GEODESIGN SOLUTIONS FOR MANAGED RETREAT: CO-PRODUCING LANDSCAPE- AND SITE-SCALE DESIGNS THROUGH STUDENT-STATE AGENCY COLLABORATIONS

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ABSTRACT
Disasters and repetitive losses are forcing more and more jurisdictions to grapple with the necessity of managed retreat. As managed retreat gains prevalence as a local tool, landscape architects will be called to repurpose, revise, and reimagine depopulated landscapes at a variety of scales. Looking ahead to this future condition, this study proceeds along two trajectories, one pedagogical, one methodological. The first (pedagogical) investigates the dynamic process of co-producing knowledge within a landscape architecture and planning studio, emphasizing the collaborative integration of student-driven planning efforts and the expertise of the New York Department of State (NYDOS). The second (analytical and systematic) focuses on assessing scenarios for managed retreat options across New York State, employing the innovative approach of Geodesign to merge the insights and perspectives of stakeholders and students. By engaging in a co-creative process, students and NYDOS personnel collaboratively shape adaptive strategies for managed retreat, striving to address the complex challenges posed by climate change, sea-level rise, and coastal vulnerability. We use surveys to assess Systems, Futures, and Strategic Thinking competencies of the students upon completion of project deliverables for NYDOS. We analyze results by understanding key sustainability competencies both within individual responses and for the class as a whole. We also use post-deliverable surveys of experts at NYDOS to assess products and project success. This method allows for exploration of the effectiveness of knowledge co-production as both a learning tool and a conduit for practical work products. Results are anticipated to illustrate the strength of knowledge co-production as a heuristic to be used in practice and within education. Further, in fostering innovative and contextually relevant solutions at the vanguard of managed retreat, results are anticipated to show that students can make a valuable contribution to the development of resilient and adaptive approaches for New York's communities in various ecoregions. This study underscores the value of interdisciplinary collaboration between academia and state agencies, highlighting how Geodesign principles can facilitate informed decision-making and lead to more sustainable and resilient futures for coastal regions.

Keywords
Geodesign, Managed retreat, Knowledge co-production, Climate adaptation

1 INTRODUCTION

Terms like ‘resilience’, ‘vulnerability’, ‘risk’ and ‘uncertainty’ have exceedingly become commonplace in the vernacular surrounding natural disasters within spaces inhabited and managed by humans. Natural ebbs and flows historically defined how and when solutions to climate and weather trends may be instituted (Citation). Climate change externalities have impacted response time to natural disturbance (Citation). Increasing impacts of climate change in conjunction with resistance to solution adoption has altered the systems-level resilience balance of this dynamic, however initiatives to enrich this adoption of climate based adaptive management solutions is slowly becoming commonplace (late adoption Citation). This project focuses on demonstrating the efficacy of an adaptive management solutions framework informed by a state agency within the context of a graduate landscape architecture studio. The studio utilized the concept of managed retreat as a solution set to address issues of change for five regions across New York State. Our research objective within this project was to understand a range of competencies within the context of an agency-informed studio project. The following sections of this paper explain a) the process used within the studio, b) a method for evaluating the pedagogical impacts for student learning, and c) a proposed framework for aligning learning objectives of a graduate studio with an initiative of a state agency.

