Joint CSCE Construction Specialty & CRC Conference 2025
Conférence conjointe spécialisée en construction de la SCGC et CRC-2025

Montreal, Quebec
July 28-31, 2025 / *28-31 juillet 2025*

ENHANCING RESILIENCE TO COASTAL HAZARDS: AN ANALYSIS OF, RESOURCES, TOOLS, AND PROCESSES TO IMPROVE LAND USE DECISION-MAKING IN THE UNITED STATES

S.T. Murphy, P.E., S.M.ASCE[1], C. Cheng, Ph.D., M.ASCE[1*], J. Kim, Ph.D. [2], and F. Leite, Ph.D., P.E., F.ASCE[3]

[1] Maseeh Dept. of Civil, Architectural and Environmental Engineering, The University of Texas at Austin, 301E E Dean Keeton St c1700, Austin, TX 78712, USA
[2] Dept. of Civil and Environmental Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea
[3] Associate Dean for Research, Cockrell School of Engineering, Joe J. King Professor in the Maseeh Dept. of Civil, Architectural and Environmental Engineering, The University of Texas at Austin, 301E E Dean Keeton St c1700, Austin, TX 78712, USA

ABSTRACT: Researchers across engineering and planning fields continue to raise concerns regarding the increased risk of flooding throughout the United States due to climate change and rapid urbanization, and this is particularly true along the nation's coasts. However, at the point of decision, communities continue to opt to develop within known-flood risk areas and simultaneously struggle to relocate existing developments out of such areas. Past research points to a need to use a combination of infrastructure and land-use change to mitigate these flood risks, but the land-use component is often not part of the final solution. This research uses semi-structured interviews and inductive qualitative analysis to gain insight as to why this may be happening and goes further by identifying local leadership buy-in, localized risk models, and dedicated resilience staff as key factors that may bolster resilience planning and implementation within coastal communities. Three resilience planning postures are also identified: pre-resilient community, establishing resilience, and established resilience culture. The findings in this study can assist coastal planners, and the technical experts that support them, better prepare for present and future climate risks.

1. INTRODUCTION

The grand challenge of adapting to climate change will require a suite of solutions. Along coasts, the combination of rising sea levels and intensified storms will increase flooding risks to many populations. To adapt to these heightened risks, a combination of resilient infrastructure and land use change is required, as depicted in Figure 1 (Ohenhen et al., 2024). However, the interplay between these two strategies can be complicated to model, and land use change specifically can be challenging to implement due to a number of social factors. Political and economic pressures from residents and developers are two examples of social factors influencing land use decision making (Malek et al., 2019). If land directly along the ocean is highly desired by either residents or developers, it can be challenging for an elected official to downzone the land to limit development and decease risk. Downzoning—the practice of using development restrictions to limit the size, types, or number of buildings located on an area of land—is one example of a policy used to limit exposure to hazard risks. Even with these known challenges, communities along the coast will eventually need to include land use change as part of their adaptation strategies. To better

understand the realities of the resilience planning field, it is necessary to learn from planning practitioners directly. This will allow for insights to be garnered that can assist planners in other communities, as well as the researchers in planning and engineering fields who aim to increase the resilience of communities up and down the coast.
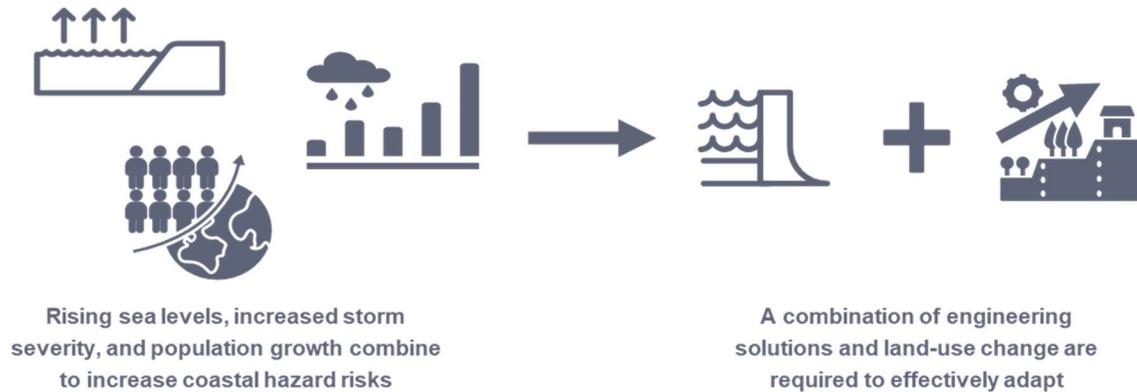

