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Evaluating Community-Engaged Capstone Projects for Increasing Coastal Resiliency

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This study explores the synergistic potential of community-engaged engineering capstone projects to enhance coastal resiliency in the face of climate change-induced challenges, such as rising sea levels. Concept designs were developed to mitigate flooding in a coastal watershed, situated less than one meter above sea level, through the collaboration of 3 engineering capstone teams with a rural coastal community. Engaging virtually due to the COVID-19 pandemic, the project integrated community insights into the engineering design process, enabling a better understanding of local priorities and challenges. The analysis of the engineering process highlights 4 pivotal lessons: 1) Economic analysis emerged as a substantial hurdle for students, underscoring the necessity for more robust educational frameworks; 2) Community concerns leaned toward long-term financial sustainability rather than intricate design specifics; 3) The influences of community feedback and constrained student timelines shaped project focus areas; and 4) While community engagement effectively guided project direction, balancing it with technical guidance remains essential. The projects demonstrated integration of community priorities, particularly emphasizing economic and functional feasibility under past storm scenarios. However, identified gaps in addressing long-term resilience and economic analysis call for enhanced faculty guidance. This endeavor underscores the critical role of academic-community partnerships in engineering education, illuminating pathways to more sustainable solutions.

Keywords dredging, engineering education, flood inundation, nature-based solutions, wetlands, community partnerships

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Photographs. Students visit the tide gates on Outfall Canal and observe where Outfall Canal enters the Pamlico Sound (Hyde County, North Carolina, United States).

1. Introduction

Coastal communities must adapt to rising sea levels, which are causing flooding and adverse effects on human and ecosystem health (Moftakhari et al. 2015). Tyrrell and Hyde counties in North Carolina, United States, are ranked as 2 of the top 3 counties in the United States for the percent of the population expected to be displaced by sea level rise (SLR) (Hauer et al. 2016). Total annual county budgets for these counties were less than \$15 million each (Board of Commissioners of Hyde County, North Carolina 2022; Board of Commissioners of Tyrrell County, North Carolina 2022). Some single projects to adapt to SLR are similar in cost to these counties' entire annual budgets, illustrating the challenge that small communities face in building resilience.

Assistance from higher education institutions with engineering programs can provide potential support to communities with limited resources. The ABET (formerly Accreditation Board for Engineering and Technology) Engineering Accreditation Commission (EAC) curriculum requirements mandate a "culminating major engineering design experience" (ABET 2025). This experience presents an opportunity for engineering students' expertise to be used to address the challenges of local communities. Engineering students who participate in community engagement demonstrate higher academic performance and critical thinking skills and develop a greater appreciation of cultural differences through these experiences (Martinez-Mier et al. 2011; Natarajarathinam et al. 2021). Besides the project deliverables, communities receive benefits such as fulfilling unmet needs and establishing access to other resources available at the university (Gouws et al. 2011; Shelton 2016).

Beginning in the fall of 2020, our research team engaged a community with 3 engineering capstone teams to complete concept designs for solutions to coastal flooding. The research team was made up of a graduate student in the East Carolina University Integrated Coastal Sciences Ph.D. program and 4 faculty with expertise in anthropology, social ecology, operations research, and ecological engineering. Local stakeholders focused on the use of nature-based solutions. The study's objectives were to describe the designs produced by the capstone teams, examine the designs under future SLR, and present lessons learned from this interdisciplinary project.

2. Capstone Project Overview and Context

2.1. Lake Mattamuskeet

The student projects were focused on the Lake Mattamuskeet watershed in Hyde County, North Carolina, United States. Both ecologically and economically critical to the area, the lake has a surface area of 16,200 ha and an average depth of less than 0.7 m (USFWS 2022), with the bottom below mean sea level (MSL ~ 0 m NAVD88) (Geosyntec 2021). The lake is the centerpiece of the Mattamuskeet National Wildlife Refuge, managed by the United States Fish and Wildlife Service (USFWS 2022). Lake Mattamuskeet's watershed is approximately 27,600 ha (NCCFb 2018). Additional land uses in the watershed include row crop agriculture (15%), residences (1%), and wetlands (24%) (NCCFb 2018). Water elevations as low as 0.3 m NAVD88 cause substantial flooding. The lake drains to the Pamlico Sound through 4 canals, dating back to the 1830s, constructed during previous efforts to reduce lake water levels or drain the lake (Figure 1) (Forrest 1999). Tide gates were placed at each canal to preserve the lake's

Highlight

Community engagement helped engineering students address the perceived primary issues from the community, but the students did not consider future sea level rise to evaluate long-term effectiveness.

freshwater nature, opening only when the lake's water level was higher than the sound's (NCCFb 2018).