1.1 Resilience: Managed Retreat

Managed retreat, also known as planned relocation or strategic withdrawal, has emerged as an innovated concept in the discussion surrounding climate change adaptation and disaster risk and vulnerability reduction. The following section presents themes, obstacles, and solutions identified in scholarly works related to managed retreat. Researchers, planners and experts in disaster and risk management have defined and presented characterizations of managed retreat, illustrating its contentious and complex nature (Hino et al., 2017). While a range of definitions is presented within the literature, managed retreat proposes the strategic relocation (horizontal retreat) or retrofit solutions (vertical retreat) for communities and infrastructure to address flooding issues in high-risk zones due to environmental threats such as sea-level rise and extreme weather events (Blakeman et al., 2023). Areas impacted typically included floodplains and vulnerable coastal areas. A range of approaches are associated with the concept, encompassing policy-based or infrastructure-driven solutions funded by state agencies and/or the federal government. Being that the main objective for managed retreat is to reduce risk and vulnerability of climate change externalities to communities, its contentious nature questions definitions of vulnerability, uncertainty, and risk as communities and individuals are asked to relocate based on said concepts (Williams et al., 2020). Novel problems such as rapidly intensifying storms, increased flood prone areas and rising sea levels present significant threats to not only coastal communities but low lying areas. These threats necessitate novel solutions imparting proactive measures to prevent ecosystem degradation, property damage and casualties of human life. Within the past decade, research indicates the urgent need for adaptive management solutions such as managed retreat to reduce future impacts while enhancing community resilience as conditions within natural disasters intensify (Williams et al., 2020; Blakeman et al., 2023). However, proposing or implementation of managed retreat solutions broaches complex social, economic and ethical considerations as communities within these vulnerable areas are commonly subject to environmental justice issues (Tubridy et al., 2022). Disaster prone areas are typically impact vulnerable populations affecting community rights and needs (Ajibade, 2019; Tubridy et al., 2022). Managed retreat solutions require attention to ensure that relocation efforts and conditions do not further compound issues for marginalized groups and communities. Due to the complex nature of the conditions surrounding managed retreat, the need for interdisciplinary approaches draws from fields including landscape architecture, urban planning, environmental design, public administration and social sciences to address legal and regulatory challenges. Current research emphasizes the importance of financial mechanisms funded by federal and state agencies to obtain and distribute funds associated with public education and buyouts for relocation as well as associated costs for infrastructure retrofits in need be (Freudenberg et al., 2016; Siders, 2019). Challenges associated with managed retreat tend to include resistance from residence, funding constraints and uncertainty surrounding future climate projections and models (Siders, 2019; Mach et al., 2019; Blakeman, 2023). Researchers utilizing adaptive management as well as adaptive governance aid in re-envisioning what land-use planning, community-based design and infrastructure solutions are currently being identified to justify changes as precedents. Flexible and resilient approaches fostering collaboration of community members, experts, state agencies, and

stakeholders are critical for addressing obstacles associated with managed retreat. Flexible and adaptive strategies to ensure community buy-in, feedback and support are required for future decision-making, and state agency alignment with innovated research is needed to ensure protection of vulnerable community and ecosystem resilience (Blakeman et al., 2023).

1.2 Understanding Vulnerability: Expert-informed Studio Directive

Collaborative approaches between academic institutions and governmental agencies in addressing contemporary challenges, within the fields of landscape architecture, planning and design, has accumulated significant attention with nuance and change within our social ecological systems (Korfmacher, 2019). This research illustrates applications of student and agency collaboration, particularly within the context of landscape architecture and planning studios focused on managed retreat strategies. Academic and agency partnerships demonstrate the rationale behind the creation of collaborative studios to provide a 'real world' example of what a project may looking like within the field of landscape architecture. Students also develop competencies in understanding methodologies employed to facilitate effective collaboration between students and agencies. This research utilized a case study aligning a state university and New York Department of State (NYDOS) as an illustration.

This project situates collaboration, within the context of academia and state-level partnership, within the principles of participatory planning (Oteros-Rozas et al., 2015), co-production of knowledge (Iwaniec et al., 2020; Kliskey et al., 2023), and collaborative governance (Linkov et al., 2006; Lockwood et al., 2010; Bianchi et al., 2021). Participatory planning demonstrates inclusiveness of diverse stakeholders, such as government agencies, in decision-making processes which align environmental management and planning initiatives (Healey, 98). Collaborative generation of knowledge amongst stakeholders, researchers, and practictioners to establish and build mutual learning and innovations in problem solving defines co-production of knowledge (Jasanoff, 2004; Kliskey et al., 2023). Whereas collaborative governance includes the joint management of public issues defined by government and agency-level decision-making (Ansell and Gash, 2008). This research demonstrates the culmination of these multiple forms to define effectiveness to simulate a collaborative process between an academic institution as well as a state agency. The justification of this collaborative effort in landscape architecture and planning aligns several key factors for both learning and decision-making: collaboration, learning competencies and opportunities, and a mutual demonstration of a platform for academic and professional communities.

