.

Wellbeing (Birch, Cherry, Colten, Moles): One of the main takeaways from the Health and Wellbeing component of this grant has been the difficulty we encountered obtaining data necessary to better understand regional outcomes. With regard to mental health outcomes and flood exposure, there were no sources of archival data that we could obtain at the community-level from state level sources such as the Office of Mental Health. We overcame this challenge by developing an online assessment of wellbeing using psychometrically sound, clinical mental health indicators. This situation was similar for the development of the regional Wellbeing Index – some necessary data was hard to come by (e.g. Public health data), only available for a portion of the area – usually East Baton Rouge Parish, or not available at a scale that was useful (i.e. parish-wide versus block groups). Further, the timing of the work means that the most meaningful shifts to regional wellbeing will be noticeable once the 2020 US Census data is released. We suspect that some of the most compelling outcomes of the Index will be discovered in the next phase of research. Finally, there were challenges to accessing local government records (records not

set up for historical review). Finally, at times there was a bit of difficulty coordinating with the modeling group, in large part because they too were waiting on data, but also because their work tends to be less interdisciplinary.

Community Design (Birch, Carney, Harmon, Serrano): Greatest difficulty was accomplishing everything we wanted to do in the time allotted. The effort to engage community members, professionals, and agency representatives and complete design processes left little time to further analyze the work completed. Further, the work is generally an intensive, in-person process that was greatly interrupted by COVID.

6.2. We like to hear about what you learned from your work and how you feel it affects future work or the work of others. Think back on your project strategies, methods, and activities, what worked and what did not? Is there anything you would do differently in the future? If so, tell us what and why. *

Engineering: [How our work affects future work] 1) Our work on the complexities of modeling runoff and hydraulics, as well as compound flooding, should prove beneficial to others in the state and in other low-slope river/coastal regions. 2) Incorporation of wellbeing data into flood risk approaches will hopefully influence how local, regional, and state policy makers, planners and engineers identify and prioritize flood mitigation projects.

Wellbeing: [How our work affects future work] Given the difficulty we faced obtaining valid mental health indicators at the community level, we created an online survey to assess mental health outcomes. This was a very successful strategy in that we have usable data across a multi-parish region, which we are working in partnership with organizations such as the Louisiana Department of Health and hospitals and Blue Cross/Blue Shield to streamline and roll out in a larger capacity to provided that much needed baseline information for residents and agencies. Similarly, production of the wellbeing index was hampered by access to data on community characteristics (both spatial and temporal). While we are confident in the results for baseline conditions within the region, we are already cognizant of the need to run the index again with 2020 US Census data rather than 2010-2019 estimates to better understand the shifts in wellbeing spatially since 2016. Changes to the Census format may also require shifts in how we classify indicators and/or categorize outcomes. We are already considering potential funding sources to undertake this work.

Design: [How our work affects future work] During the course of this grant, the State of Louisiana

implemented the Louisiana Watershed Initiative. This program is intended to guide how the state prioritizes investment and how local governments undertake development and planning. We are working with regional agencies such as the Capital Regional Planning Commission and LA Office of Community Development to coordinate our findings with the implementation of this program. Specifically, we hope 1) our findings on inter-parish conflicts would influence the state's current Watershed Initiative and cast a light on what should be a priority to deliver on watershed scale management; and 2) that the results of our regional planning/design workshop will influence how the state prioritizes investment in green infrastructure, which enjoys broad support of the region, and can provide co-beneficial risk-reduction opportunities. Further, we would hope our findings help local governments seek out approaches to local governance, community planning and design that prioritize safety and bring it to the same level of importance as economic development. We are also hopeful that the community connections we have developed mean that these and other communities will work closely with LSU on this work in the future.

6.3. What are the next steps for this work, either for you and your project team or other researchers? Has this project led to other opportunities to work in this area? *

Engineering: This work has already led to at least one other project, funded by the US Army Corps of Engineers (USACE), looking at the impact of climate change on ecosystems in low-slope coastal margins impacted by river and coastal system. Furthering our work on "getting the hydrodynamics" correct based on the physics, vertical features, etc. is critical for coupling with ecosystem models that require inputs such as inundation depth & time, salinity levels, and nutrients will build on this project's work and results. We also have had preliminary discussions with planners who want to use information such as land use and cover, wellbeing and other indices to better inform decision-making and mitigation strategies.