Due to increased flooding in the watershed and degradation of the lake's water quality (Moorman et al. 2017), USFWS, North Carolina Wildlife Resources Commission, and Hyde County collaborated to fund a watershed restoration plan. The planning process started in August 2017 and ended in November 2018 (NCCFb 2018). A core stakeholder group involved members of the research team in the planning (Etheridge et al. 2020). The goals of the restoration plan were to (1) "protect the way of life in Hyde County", (2) "actively manage the lake water level", and (3) "restore water quality and clarity" (NCCFb 2018). The plan suggested directing water to surface flow wetlands but included few details, and more funding was needed to begin the designs. Because of existing partnerships, the research team received support to have students develop concept designs for potential solutions. The research team's and community's shared goal was to provide the community with cost and effectiveness estimates so the community could decide which solutions to pursue further.

2.2. Capstone Community Engagement

Undergraduates in the Department of Engineering at East Carolina University (ECU) receive a Bachelor of Science in Engineering with one of 6 concentrations. The concentrations include biomedical, bioprocess, electrical, environmental, industrial and systems, and mechanical engineering. Capstone projects in the department span the year prior to graduation (ECUb 2025). Three teams were assigned to the Lake Mattamuskeet projects in August 2020 and completed work in April 2021. Each team was comprised of 4 students. Two or 3 students on each team were in the environmental concentration, and the rest were in the mechanical or industrial and systems

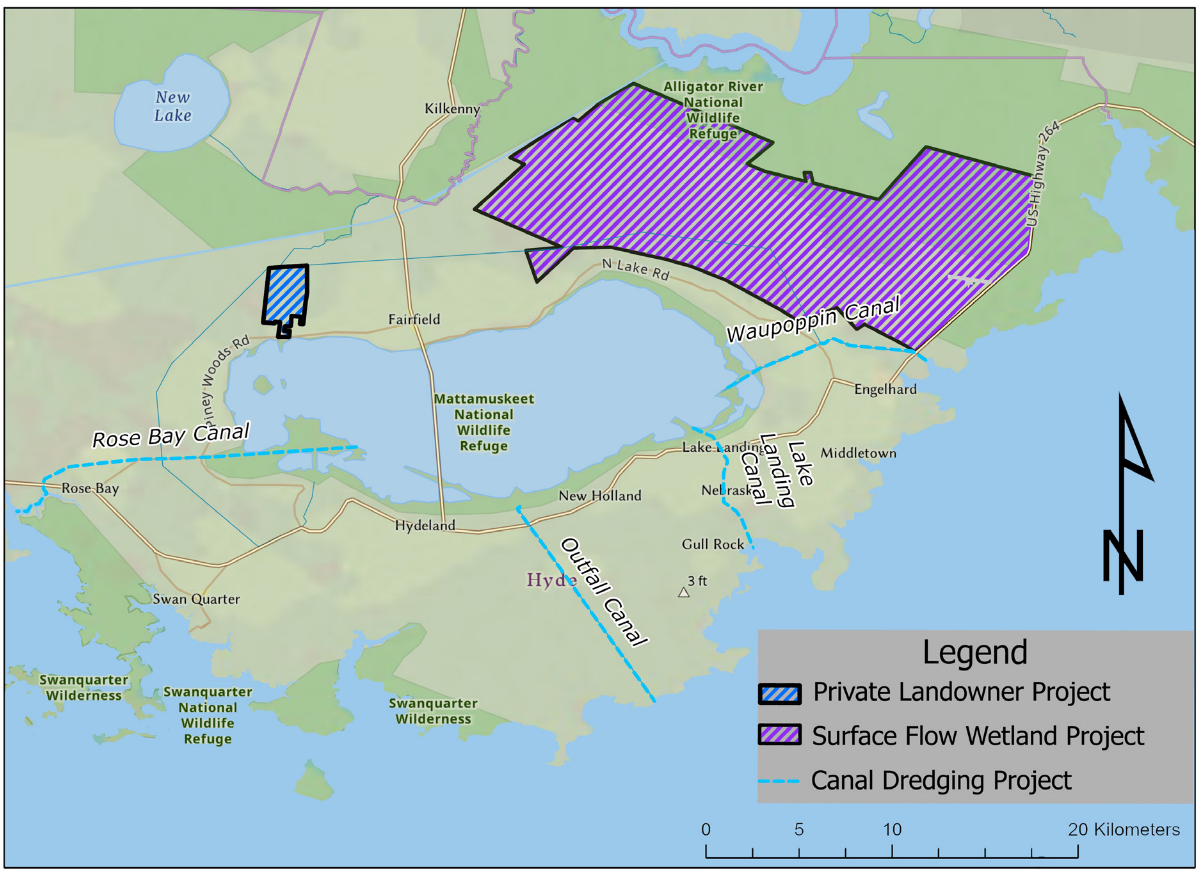

Fig. 1. Map of Lake Mattamuskeet and the locations of the capstone projects (map image, Esri 2018).

concentrations. The research team was not responsible for assigning students to the capstone teams. Teams are typically put together to provide the knowledge necessary for the project and balance student capability across all capstone teams. All teams are tasked with going through an engineering design process: (1) define the problem, (2) gather pertinent information, (3) generate multiple solutions, (4) analyze and select a solution, and (5) test and implement the solution (Khandani 2005). ABET student outcomes 1, 2, and 3 were assessed for each capstone team based on its final presentation and report (ABET 2025). This data was used to see how the community-engaged projects may have altered outcome achievement by comparing the 3 teams doing community engagement to the 13 other teams completing capstone at the same time.