Collaboration bolsters the relevance and applicability of studio projects by grounding them in real-world challenges through active projects in state-wide initiatives (Talen & Ellis, 2002). Co-production efforts, including this project, provide students with valuable experiential learning opportunities, challenging them to gain practical skills and insights while contributing to compelling and relevant projects (Jones et al., 2017). Lastly, communication across academic and agency partnership fosters mutual learning and knowledge exchange, enriching both communities (Susskind et al., 2012).

Frameworks have been developed and employed to facilitate effective academic and state agency collaborations within landscape architecture and planning studios. Researchers and facilitators employed engagement processes through stakeholder interviews, collaborative co-production sessions (charrettes), and workshops demonstrating mutual exchange of ideas (Neuman et al., 2022). The geodesign framework (Steinitz, 2012), which is an iterative method to merge geospatial analysis, design, and stakeholder engagement, has emerged as a compelling and useful process for collaborative decision-making in landscape planning and design (Gottwald et al., 2021). Enrichment of qualitative input and evaluation tools has also become an effective component for student learning to evaluate various scenarios against a status quo scenario trend (ESRI, 2019l; Newman et al., 2020).

Tools to bolster a collaborative student and agency engagement in landscape architecture and planning studios, particularly in the context of managed retreat strategies, have been vetted as effective thus justifying use of various theories within the context of our project. Method and theory utilized within the context of this project aims to demonstrate effectiveness in collaboration but also co-production of knowlege in academia and within state agencies. Further research is needed to test efficacy of various methods for collaboration, however we intend to demonstrate our framework for transferability in future studio and agency-informed projects.

1.3 Risk and Uncertainty: Frameworks and Tools for a Graduate Student Studio

Geodesign operates as an interdisciplinary approach that integrates geographic science, design thinking, and stakeholder engagement through an iterative, stakeholder-informed framework (Steinitz, 2012). Within the context of landscape architecture education and the case study of our Fall 2023 studio, we focused on its utilization to inform collaboration between students and the New York Department of State (NYDOS) in developing managed retreat strategies. The method was selected for this project as the framework is grounded in systems thinking, participatory action research, futures-thinking, and spatio-temporal analysis (Steiner and Shearer, 2016). The approach integrates qualitative and quantitative inputs through data-driven analysis informed by perspectives of stakeholders and/or experts (Steinitz, 2018; Pettit et al., 2019). Operationalizing theories in geography, planning, design, environmental science and landscape planning, the framework proposes solutions to address future conditions and complex issues through projected scenarios. By incorporating geodesign principles into a studio pedagogy, student outputs have the capacity to demonstrate the utility of experiential learning, critical thinking, and collaborative problem-solving with opportunities to align inputs from stakeholders or experts. Students are given opportunities to incorporate spatial data and analysis into their design process, and iteratively refine their solutions based on feedback and evaluation (Newman et al., 2020).

Geodesign and Managed Retreat: Critical uncertainties can be defined as “those elements of the future that are the most difficult to predict and that may have the greatest consequences on the ultimate outcomes of actions taken in the present” (Shearer, 2013). Being that outcomes of actions or solutions applied to present and future states address critical uncertainties, a geodesign framework demonstrating how these interventions might play out are important for understanding a range of future possibilities. Within the context of managed retreat strategies, research projects have applied geodesign to the assessment of coastal vulnerability, identification of relocations sites and design of resilient land use and site plans

In the context of managed retreat strategies, geodesign offers a powerful framework for assessing coastal vulnerability, identifying suitable relocation sites, and designing resilient land use plans (Zandvoort and van der Vlist, 2014; Newman et al., 2020). Geodesign enables stakeholders and experts to integrate spatial analysis tools along with design methodologies explore alternative future scenarios Hulse et al., 2009), visualize potential outcomes, and make informed decisions about land use and development in hazard-prone areas (Flint Ashery and Steinitz, 2022).