Figure 1: Coastal risks require dual-solution planning

2. RESILIENCE THROUGH LAND USE CHANGE

Land use planning in the United States is a locally driven process. Federal, state, and regional stakeholders certainly play a role, but the vast majority of authority to guide land use resides with cities and towns (Felter & Morris, 2016). We will use the term *community* throughout this paper to represent these cities and towns. Counties can also play a role, and in some cases more of a role than others, but communities and the leaders they elect still hold the greatest responsibility for directing land use.

No matter the size of the community, several stakeholders—with a variety of drivers— affect the land-use decision space (P. Berke & Kaiser, 2006). We will focus on US coastal communities for this study—each of these communities has residents, tourists, developers, elected officials, and regional/state/federal partners. The size of each community and its specific characteristics will affect the power balance of these stakeholders, and this power balance greatly affects the way a community's land is used. To improve the resilience of a community through land use change, the land use decision space needs to be understood. Thankfully, the planners working in these communities are experts in this area. They work with these stakeholders on a regular basis and have seen the power dynamics of their community play out over years and often decades.

In the United States, the concept of planning for resilience is relatively new, but recent disasters have motivated many communities to look closer at resilience (Smith, 2021). Hazard mitigation—and associated plans—lay the groundwork for resilience planning, but do not go far enough on their own. The integration of resilience across multiple plans is a key component to resilience planning. The Plan Integration Resilience Scorecard is one example of how a community can look across their plans to access this integration (P. R. Berke et al., 2019). There is no simple solution to resilient planning however, the scorecard system requires significant time and resources to implement correctly and without follow through of its recommendations, the results are not effective.

In general, implementation of resilient land use change is proving challenging—even when planning documents call for land use change, zoning and other policy documents are often not updated to enforce the plans (Shi et al., 2018). Finding ways to break through the planning-to-implementation barrier is necessary. This will allow communities to not only plan for adaptation but follow through and implement the appropriate strategies for their specific circumstances.

3. QUALITATIVE THEORY AND RESEARCH METHODS

The goals of this study led to the use of qualitative research. Specifically, this study included semi-structured interviews with practicing city planners. The semi-structured nature of the data collection allowed for inductive qualitative analysis to take place. This method of qualitative research allows researchers to adjust the details of the interview to flow with the responses received, to gain a better understanding of the lived experience of the interviewees. This method is recommended when attempting to understand a process or set of experiences that are not already well-defined by past research (Spearing et al., 2022). As resilience is a relatively new priority in city planning, the existing literature has not yet detailed the process a city goes through to implement this new effort.

The data collection and analysis methods consisted of a four-step process, as shown in Figure 2. After receiving institutional review board (IRB) approval for the interviews, the researchers built an interview guide. Inductive interview guides structure the interviews so the research questions can be answered, but are not as formal as a survey. By utilizing the guide's open ended questions and follow up questions, the researchers were able to stay on topic while also allowing the interviewee to provide insights into their lived experiences. As is common when using these methods, after each interview took place, the interview guide was slightly updated to reflect new insights uncovered (Spearing et al., 2022). Finally, inductive analysis took place using the qualitative data collected throughout the interview process.
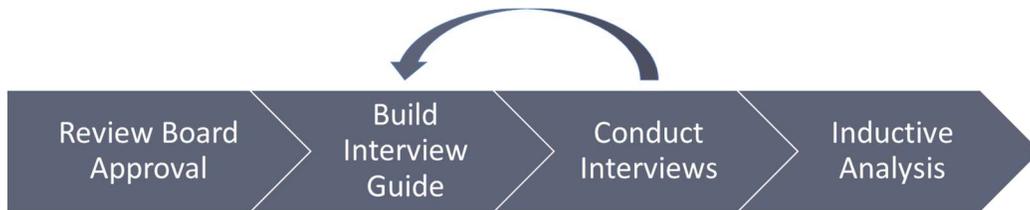