Community engagement was included in each step of the design process. Details on community engagement training, the level of community engagement achieved, and the students' perspectives on community engagement can be found in Grace-McCaskey et al. (2022). The original community engagement plan included the faculty researchers engaging the broader community in selecting the projects assigned to the capstone teams and participating in regular, face-to-face engagement at public meetings. However, the COVID-19 pandemic required much of this to change. The core stakeholder group interacted with the students more often than any other group through long (2-plus-hour) virtual meetings that covered all efforts related to restoration of the lake—many of which were beyond the student projects. The core stakeholder group for this project was made up of leaders from agriculture, the hospitality industry, the residential community, and government agencies that had sufficient internet connectivity to participate virtually. Because of the COVID-19 pandemic, most of the students' interaction with the community was virtual.

All the capstone teams met weekly with at least 2 research team members. During the first weeks, these meetings included training on community engagement and the importance of community engagement in engineering design. Presentation practice was another essential part of the meetings, and the entire research team assisted the students in developing and making technically accurate presentations that could be understood by non-engineers.

The students first learned about the community's perspectives by attending a public meeting in August 2020. Thereafter, members of each capstone team visited the sites of their projects and talked with either the owner or manager of the property where the project would be located. In November 2020, each team presented 3 potential solutions to the core stakeholder group. The student teams considered the feedback they received when selecting the best solution. In February 2021, the research team organized focus groups where students could get feedback from key stakeholders on their projects. Members of the research team with expertise in social ecology and anthropology facilitated these focus groups. There was one focus group per capstone team. In addition to the students and research team, each focus group included 2 to 5 participants recruited from a list of attendees from the August 2020 public meeting. Those participants were local residents and/or landowners as well as non-local people who were interested in the lake. During each focus group, the student team presented its draft design, then the students and moderator asked discussion questions about the specifics of the design and the lake generally. In March 2021, the teams presented their concept designs to the core stakeholder group. Their presentations included estimates of effectiveness and costs. In spring 2021, the students used an iterative process to refine their designs to meet objectives, maximize benefits, and minimize costs based on their previous interactions with the community. It is important to note that the effectiveness of designs, as evaluated by the student teams, focused on flood reduction and water quality improvement. The students presented their final designs at a public meeting in April 2021. Due to the virtual nature and busy agendas of all meetings, the interactions between the students and community members could have been improved. In-person meetings would have allowed more informal and one-on-one interactions with community members before and after the official meeting time. However, attending the meetings allowed the students an opportunity to hear the community's perspectives on many issues, including the challenge of flooding. Full details on the original community engagement plan and what was able to be accomplished can be found in Grace-McCaskey et al. (2022). ECU's University and Medical Center Institutional Review Board approved all research activities conducted with community members and students.

3. Capstone Designs and Education Application

The stakeholders in the watershed wanted to consider 2 approaches for addressing flooding and water quality in the lake: (1) a single large project to move water out of the lake to reduce flooding or (2) many small projects with individual landowners, using nature-based solutions to reduce flooding and improve water quality. Due to the challenges presented by the pandemic, the core stakeholder group was the primary group providing input on the selected projects. Details on the selected projects and each team's final design can be found in Table 1.

Table 1 Summary of student projects, designs, and outcomes

Project Name	Key Objective	Design Summary	Estimated Costs	Community Feedback	Water Level Outcome	Water Quality Outcome
Private Landowner	Route drainage away from lake; treat drainage using surface flow wetland	66-ha area designated for drainage storage; use of a 0.6 m (24 in) axial flow pump; outflow controlled by 2 flashboard risers	Initial: $1.4 million	Community focused on water quality benefits, not flood protection	Adequate for project property; not evaluated for lake	1,500 kg annual reduction in inorganic nitrogen input to the lake*
Canal Dredging	Investigate dredging canals to alleviate flooding	Evaluation of dredging scenarios; recommendation to dredge Outfall Canal (12 km) to a shallower depth than original dimensions	Initial: $4.5 million – $6.75 million	Strong community support for dredging despite uncertainties	Lowered peak water level in lake, reduced flooding duration by 29 days	Not evaluated
Surface Flow Wetland	Reroute water to adjacent drainage entity to reduce flooding	Connect lake to 856-ha wetland for treatment; use of 2, 1.2 m (48 in) axial flow pumps; wetland outflow controlled by 5 flashboard risers	Initial: $2.2 million Annual: $450,000	Community focused on recurring costs once design shown effective	Lowered peak water level in lake by 0.12 m, reduced flooding duration by 35 days	Mean hydraulic retention time of 15.5 days; nitrogen concentration reduced close to natural levels

*(Chescheir et al. 1991, 1992)

The comparison of student outcome assessment shows little difference between the teams doing community-engaged projects and the rest of the class for outcomes 1 and 2 (Table 2). A larger difference does occur for outcome 3. For outcome 3, which is focused on communication, the students completing community-engaged projects scored higher. This is an expected result, as there was substantial emphasis on communicating with the community. The results indicate that community engagement improved communication but did not hinder attainment of outcomes 1 and 2. Given the small number of community-engaged teams (n=3), these comparative results regarding ABET student outcomes should be considered indicative. Further studies with larger samples would be necessary to confirm these findings with statistical confidence.

