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Planning for Adaptation? Examining the Planning Integration for Hazard Risk Reduction

Yiwen Wu [1,*], Ward Lyles [1], Kelly Overstreet [1] and Elaina Sutley [2]

1 School of Public Affairs and Administration, University of Kansas, Lawrence, KS 66045, USA
2 Department of Civil, Environmental, and Architectural Engineering, University of Kansas, Lawrence, KS 66045, USA
* Correspondence: yiwen@ku.edu

Abstract: Integrated planning—including multiple planning practices for common purposes—is deemed essential for bringing stakeholders together for effective hazard risk reduction. Scholarly attempts to examine if and how distinct plans and planning processes are integrated have ebbed and flowed over time, with a recent resurgence in attention. Utilizing tools from network science, we analyzed four types of planning practices and uncovered considerable variations across local hazard risk-reduction support networks. Our findings reveal that certain communities relied heavily on a few critical actors for risk reduction, making them vulnerable to institutional turbulence. In turn, we point to growing needs for far-reaching and overlapping networks. Our study adds to the literature by integrating multiple planning practices to support more concerted local efforts in hazard risk reduction.

Keywords: planning integration; hazard risk reduction; network of people; network of plan; social network analysis

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1. Introduction

Climate change increases exposure to and the severity of hazards or disasters for virtually every community, posing monumental challenges for long-range planning [1]. Central to the challenge planners face is the fragmented array of policies and practices essential for climate change and disaster policy and planning. The United States' National Climate Assessment, for instance, identifies 17 different nationally relevant topics, such as water, energy, land, transportation, and human health, planning for which already involves myriad people and processes [2]. National and sub-national disaster policy and planning often is categorized into four phases—preparedness, response, recovery, and mitigation—each often subject to a complex interplay of planning processes and practices.

In the United States, communities that engage in long-range planning utilize multiple types of planning processes and documents relevant to hazards and disasters. Communities often develop land use plans aimed at shaping sustainable development patterns and hazard mitigation plans aimed at reducing long-term risks. Some communities also develop recovery plans that can be used in the aftermath of a disaster or disasters. Over the last decade, more and more communities have developed climate plans, often primarily aimed at reducing greenhouse gas emissions, but increasingly aimed at adapting to the impacts of climate change. Additionally, transportation plans, housing plans, and other plans can influence the effectiveness of reducing risks from climate-exacerbated hazards and disasters.

A vital question that only recently has gained the attention of scholars and practitioners is, do these distinct plans work together as a cohesive whole? Building on decades of conceptual work pointing to the importance of networks as a heuristic for understanding planning [3,4], planning scholars have formulated and implemented methodological approaches to understand and evaluate networks of people engaged in planning processes and networks of plan documents for integrated risk-reduction knowledge [5,6]. Among other benefits, these evaluations can highlight areas of goal alignment, or lack thereof; strengths in the structure of the connections between key stakeholders, as well as gaps or weak points; and specific instances of policy alignment or contraction.

This article aims to contribute to this growing body of crucial knowledge on the dynamic of plan integration and long-range risk reduction planning. We focus on the linkage between the hazard mitigation planning typically concerned with pre-event actions and disaster recovery planning typically concerned with post-event actions while accounting for the broader network of relevant plans and planning processes. To this end, we seek to answer three inter-related research questions: (1) To what extent are local hazard mitigation and recovery planning documents integrated? (2) To what extent are local hazard mitigation and recovery planning processes integrated? (3) What institutional factors explain the variations in the integration of mitigation and recovery efforts? If pre-event mitigation and post-event recovery planning are disconnected, then this raises major questions about the entire disaster planning framework in the United States.

First, we draw on the literature on plan integration, long-term risk-reduction planning, and network science to conceptualize the linkages among various planning practices related to hazard risk reduction. Next, we describe the research design, including case selection, and methods used to assess the integration of plan documents and planning processes. Then, we present our findings, answering each of the three research questions above. Our discussion section situates the findings of mediocre-to-low integration in the literature to highlight key implications for intergovernmental efforts to reduce risks. We conclude with policy- and practice-relevant recommendations.

2. Literature Review

2.1. Planning Integration: Concepts and Evaluation Approaches

Planning integration describes actions taken to increase linkages between and synthesize plans and planning processes that might otherwise take place in isolation from each other or with minimal attention to ways different plans can support or constrain each other [5,7].

Theoretically, plan integration offers a mechanism to help practitioners and stakeholders share knowledge across disciplines and domains of activity (e.g., transportation, land use, housing, etc.), understand challenges that cut across domains and those unique to certain types of planning, and align myriad goals and policies to support and enhance individual plans. However, as planning scholars have long noted, the process of creating even a single plan in isolation raises problems of time and resource demands, competing interests and aims, and commitment to implementing plans [8]. These challenges are amplified when planners aim to integrate planning processes that unfold with different groups of stakeholders, different timeframes, and different bases of information used, among others.