Wellbeing: [Mental Health] The next steps for basic research in Health and Wellbeing component is to conduct a follow-up assessment of the online mental health survey. In future work, we plan to track the temporal course of elevated mental health symptoms to determine whether psychological first aid or other interventions to reduce adverse mental health impacts of severe weather events. Published findings from the online survey will lead to new opportunities for assessment. In particular, our findings should motivate researchers to develop a shorter assessment that could be administered using a smartphone or other device to facilitate data collection. [Index] As noted, next steps include securing funding to support a graduate student and additional research on the Index as the 2020 Census data is released. Having a clear picture of the aftereffects of the 2016 flooding (roughly 5 years out) will allow us to better understand how the region has shifted and how these shifts might inform modeling and

planning/design processes. Finally, Colten is launching a project that will consider the threats to historical landscapes in the zones of transition. What does the inland creep of coastal influences mean to critical cultural resources subject to increased flood risk?

Design: This work has already led to at one other project, funded by the National Endowment for the Arts, which focuses on improving stormwater management and quality of life in the North Baton Rouge neighborhoods. Further, CSS is working with the City of Baker to determine how the projects developed during the design phases can fit into the State's LWI initiatives for funding and implementation. Our goal is to continue this work with Denham Springs and other communities as well. This work has also generated a range of ideas that will help support course studio work at LSU (in disciplines such as architecture and landscape architecture) for the upcoming years. This work will continue to be used to teach the next generation of architects, landscape architects, and civil engineers about the importance of community wellbeing, risk reductions, and collaboration.

6.4. Have you developed new collaborations or partnerships (formal or informal) as a result of this work? If yes, please describe the new collaborations or partnerships. *

Beyond the collaborations and partnerships already mentioned, the following collaborations are notable:
Engineering: This project has resulted in 1) much closer and more direct collaboration with planning researchers and practitioners (e.g., Capital Region Planning Commission, Louisiana Office of Community Development, the Water Institute of the Gulf, and others) on incorporating wellbeing and other socio-economic data into mitigation strategies and approaches; 2) active involvement with Louisiana Watershed Initiative staff, supporting state agencies and practicing engineers and planners; 3) a proposal through The Water Institute of the Gulf to develop a Real Time Forecasting tool for the state.
Mental health: Interdisciplinary partnerships are critical to advance research objectives that pertain to psychosocial wellbeing and provide end users with evidence-based information to mitigate risks to health. We are in the process of developing new partnerships with the Institute of Women and Ethnic Studies (IWES), a non-profit organization in New Orleans, LA that is interested in basic research to inform the long-term post-disaster outcomes in the years after losing homes and property in a devastating hurricane.
Wellbeing (Colten, Birch): 1) Working with scholars at the University of Alicante in Spain. Our case study will provide a component of a larger international study that compares social impacts of flooding in coastal areas due to climate change. 2) Collaboration with scholars at U. of Georgia, U. of Florida, and U. of North Carolina to foster the development of environmental humanities scholarship on coastal areas. 3) Secured fellowship to participate in program at the Rachel Carson Center in Munich, Germany. My contribution (Colten) will focus on heritage landscapes at risk in coastal zones. 4) Currently producing two journal special issues on the topic of coastal cities in a changing climate (Global Environment and Frontiers in Science) which arose in the course of a workshop on that topic conducted at Shanghai University in October 2019 (Colten).
Design: This design work in the wake of the 2016 floods has resulted in additional funding from FEMA and the LA OCD to conduct similar engagement/design processes in SW Louisiana (e.g. Lake Charles/Calcasieu Parish, Cameron Parish, Vermilion Parish) with communities severely impacted by Hurricanes Laura and Delta (2020). This work will start in 2022 (January).