Table 2 Average scores from an ABET student outcome assessment, comparing the capstone teams participating in a community-engaged project to those not participating in community engagement. Student outcomes are assessed on a 1 – 4 scale with 1 being no significant achievement and 4 being superior achievement.

ABET Student Outcome	Community Engagement Teams	Other Teams
1: an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.*	3.3	3.3
2: an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.*	3.3	3.4
3: an ability to communicate effectively with a range of audiences.*	4.0	3.6

*(ABET 2025)

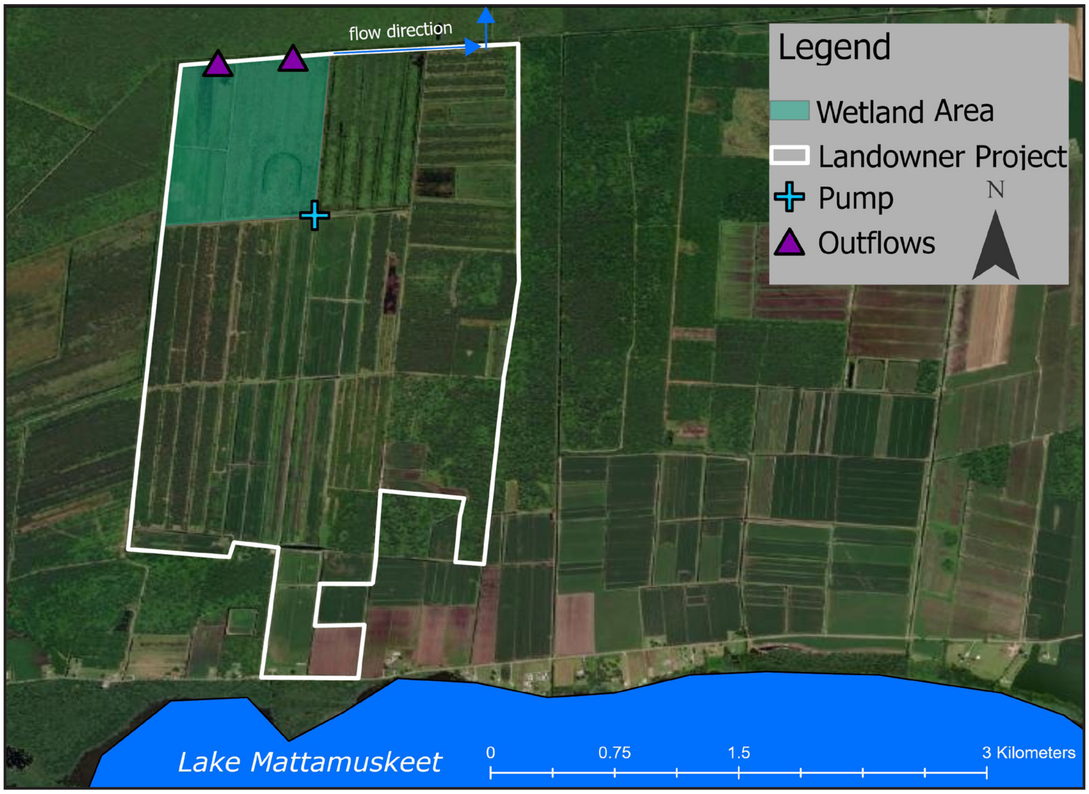

Fig. 2. Concept design for the private landowner project (map image, Esri 2015).

3.1. Private Landowner Project

The private landowner project (Figure 1, blue stripes) emphasized ecological engineering approaches by utilizing constructed wetlands to improve water quality and wildlife habitat on privately managed land. The property in this project has an area of 519 ha. The land was primarily forested, with a portion used for corn production. A berm surrounds the entire property, which keeps out surface water from adjacent properties and the lake. The landowner used ditches and a pump to drain the area directly to Lake Mattamuskeet. Pumping is needed because the lake's water level is often higher than water in the ditches. This project aimed to treat the drainage using a surface flow wetland before discharging it north to the Intracoastal Waterway (Messer et al. 2017). The students developed a water balance model and determined that a 66-ha area on the northwest corner of the property would be adequate to store drainage from the rest of the property (Figure 2). The stakeholders who interacted with this team focused on the wildlife benefits of wetlands, water treatment, and the use of this project as an example of what could be done with individual landowners throughout the watershed. Focus group participants expressed approval of the draft design and its potential as a long-term solution, but they felt it would have minimal impact on flooding. They emphasized consideration of impacts to neighboring properties and the importance of communicating with adjacent property owners.