In the Fall 2023 graduate landscape archtiecture studio students and NYDOS utilized geodesign as a central methodology for informing the development of managed retreat strategies across five regions within New York State. Students used geospatial analysis, alternative future scenarios, and evaluative frameworks to assess coastal risks, evaluate adaptation trends, and co-create adaptive strategies with agency professionals. Geodesign provided the platform for student-driven planning efforts and the expertise of NYDOS, fostering a learning environment with a supporting methodology. The outcomes led to a suite of solutions to address the complex challenges posed by climate change and coastal vulnerability.

The significance of geodesign in informing studio education and addressing contemporary environmental challenges, such as managed retreat, provided the students with a range of key competencies in sustainability (Redman and Wiek, 2021) to help inform future work in practice but potentially also in future research pertaining to the application climate science analysis, vulnerability and adaptive management in landscape architecture and planning. Key competencies, through a geodesign framework, specifically addressed within the studio were: systems-thinking competence, futures-thinking competence, and stategies-thinking competence (Redman and Wiek, 2021). Our intention with this project was to measure, through surveys, if students felt that they achieved a sense of these competencies within the contexts of a 16-week, agency informed studio project.

1.4 Research objectives

The research intent of this project is to gauge the ability of students to address complex topics and solutions associated with climate change issues through an understanding of self-reported achieved competencies in sustainability. During the Fall 2023 semester, students conducted multiscalar analysis to inform design decisions. Upon completion of plans and designs, students were asked to evaluate their

designs and plans with the intent of providing guidance for revision of their work. Students were asked to complete a survey upon completion of the course. The survey instrument was used to evaluate student understandings of project outcomes but more so this qualitative tool was a mechanism to gauge systems-thinking (analysis), futures-thinking (design), and strategies-thinking (evaluation and re-design).

2 METHODS

The pedagogical aspect of this study delved into the dynamic process the graduate studio, focusing on the collaborative integration of student-driven planning efforts and the expertise a state agency, NYDOS. To understand and gauge the efficacy of collaboration within the course, students were asked a series of questions upon completion of the course to better understand a) if key competencies in sustainability were met, and b) if the complexity, topics and/or tools helped to facilite the goals and objectives of the state agency within the context of managed retreat.

Data collected from surveys were analyzed to assess the following competences: Key sustainability competencies (Redman and Wiek, 2021) within student responses were identified and analyzed to gauge the overall proficiency of the class. Similarly, expert feedback from NYDOS was analyzed to evaluate project products and success. The analysis aimed to illustrate the strength of knowledge co-production as a heuristic for both academic and practical purposes.

2.1 Course Schedule and Directives

The Fall 2023 graduate studio was composed of 13 graduate students, As geodesign is divided into discrete models, the studio schedule was divided into four modules aligning course project statements with geodesign models (Steinitz, 2012). Utilizing a geodesign framework (Steinitz, 2012), the course deliverables reflected each ‘model’ component within the framework. ‘Representation Models’ and ‘Process Models’ address current system description and operations. A project statement for ‘module 1: inventory and analysis’ was delivered to the students to address both models. As a proof of concept, we will illustrate outputs of each module with one student group’s work (Figures 1, 2, and 3).