Figure 2: Inductive Qualitative Analysis Process

This study included interviews with two cities on the east coast of the United States. To keep the identity of the planners unidentifiable, we will represent the cities with pseudonyms City A and City B. Some demographic information is provided in Table 1. These two cities were chosen because climate change and, specifically, sea level rise pose similar risks to both, but one far exceeds the other when it comes to resilient planning efforts.

Table 1: City Demographics

Pseudonym	Population	Completed Plans	
		Hazard Mitigation	Resilience
City A	40,000	✓	
City B	1,000,000	✓	✓

The goal of the interviews was to gain an understanding of the role of resilience in their city's planning efforts, and to answer the following research questions:

RQ1: What are the primary steps a city can take to increase its resilience planning?

RQ2: To what extent are land use change strategies integrated into existing resilience plans?

4. RESULTS

The interviews and analysis provided several observations that can be used to understand resilience planning and answer the research questions proposed. Accordingly, figure 3 provides three postures to categorize a community's resilience efforts. Before resilience planning takes place, a community resides in the pre-resilient community posture. These communities may be planning and implementing sustainable practices, completing traditional hazard mitigation planning, and even implementing large-scale

infrastructure projects. But they have not completed specific resilience planning that takes into account climate change, and have not integrated hazard mitigation or resilience efforts into their comprehensive plans. The second posture (establishing resilience) includes communities that are actively engaging in resilience planning and beginning implementation of resilience efforts. The final posture (established resilience culture) seems near-utopian under current realities, but nonetheless this posture should be the target of communities already in the second posture.

Pre-Resilient Community

- Lack of buy-in from: local leadership, residents, developers and regional partners

- Prioritize short-term economic wins

- Focus on sustainability vs. resilience

Establishing Resilience

- Buy in from: local leadership, residents, developers and regional partners

- Resilience officer or resilience office stood up

- Local risk models developed

$$

Established Resilience Culture

- Large-scale projects and programs with positive effects across the majority of at-risk populations

- All plans incorporate resilience efforts
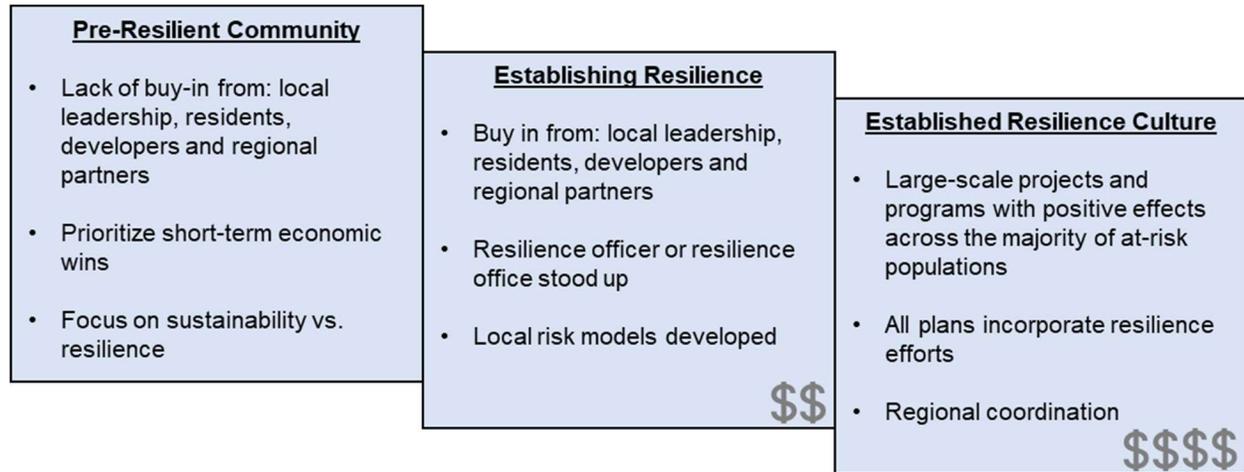
- Regional coordination

$$$$

Figure 3: Community Resilience Postures

City A is a **pre-resilient community** and City B is **establishing resilience**. Neither community has fully established a resilience culture, but City B is well ahead of City A in its efforts. The remainder of this section will include a breakdown of key components of establishing resilience uncovered during the study and will re-address the research questions.