Each capstone team had strengths and weaknesses in its design and analyses. These were often determined by what the students prioritized in their limited time. A strength of the private landowner team was putting together reasonable cost estimates. It wanted to show the landowner and the community what it would take to complete the project and the potential costs for similar projects. This team evaluated the project's water quality benefits but did not evaluate the flood protection benefits, likely because the team heard the importance placed on water quality while talking about this project with community members.

3.2. Canal Dredging Project

The canal dredging project primarily utilized conventional engineering methods focused on dredging to alleviate flooding, reflecting strong community preferences. The students considered implementing 2-stage channels as a nature-based solution, but bridge and landowner constraints made these unfeasible. Community members articulated that dredging the 4 canals that drain

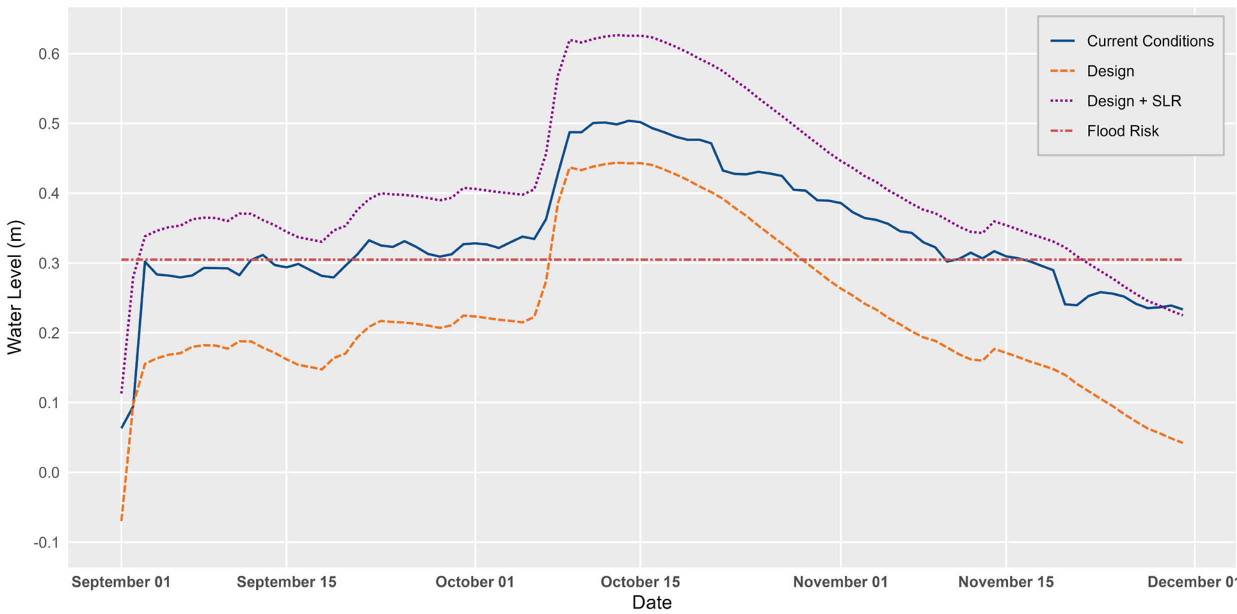

Fig. 3. Actual water levels (Current Conditions), simulated water levels with the canal dredging team's design (Design), and simulated water levels with the team's design plus 0.18 m of SLR (Design + SLR) in Lake Mattamuskeet during a 3-month period of 2016, which includes Hurricane Matthew. Note: Simulations clearly illustrate diminished effectiveness of canal dredging under projected future SLR.

Lake Mattamuskeet to the Pamlico Sound (Figure 1, dashed turquoise lines) was the preferred solution to the flooding problems. Conversations with the community revealed that the canals had not been maintained over multiple decades. Focus group participants expressed concern about flooding frequency and persistence on properties surrounding the lakes. While aware of the expense, they did not want cost to drive decision-making. They approved the draft design and expressed interest in a long-term solution that would provide beneficial effects into the future. The work of this team received the most attention from stakeholders, with the primary focus being on the potential reduction in flooding and costs.

The students used a hydrologic model for the lake to evaluate many scenarios. Based on their model results and estimated costs, the students recommended dredging only Outfall Canal to a shallower depth than its original dimensions (Table 1). Their simulations showed this solution would bring the lake below 0.3 m NAVD88 29 days sooner than without the project following Hurricane Matthew in October 2016 (Figure 3), a benchmark storm event that inundated the community. However, no estimates of the solution's effectiveness with future SLR or the project's effect on water quality were completed.