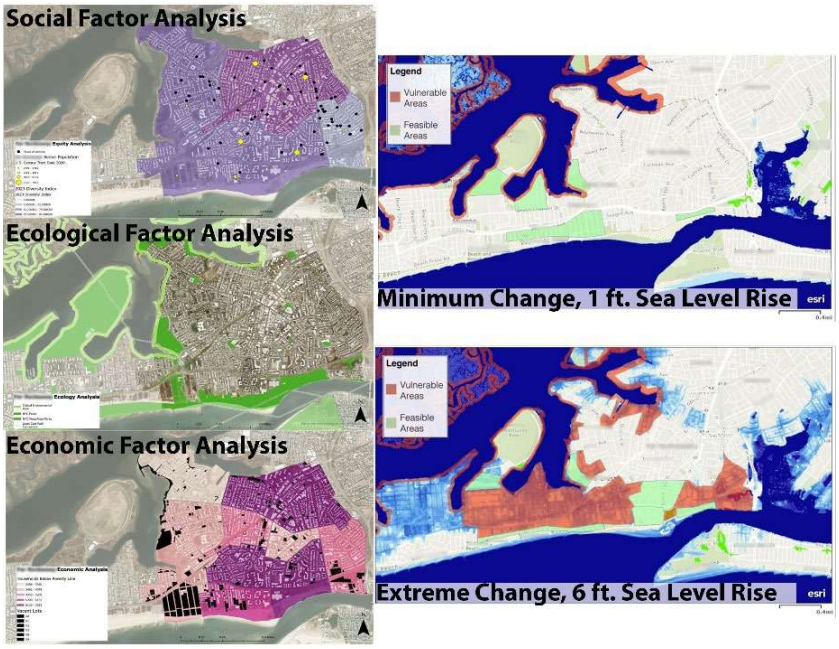

Figure 1. Module 1: Inventory and Analysis Student Example.

‘Evaluation Models’ and ‘Change Models’ provided students within an opportunity to develop a program, a regional plan and then a site level plan for their region. A project statement for ‘module 2: program, plan, and design directed students to derive planning and design decisions based on NYDOS feedback as well as synthesis of their work from the previous module regarding inventory and analysis.

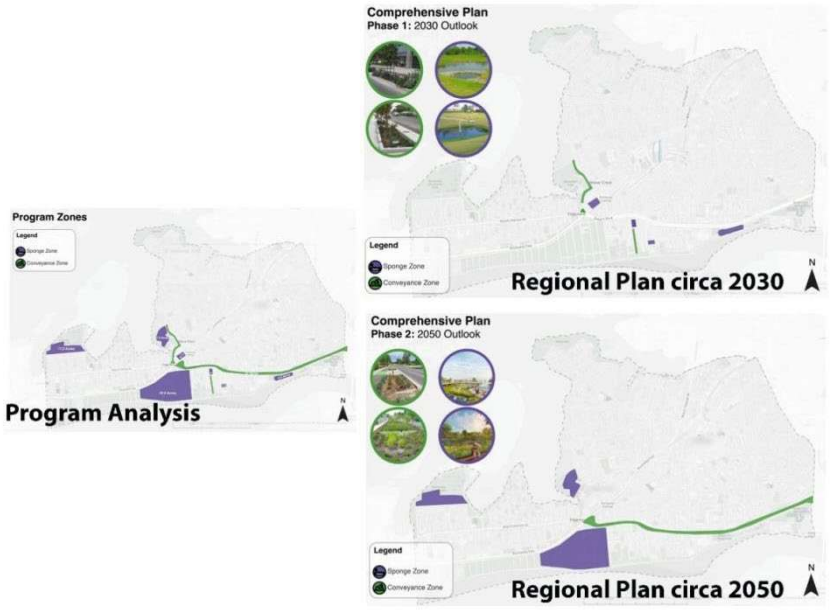

Figure 2. Module 2: Program, Plan, and Design Student Example.

'Impact' and 'Decision' models were delivered and carried out within an assignment referred to as a module 3: Evaluation Metrics and Re-Design. Student groups were tasked with evaluating all group outputs at the regional level and site level plans and designs. Students were then asked to redesign their own work based on the cumulative outputs of the cohort and feedback from classmates (Figure 3).