6.5. What, if any, positive changes in policy or practice do you foresee as a result of your work? *

Engineering: Incorporation of pre-, during- and post-Flood Vulnerability Indices into risk mitigation strategies. While our work was not definitive or all-encompassing, it does lay out the framework for how it can be done.
Mental Health: One potentially important positive change in practice that may result is to bring attention to the significant personal distress that individuals with flooded homes and properties experience. As a result of the online survey we created, there is measurable evidence of a rise in anxiety, depression, and post-traumatic stress symptoms that constitute a significant public health concern that can/should be addressed at the local and state levels.
Design: As previously noted, this project 1) allowed LSU to build partnerships regionally, which have already allowed us to expand this work both within the university and to additional communities. As we move forward, our goal is to work closely with the Louisiana Watershed Initiative to make sure that investments in watershed management engage designers and residents in the process EARLY, rather than as an afterthought once engineering plans are complete and funds are already spent.

6.6. If you could make one recommendation to the Gulf Research Program for how best to build on the work you conducted in this project, what would it be? *

Provide additional funds/opportunities to more directly apply the approaches and results developed to specific/additional communities or regions as case studies. This may include taking the results and actively applying the work to other areas, and/or including one or more of the IFC principal investigators as consultant(s) for future work designed to build upon and extend the present project outcomes.

7. Communication and Dissemination

Before the form is completed, you may click "Save & Continue Editing" at the bottom of the page at any time to save your work or "Next" to move onto the next page of this form.

When the form is completed, you may click "Mark as Complete" at the bottom of the page to save your work and return to the dashboard.

** denotes required fields*

Note to Grantees: In Section 7, we ask you to help us communicate the importance, progress, and accomplishments of your work. Information provided in this section will be used by the Gulf Research Program to highlight its funded projects in print and electronic informational and promotional materials. The intended audience for the information provided in this section is different and should be thought of as a general audience. When you return to the dashboard, you may upload images that represent and illustrate the work of your project.

7.1. Please describe the most exciting or surprising thing you have learned while working on this project in a way that is understandable by a general audience. *

The goal of this project was to create a framework to restore and enhance community wellbeing in the face of extreme weather and climate change, and support community adaptation strategies for sustainable futures. The project engaged engineers, social scientists, legal professionals, and designers in the Baton Rouge region to help this area recover from devastating floods in 2016. We learned many things about these communities, including: 1) how the water flows, and how much the built environment can change these flow patterns, 2) that every community has strengths and weaknesses that need to be overcome when a disaster strikes, and 3) that in spite of the difficulty of rebuilding in the wake of disaster, community members from all walk of life will come out and help to design the future of their communities so that they continue to live in a community that invests in all of the things that make their place home. Surprisingly, we also learned that no matter how we engineer or design our communities, we will always have risk. With changing climates and more extreme weather, it is nearly impossible to engineering total solutions. Therefore we need to design spaces to hold water, that also provide a respite for the stress of day-to-day life as well as the tolls disaster impacts can inflict on communities.

7.2. Do you have any stories that capture the impact of this project? (optional)

If so, please share one or two. Examples of what we are interested in include stories of people/communities that the project has helped; lives that have changed; work that led to policy change, such as legislation or regulation; and research breakthroughs.

(No response)

7.3. Have any communications, outreach, or dissemination activities occurred in relation to your project?*

Please describe:

- Any press releases issued (other than that issued by the National Academies of Sciences, Engineering, and Medicine) about the project.
- Any media coverage or news stories about the project.
- Any social media accounts, websites, listservs, or other communication vehicles used to communicate information about this project. Please include relevant web addresses if available.

This work has been featured in the following ways:
LSU released a press release on the award when it was given in 2017
Awards for student work: 1) https://www.iberianet.com/news/lsu-architecture-students-real-world-designs-continue-to-win-national-awards/article_d8cbd3aa-0720-11eb-b33a-5b2758bca2df.html , and 2) https://www.lsu.edu/mediacenter/news/2020/10/02arch_palagi_acsa.php
CSS Website: https://css.lsu.edu/project/inland-from-the-coast/
CSS Social Media: https://www.facebook.com/LSUCSS (primary platform); https://www.instagram.com/lsu.css/?hl=en