This capstone team spent considerable time evaluating design alternatives and project costs. These are clear strengths of its outcomes. The team's final presentation compared the reduction in flooding for dredging all 4 canals to its recommended design of dredging only Outfall Canal. Understanding the effectiveness of dredging the canals for reducing flooding and the potential costs was considered extremely important by the community. The capstone team acted upon this message. Two weak points included the need for more consideration of water quality and evaluation of the effect of SLR. These issues were separate from the primary topic of discussion about this project. However, evaluating how SLR would alter the effectiveness is a critical outcome that would have better informed the community.

3.3. Surface Flow Wetland Project

The surface flow wetland project (Figure 1, purple stripes) explicitly incorporated nature-based solutions through the use of constructed wetlands designed to mitigate flooding, improve water quality, and enhance resilience. Along the northeast boundary of Lake Mattamuskeet's watershed is the 17,200-ha Mattamuskeet Association. It is a non-profit private association that manages drainage using a system of berms and pumps. The Association has its own watershed restoration plan (NCCFa 2013) that focuses on reducing the volume of water pumped into the Pamlico Sound by redirecting water to constructed wetlands. The large area of the Association, existing drainage

Fig. 4. Concept design for the surface flow wetland project (map image, Esri 2015).

infrastructure, plans for treating drainage, and willingness of the Association to work with the research team led to the community supporting the students in developing a concept design where the Association accepted a portion of the drainage from Lake Mattamuskeet. This project was undertaken knowing that none of the partners were committed to going beyond a concept design and with the idea that the concept could be transferred to similar nearby drainage entities. The conversations with the community about this project focused on who would pay recurring costs. This was a concern because the National Wildlife Refuge, which covers over 73% of the watershed, could not commit to assisting with the annual costs. This means those costs would be the responsibility of the landowners, whose property makes up less than 27% of the watershed. Focus group participants expressed concern about the volume of water the designed wetland could treat and whether the distribution of pumps would equitably distribute the project's benefits. They believed the project was more likely to affect water quality than water level in the lake.

The students identified an existing canal that could connect the lake to the Association (Figure 4). Their design included an adjustable weir structure to control flow out of the lake. Adjustability was necessary so that flow into the Association could be restricted if its pumps were not keeping up with input. The weir structure would help quantify flow so the Association could be compensated for handling the additional volume of water. After evaluating multiple options in a hydrologic model, the students recommended that water from the lake travel through the network of ditches to an 856-ha surface flow wetland on the northern boundary of the Association (Figure 4; Table 1). This team simulated all of 2016 including Hurricane Matthew. The results demonstrated that its design lowered the peak water level in Lake Mattamuskeet by approximately 0.12 m (0.4 ft) and reduced the duration of time water was above 0.3 m NAVD88 by 35 days, compared to what occurred after Hurricane Matthew (Figure 5). Unlike other teams, this team estimated recurring costs, which were primarily pump fuel and compensation to the private landowner for using the wetland.

This capstone team spent substantial time developing its hydrologic model. This model was the most complex because it considered flow over the weir, water level in the Association ditches, water level in the wetland, water level in Lake Mattamuskeet, and how rerouting the water affected flow through the outflow canals. As a result, many of the team's other analyses could have