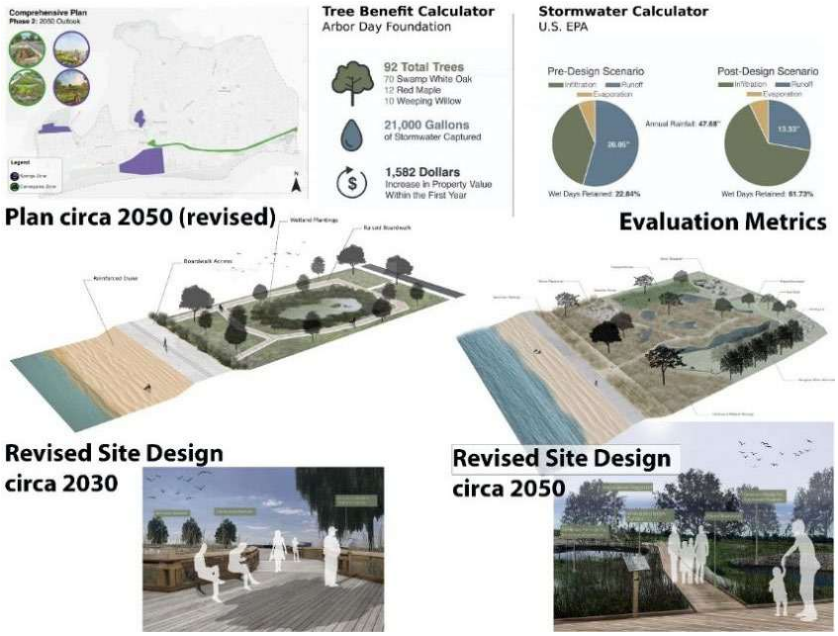

Figure 3. Module 3: Evaluation Metrics and Re-Design Student Example.

2.2 Survey Methodology

The methodological approach centered on assessing understandings of analysis, design, and evaluation of post-design conditions for managed retreat options across New York State. Geodesign (Steinitz, 2012) principles were employed to integrate diverse perspectives and spatial data into the analysis and design process. The approach facilitated the development of adaptive strategies for managed retreat, addressing

complex challenges posed by climate change, sea-level rise, and coastal vulnerability; however, the evaluation of student competence was limited to self-reported, qualitative data responses. In future research, analyzing geospatial responses and quantifying revision and/or comparisons of design futures would aid to inform where competence was established or obtained. Due to the nature of the studio, having student groups address five different regions across the state would make comparison of outputs staggered potentially providing inconclusive results. As a forethought, a decision was made to only use self-reported, qualitative data taking the form of surveys.

Survey instruments were utilized to assess competencies of students upon completion of project deliverables for NYDOS. The surveys aimed to understand key sustainability competencies within individual student responses and across the class as a whole. Surveys were utilized to assess futures-thinking competence, systems-thinking competence, and strategic competence (Redman and Wiek, 2021). Additionally, this survey methodology enabled the exploration of the effectiveness of knowledge co-production as both a learning tool and a conduit for practical work products.

2.3 Data Analysis

Data collected from surveys were analyzed to assess the effectiveness of knowledge co-production in facilitating learning and practical outcomes. Key sustainability competencies, specifically systems-thinking, futures-thinking, and strategies-thinking competencies, within student responses were identified and analyzed to gauge the overall proficiency of the class. Similarly, expert feedback from NYDOS was analyzed to evaluate project products and success. The analysis aimed to illustrate the strength of knowledge co-production as a heuristic for both academic and practical purposes. Each competence was evaluated as a gradient from ‘not mentioned’, ‘low’, ‘medium’, and ‘high’ to understand the level of each self-reported understanding of individuals in the course as well as the class as whole. The following questions were used to gauge each level of competence reported:

Table 1. Key Competence Reported, Definition, and Survey Question.

Key Competence	Definition (adapted from Redman and Wiek, 2021)	Post- Studio Survey Question
Systems-Thinking Competence	*Ability to apply modeling and complex analytical approaches: 1) to analyze complex systems and sustainability problems across different domains and across different scales, 2) analyze the impacts of sustainability action plans and interventions*	*How reasonably professional of a knowledge base do you think you have for intergrating terrain-related variables, systems-related analyses, and suitability for available, potential and relevant solutions?* *Please list some regional and place-based conflicts that you have encountered while determining, analyzing and designing for resilient typologies within your project?*
Futures-Thinking Competence	*Ability to carry out or construct simulations, forecasts, scenarios, and visions: 1) to anticipate future states and dynamics of complex systems and sustainability problems, 2) anticipate how sustainability action plans might play out in the future*	*With your current understanding, what are some viable and probable solutions that you have planned and designed?* *What are key uncertainties in landscape planning associated with managed retreat for your site?*
Strategic-Thinking Competence	*Ability to construct and test viable strategies for interventions, transitions, and transformations toward sustainability.*	*Please describe how well you think you understand how to integrate systems-related factors of managed retreat interventions at the site, landscape and regional scale.*