4.1 Resources: Local Leadership Buy-In

When it comes to resilience planning, support from the top is key—as suggested in prior research efforts (Shi et al., 2018). City A does not have such support and this hampers any serious progress toward a more resilient future. As detailed in the quote below, City A's leadership is focused on near-term economic opportunities, which in this case impedes the process of improving the resilience of their community. Contrarily, City B's leaders support resilient planning efforts as evident with the corresponding quote below.

City A Planner: *"Unfortunately, the decision-makers over the past 30 years have been influenced by the quick buck."*

City B Planner: *"The past two [local] administrations have really heavily been invested in resilience"*

Resilience planning cannot take place without resourcing the time and funding required. Those resources are controlled by a few decision-makers who are acting in response to a variety of stakeholders. To move from one resilience posture to the next, it is essential local leadership is supportive of resilience planning.

4.2 Tools: Localized Risk Models

Climate data and the many types of national models currently available provide a great resource for resilience planning. However, if the individual stakeholders of a community are not receptive to the outputs of such datasets and models, they are not effective. City A is currently dealing with this problem as detailed in the quote below. Tailoring these models to the local context is necessary to gain trust and provide clarity. With this in mind, City B is in the process of acquiring a high-end localized model through its dedicated resilience office.

City A Planner: *"[Climate risk models are] going to have to be [City A] specific to be effective."*

City B Planner: *"We actually have a resilience office, and they are working with some very capable individuals putting together what's called a compound flood model [for City B specifically]."*

4.3 Process: Resilience Staff

Establishing resilience is a process. This process cannot happen on its own, but rather requires dedicated individuals for ownership and implementation. City A does not have any dedicated resilience staff—see *4.1 Resources* as to why—and this lack of staff makes it unrealistic to assume the community can move forward into the second resilience posture. Planners, engineers, and other local government employees are already task-saturated, and adding resilience to their plate does not lead to significant levels of change. City B started with one Resilience Officer, who led the development of the City's first Resilience Plan. Once this plan was created, local leadership followed through by standing up an office with 5+ full-time employees to ensure the action items in the plan were carried out.

RQ1 asked: *What are the primary steps a city can take to increase its resilience?* The postures in Figure 3, and the key resources, tools, and process components listed above begin to provide an answer, but as covered in the discussion, further analysis will be necessary to fully validate these initial findings.

RQ2 asked*: To what extent are land use change strategies integrated into existing resilience plans?* Neither City A or B was able to provide evidence that land use change was a significant (or even minor) portion of their current plans. City B did mention that once the results of their compound flood model are completed, they may need to consider land use change and concepts like 'managed retreat'. But so far these concepts are not well represented in their planning efforts. This is discussed further in the following section.

5. DISCUSSION

5.1 Developers are Essential Partners

Both cities made it clear the importance of developers. This was not only in terms of the greedy developers have all the power, but more from an understanding that development is important to their local economy. City B was able to bring developers into the resilience planning process, which ensured alignment of priorities from the early stages of planning. City A is in a position where developers and resilient planning are pushing against one another. This is not a good starting position for planning, and local leadership will need to align those two priorities to move the city in a resilient direction.

5.2 Land-Use Change is Not Currently Planned

Managed retreat is a challenging topic to plan and implement (Ajibade et al., 2022). The two cities in this study are not engaging in planning or implementing this strategy. Over the coming decades, if rising sea levels change as widely predicted, these two communities, along with hundreds of others will have to find ways to include this strategy in their larger plans. The US Government Accountability Office agrees this reality is coming, and suggests the federal government assist with financing pilot programs for the effort (United States Government Accountability Office, 2020). Perhaps lessons learned from such a project would assist other communities as they develop their plans.