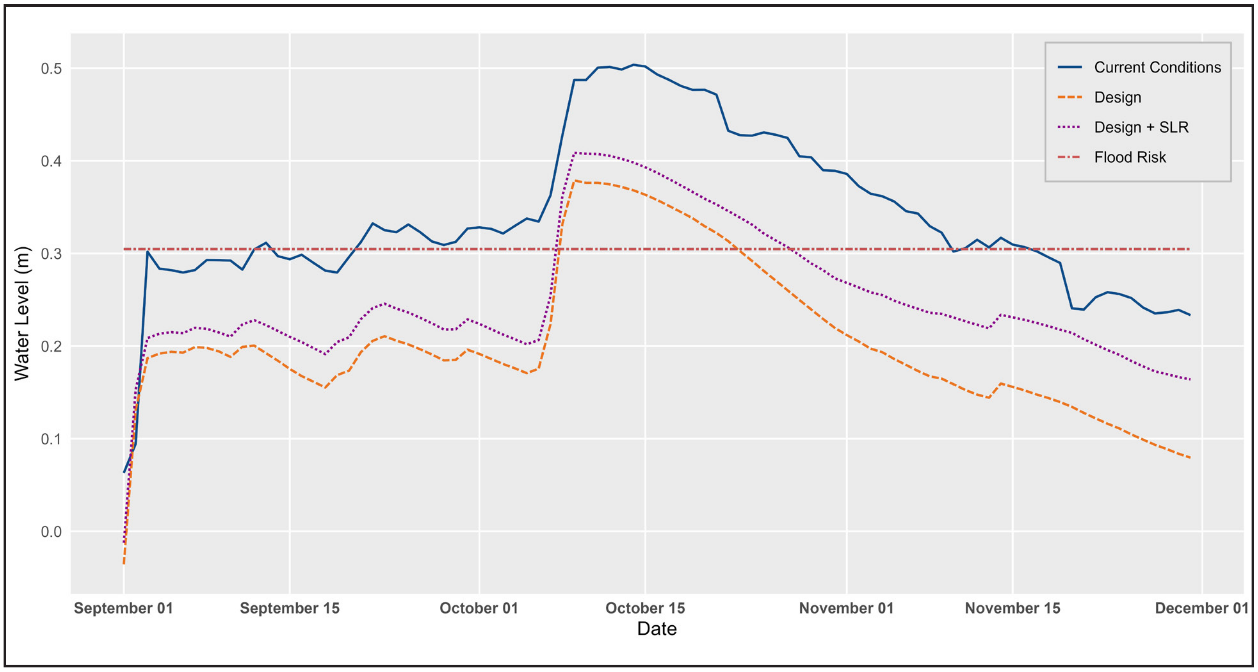

Fig. 5. Actual water levels (Current Conditions), simulated water levels with the surface flow wetland team's design (Design), and simulated water levels with the team's design plus 0.18 m of SLR (Design + SLR) in Lake Mattamuskeet during a 3-month period in 2016, including Hurricane Matthew.

been stronger. The team addressed water quality by looking at hydraulic retention time but did not estimate the mass of nitrogen removed by the wetland. The team's implementation costs were also underestimated because it needed more time to get accurate cost estimates for multiple project parts. Its annual cost estimates, however, were reasonable.

3.4. Retrospective Sea Level Rise Analysis

Key analysis not completed by the capstone teams included how the designs may function under future conditions. The results presented in this section were completed by the research team after the students finished their projects. A simple simulation of SLR was completed by adding 0.18 m (0.6 ft) to the sound levels during the period that the capstone teams used for their design. This value of SLR is a median value for what is expected over the next 50 years (NC CRC 2015). Because tide gates control the flow out of the lake, rising sea levels will influence when the tide gates are open. For the canal dredging project, the simulations show that a 0.18 m increase in sea level would render any dredging work ineffective, and the flooding would be worse than what had been previously experienced (Figure 3). For the surface flow wetland project, the increase in sea level by 0.18 m (0.6 ft) would result in an expected increase in peak flooding depth of less than 0.06 m (0.2 ft) during the simulated Hurricane Matthew event when compared to the design under current conditions (Figure 5). The design with SLR would result in a reduction in the time water was above 0.3 m NAVD88 by 30 days, compared to during Hurricane Matthew. The flooding increase is driven by less water leaving the lake through the 4 canals. This shows that the surface flow wetland project will be the most effective for long-term reduction of flooding in the watershed. A weakness of our effort was that this was not conveyed to the community because it was conducted after the fact and not as part of the student projects.

3.5. Lessons Learned

In addition to navigating the interruption to community engagement caused by COVID-19 detailed in Grace-McCaskey et al. (2022), the research team learned multiple lessons that may benefit others doing similar work.

First, the students were challenged by how to conduct a project economic analysis. All ECU engineering students take a 2-credit hour engineering economics course in their third year (ECUa 2024). This course covers topics such as cash flows, equivalent worth, benefit-cost, and rate of return, which should have made it possible for a standard economic analysis to be completed for all 3 projects. However, the greatest challenge for economic analysis was the students' lack of experience on projects of this size and scope. The initial cost and operation and maintenance costs put together by the teams on this project required substantial effort. We attempted to link the capstone teams with a professional engineer who was paid to help them with estimating these costs. This was not as effective as originally anticipated due to the limited time between when the teams completed their model simulations and when they needed to present their final results.

The second lesson is that the public was more concerned with recurring costs than design details. The research team expected the community to give students feedback on acceptable water levels, preferred pump locations, features they would like to see in nature-based solutions, and other design considerations. However, the primary topic of discussion regarding the designs was recurring costs. The combination of perceived lower recurring costs, similar effectiveness to the surface flow wetland project, and restoring the ecosystem to how it functioned many years ago made the canal dredging project a favorite of the community. Community partners choosing the most cost-effective design alternative is a typical response observed in similar projects (Marsolek et al. 2012; Seay and Lumkes 2014). One approach that may be effective for allowing students to get better feedback is the use of more project-specific focus groups. Across all focus groups, students noted the value of learning about local context directly from knowledge holders, and in each case emerged with new considerations to include in the designs.

The third lesson was that community feedback and students' lack of time influenced the areas to which students devoted their time. What the teams heard from the community as most important was reflected in how the students spent their time. A downside to this was that none of the teams evaluated the effectiveness of their designs under future SLR scenarios. As a result, the information that would have been most effective for improving resiliency was not presented to the community because of the challenge of balancing time between community engagement and engineering analyses.