3 RESULTS

The analysis of the survey results aligned with the systems, futures, strategic thinking competence metrics indicate students report competence in understanding and activating content within the context of managed retreat and geodesign. Of the 13 students within the studio, 7 participated in the survey contributing to a 54% response rate. Qualitative results were coded based on level of response denoted within the survey instrument. Codes were ranked from ‘not mentioned’ as simply absence of response. Responses deemed as ‘low’ had descriptive words conducive to basic levels of understanding and/or

adjectives stating a superficial categorization. Coded responses for ‘medium’ indicated a response with a modifying word suggesting understanding but lack of a clear picture in understanding (e.g., ‘fairly well, but needs more work’). ‘High’ responses illustrated a strong understanding an indicator of easy (e.g., ‘after seeing the example, it made total sense’).

Table 2. Survey Result Gradient and Testimonials.

Key Competence	Result Gradient				Post- Studio Survey Question
	Not mentioned	low		med high	
Systems-Thinking Competence	*0*	*2*	*3*	*2*	*How reasonably professional of a knowledge base do you think you have for intergrating terrain-related variables, systems-related analyses, and suitability for available, potential and relevant solutions?*
	0	*2*	*1*	*4*	*Please list and rank your understanding of some regional and place-based conflicts that you have encountered while determining, analyzing and designing for resilient typologies within your project?*
Futures-Thinking Competence	*1*	*2*	*1*	*3*	*With your current understanding, what are some viable and probable solutions that you have planned and designed, and how effective do you think you have designed them?*
	0	*2*	*3*	*2*	*What are key uncertainties in landscape planning associated with managed retreat for your site and how well do you feel like you understand the associated conditions?*
Strategic-Thinking Competence	*0*	*1*	*3*	*2*	*Please describe how well you think you understand how to integrate systems-related factors of managed retreat interventions at the site, landscape and regional scale.*

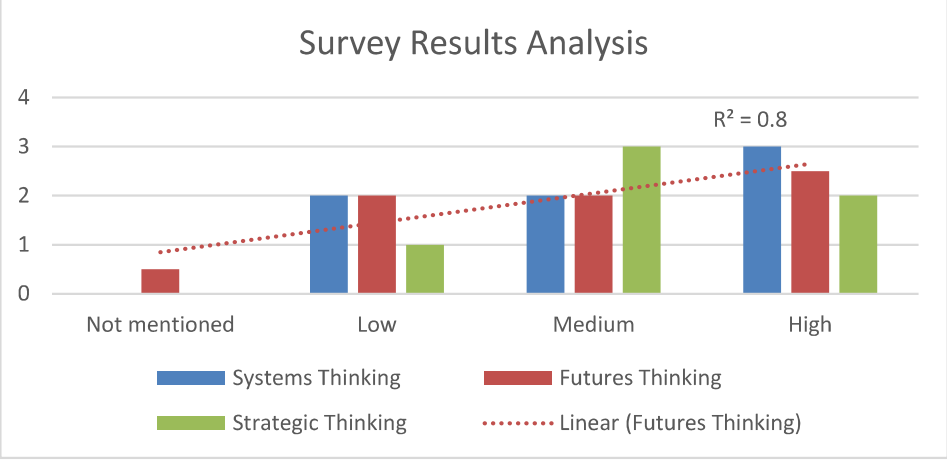

Figure 4. Survey Analysis Results.

Quantitative responses to questions indicated how students identified within the process. The following question was used to illustrate how students defined their role within the group and the studio project: ‘Which role would you identify with for solving the design and planning components of the project?’ The

following graphic illustrates roles and percentages that participants identified. Two part question results that were aligned with one compentence were averaged to determine outcome.

Results indicate that participants, on average, reported as ‘medium’ for all three competencies. For this sample size and the response rate this illustrates a significant result for students within the studio self-reporting learned competencies for managed retreat through a geodesign framework. Intrestingly, the students who identifed as ‘Analysis Specialists’ or as ‘Solutions and Strategies’ specialists reported higher than other particiants for all three compentencies.