5.1 Future Work

Limitations of this work include the small scope of two cities. The researchers intend to expand this effort to include more cities along the US coast to validate and expand upon the findings in this initial study. By interviewing planners across communities at different stages of resilience planning and implementation, a more detailed understanding of this process will be possible. The priority interview target of this study is local planners, but interviewing regional, state, and federal planners would also add to the understanding of building resilience along our coasts. Building codes are one example of a state-run program that local

planners often do not control. The many layers of resilience need to align to tackle the challenges these communities are facing.

6. CONCLUSIONS

Many coastal communities find themselves in a unique position of increasing populations and climate risks. Adapting to these new realities will be a grand challenge lasting decades. This study interviewed planners in two of these communities and found they are aware of these challenges, but will need to expand their strategies to ensure their communities increase their resilience. This study identified three resilience postures for coastal communities: pre-resilient community, establishing resilience, and established resilience culture. The inductive analysis further uncovered local leadership buy-in, localized risk models, and dedicated resilience staff as key factors that will bolster the resilience planning and implementation efforts of coastal communities. The study did not find land-use change as a current strategy for resilience planning, but the researchers remain confident land use change will inevitably be a part of adapting to coastal climate risks. However, social pressures are inhibiting such strategies from being included in current planning efforts.

REFERENCES

Ajibade, I., Sullivan, M., Lower, C., Yarina, L., & Reilly, A. (2022). Are managed retreat programs successful and just? A global mapping of success typologies, justice dimensions, and trade-offs. *Global Environmental Change*, *76*, 102576. https://doi.org/10.1016/j.gloenvcha.2022.102576

Berke, P., & Kaiser, E. J. (Eds.). (2006). *Urban land use planning* (5th ed). University of Illinois Press.

Berke, P. R., Malecha, M. L., Yu, S., Lee, J., & Masterson, J. H. (2019). Plan integration for resilience scorecard: Evaluating networks of plans in six US coastal cities. *Journal of Environmental Planning and Management*, *62*(5), 901–920. https://doi.org/10.1080/09640568.2018.1453354

Felter, E., & Morris, M. (with American Planning Association). (2016). *Coastal zone management*. American Planning Association.

Malek, Ž., Douw, B., Van Vliet, J., Van Der Zanden, E. H., & Verburg, P. H. (2019). Local land-use decision-making in a global context. *Environmental Research Letters*, *14*(8), 083006. https://doi.org/10.1088/1748-9326/ab309e

Ohenhen, L. O., Shirzaei, M., Ojha, C., Sherpa, S. F., & Nicholls, R. J. (2024). Disappearing cities on US coasts. *Nature*, *627*(8002), 108–115. https://doi.org/10.1038/s41586-024-07038-3

Shi, L., Chu, E., & Debats Garrison, J. (2018). Explaining Progress in Climate Adaptation Planning Across 156 U.S. Municipalities. In E. M. Hamin Infield, Y. Abunnasr, & R. L. Ryan (Eds.), *Planning for Climate Change* (1st ed., pp. 340–351). Routledge. https://doi.org/10.4324/9781351201117-38

Smith, T. (2021). *Protecting Vulnerable Populations from Flood Hazards* (No. Issue Number 9). AMERICAN PLANNING ASSOCIATION. https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/Zoning-Practice-2021-09-Rev.pdf

Spearing, L. A., Bakchan, A., Hamlet, L. C., Stephens, K. K., Kaminsky, J. A., & Faust, K. M. (2022). Comparing Qualitative Analysis Techniques for Construction Engineering and Management Research: The Case of Arctic Water Infrastructure. *Journal of Construction Engineering and Management*, *148*(7), 04022058. https://doi.org/10.1061/(ASCE)CO.1943-7862.0002313

United States Government Accountability Office. (2020). *A Climate Migration Pilot Program Could Enhance the Nation's Resilience and Reduce Federal Fiscal Exposure* (Report to Congressional Requesters No. GAO-20-488; CLIMATE CHANGE). https://www.gao.gov/assets/gao-20-488.pdf