The last lesson was that this method was effective for evaluating what the community desired. In parallel to the students' efforts, the organizations leading the watershed restoration worked with an engineering consultant on a design for active water management through different grant funding. It became clear that many in the community preferred the canal dredging solution presented by the students over the solution presented by the consultant. The solution of dredging the canals had been a favorite of the community since the watershed restoration planning effort started. However, the grant the leading organizations received was focused on active water management, which pushed efforts in that direction. Through listening to the community, the capstone projects better represented the community's voice and provided engineering analyses to show the expected effectiveness and cost of multiple proposed solutions.

3.6. Applications to Ecological Engineering Programs

Although this work was conducted in a general engineering program, there is a clear link to ecological engineering programs as illustrated through the recently approved ABET curriculum criteria specific to ecological engineering. The student projects show an understanding of material in criteria d ("material and energy balances; fate and transport of substances in and between air, water, and soil; thermodynamics of living systems" [ABET 2025]). However, there are mixed results for criteria e ("applications of ecological principles to engineering design that include considerations of climate, … sustainability, resilience, interactions between ecological and social systems, and system-scale impacts and benefits" [ABET 2025]) as illustrated by the students not considering the effects of sea level rise or ecosystem services beyond flood reduction and water quality improvement.

Time was one of the greatest challenges for these capstone teams due to some of the members having no background in hydrology or water quality, as well as the challenges presented by the pandemic. These shortcomings present opportunities for ecological engineering educators. Students going through an ecological engineering program should have a better understanding of ecology and ecosystem services than the students in the general engineering program that is presented here. Highlighting the links and interactions between the social and ecological systems in early ecological engineering coursework would better prepare students to evaluate the benefits of their designs to the system as a whole, instead of a narrower definition, such as flood reduction in this project. Students in an ecological engineering program are also more likely to be exposed to the type of design project completed by the capstone teams, potentially better preparing them to complete cost estimates.

Conclusion

For engineering solutions to succeed, their designs must be acceptable to communities where they are implemented. A vital component of this is training future engineers to consider the needs and desires of communities and the insights gained from local knowledge. This project successfully taught students how to interact with community members and focused on giving the community the information they wanted on each design.

However, the student teams struggled to complete an economic analysis and did not evaluate the designs under future SLR conditions. More guidance from the research team early in the project may have resulted in better economic analysis and additional design evaluation. To better prepare students for realistic project evaluations, integrating practical economic analysis exercises—such as detailed cost-estimation case studies involving ecological engineering projects—into earlier coursework is strongly recommended. Such exposure would enhance students' competencies, enabling them to more effectively address economic considerations during their capstone experience.

Finding the balance between guidance on community engagement and engineering analyses is challenging in this type of project. The designs and analyses presented by the students suggest effective engagement with the community and an awareness of its priorities. Active guidance from faculty advisors is essential for helping students find that balance while maintaining reasonable expectations of the community. One solution to the time and balance challenge faced in this project is to incorporate community engagement training earlier in the curriculum. Many ecological engineers will be working with communities throughout their careers and developing these skills as undergraduates will benefit them and their future work. Giving students experience with discipline-relevant cost estimates would also help address the challenges faced here. Both of these could be accomplished through projects in classes taken prior to students' capstone experience, allowing students to focus more on the engineering analyses during capstone.

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Author Contributions Statement

Conceptualization: RE, RLS, LD, CAG-M; methodology: RE, RLS, LD, CAG-M; data analysis: RE, RLS, LD, CAG-M, JES; writing original draft: RE, RLS, JP-G, JES; review/editing original draft: RE, RLS, LD, CAG-M, JP-G, JES; project administration: RE, RLS, LD, CAG-M; funding acquisition: RE, RLS, LD, CAG-M. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest Statement

The authors have no conflict of interest to report.

Data Availability Statement

The raw data for the hydrologic models used by the students can be found at the following links:

- Rainfall input was measured by USGS at the center of the lake: https://waterdata.usgs.gov/monitoring-location/352936076125245/#parameterCode=00045
- Evapotranspiration output was estimated using measurements from the North Carolina Forest Service weather station at Fairfield, NC (TS161), and can be retrieved using the North Carolina State Climate Office system: https://products.climate.ncsu.edu/cardinal/
- Evapotranspiration output was also estimated ECONet weather stations managed by the State Climate Office of North Carolina, located in nearby Aurora, NC (https://econet.climate.ncsu.edu/stations/AURO/), and Plymouth, NC (https://econet.climate.ncsu.edu/stations/PLYM/).
- Lake level inputs were measured by 2 USGS monitoring stations: https://waterdata.usgs.gov/monitoring-location/0208458893/#parameterCode=62615 and https://waterdata.usgs.gov/monitoring-location/0208458892/#parameterCode=62615
- Pamlico Sound level input was measured by North Carolina Emergency Management's monitoring station on the Bell Island Pier at Rose Bay, NC: https://contrail.nc.gov/
- ABET data, excluding any personally identifiable or sensitive information, are available by request from Raymond L. Smith or Randall Etheridge.

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