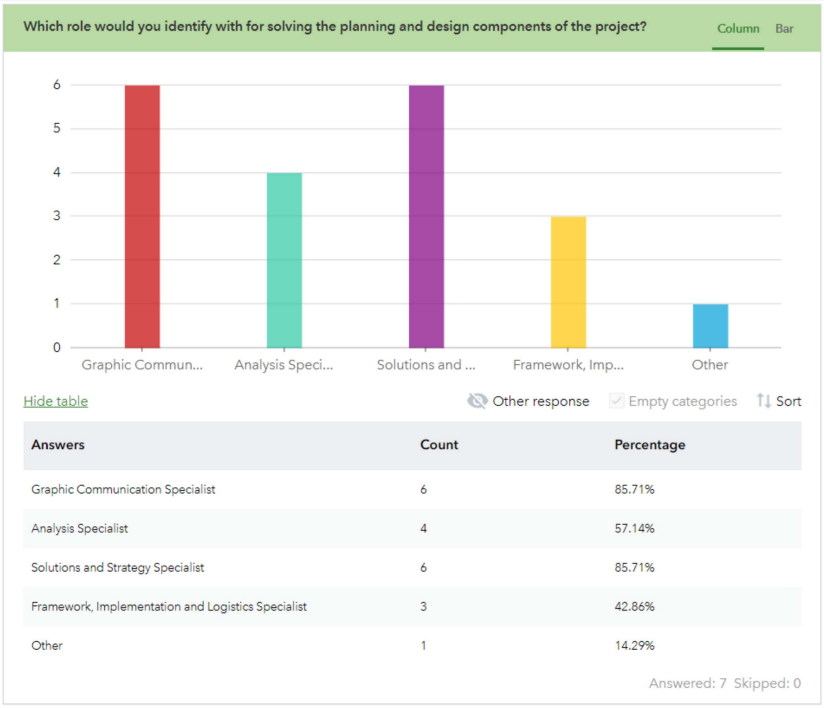

Figure 5. Self-Identified roles within the Studio Project via Survey Instrument.

4 DISCUSSION

The interpretation of the results show that students within the studio were able to identify as specialists to some degree upon completion of the studio. This illustrates the capacity for students to self-report as compenent and successful within a graduate studio addressing a topic as complex as managed retreat. Limitations of the study included lack of a pre- and post survey or a geospatial assessment for learned or aquired compentencies. However if students are able to feel successful about utilizing a geodesign process to analyze, design, evaluate performance, and redesign a set of problems dictated by a state agency, further research can examine use of certain tools to demonstrate effectiveness of practices in instruction and collaboration between academia and state agencies.

5 CONCLUSION

Throughout the course of the studio, we developed a rigorous application of analysis to inform design decisions enriched by a state agency. Spatial extents were variable within the project, however themes emerged upon completion of the study. Employing a structured methodology to encompass research, analysis, planning, and targeted area design requires instructor and expert-informed support throughout a complex project and this studio was no different.

Our objective was collaboration. Throughout the course, we showcased the effectiveness of collaborative efforts between students and NYDOS in addressing challenges of managed retreat and climate change impacts. The integration of geodesign as tool for collaboration in our studio pedagogy, instilled a dynamic

learning environnment where students were able to engage with a state agency to tackle a complex problem in which they may face in practice or future research. Results indicate were able to develop key compentencies in sustainability (Redman and Wiek, 2021), particularly in systems-thinking, futures-thinking and strategic thinking, through their involement in the studio. Despite limitations of the studio, our findings suggest the notion that students felt competent in addressing managed retreat issues. Our collaboration with a state agency demonstrated the value of interdisciplinary partnership to address social ecological issues affecting our built and natural environment. This research illustrates that co-production of knowledge through a geodesign framework can aid in starting the conversation about difficult issues that state agencies are being asked to address as well as providing students with relevant skills and knowledge to tackle large climate change-driven issues for the future. To conclude, our research contributes to the growing body of managed retreat and geodesign but also demonstrates the potential for interdisciplinary collaboration between a university and a state agency. We hope that similar frameworks will provide for future endeavors for sustainable and resilient coastal communities in New York State and other regions with similar issues.

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