Plans vary widely in their purposes, adding challenges for integration [9]. What does plan integration mean when a community's hazard mitigation plan exists only to comply with the federal mandate of the Disaster Mitigation Act of 2000, while its climate plan articulates the vision of political leaders and specific interest groups acting from a place of local urgency, and its current comprehensive land use plan embodies a cumulative body of work spanning decades of regular updates? The complex, uneven, and dynamic policy and governance contexts that complicate plan integration also raise questions about how one even begins to define, much less measure changes in the type and extent of plan integration [10]. Holden focuses attention on whether integration is focused on aligning (a) visions and agendas, (b) governance institutions, (c) communities and voices, (d) policy sectors, and/or (e) knowledge types. Drawing from empirical evidence on integrated land use and transportation planning in Sweden, Hrelja documented difficulties that arise when one stakeholder or group of stakeholder dominates the planning process [7].

Power dynamics within a steering committee can impede policy integration when stakeholders hold divergent priorities or interests, particularly when more powerful stakeholders choose to impose their ‘steering culture’ rather than collaborate or compromise [7]. Even if power dynamics could be attenuated, incentives remain for stakeholders to focus on their own discipline or sector, thereby undermining the potential for integrated, system-wide benefits. Scholars working with case evidence from transportation planning in the Netherlands highlight the dynamic nature of integration, as planners contend with the reciprocal interplay of strategic and operational aspects of planning processes, each of which can generate different types of integration challenges [11].

Planning scholars have developed and tested multiple frameworks for assessing plan integration that contend with these challenges. Much of this work has been carried out in the realm of hazard risk reduction planning, some dating back to the 1990s [12]. More recently, Berke and colleagues developed the Plan Integration for Resilience Scorecard and have applied it across multiple national contexts [5,13]. Scholars conceptualize four approaches to plan integration evaluation [6]: (a) cross-referencing, (b) plan quality evaluation, (c) plan integration for resilience scorecard, and (d) social network analysis. They apply each to a network of risk reduction plans in Boston, MA. Some of the most promising insights to date are gained by applying network analysis concepts and methods to plan documents and the participants in planning process, harnessing aspects of multiple approaches and drawing from complementary data sources.

2.2. Integrating Planning for Long-Term Risk Reduction

Reducing long-term risks from natural hazards presents an excellent testbed for studying plan integration. First, risk reduction planning requires information and analysis drawn from multiple disciplines (e.g., planning, emergency management, and engineering) with specific issues of concern including, but not limited to, land use patterns, environmental conservation and restoration, building codes and property protection, emergency preparedness and response, and budgeting and fiscal management. Second, planning processes in each of these domains are often led by different departments with different professions in leadership positions, introducing myriad opportunities for gaps in integration due to divergent knowledge bases and assumptions, goals and priorities, and disciplinary cultures and biases. This study acknowledges that a wide range of factors can alter the mainstream planning practices either mandated or nonmandatory. Third, these distinct planning processes relevant for risk reduction each unfold over different timelines, some of which follow regular and predictable schedules (e.g., comprehensive planning), while others arise over irregular and uneven schedules (e.g., disaster recovery planning).

To set the stage for using network analysis to evaluate plan integration, we briefly summarize four key domains (Table 1): land use planning, hazard mitigation planning, disaster recovery planning, and climate change adaptation planning. A key takeaway of this analysis is that despite advances in conceptualizing and understanding plan integration in the realm of hazards, we still know very little about if and how hazard mitigation and disaster recovery, in particular, are integrated.

Table 1. Four domains of planning.

Planning Practices	Legal Framework	Professional Responsibilities	Typical Timing
Land Use Planning	Not uniformly consistent, depending on state legislature.	Carrying out planning processes like plan development, public engagement, and evaluation [14].	At least every five to seven years
Hazard Mitigation Planning	*Disaster Mitigation Act*	Mitigation planning processes for hazard risk reduction and long-term sustainability [15].	Every five years

Table 1. *Cont.*

Planning Practices	Legal Framework	Professional Responsibilities	Typical Timing
Disaster Recovery Planning	Based on locality's discretion and available programs/resources.	Policies that guide post-disaster redevelopment and build back quickly [16].	Depends on local capacity and needs
Climate Change Adaptation	Not standardized	Location-based climate risk reduction, coordination of local resources, strategies for co-benefits across local policy agenda [17].	Depends on local capacity and needs

2.2.1. Land Use Planning

Land use planning influences spatial patterns of public infrastructure and private development that shape everything from people's daily activities to a community's long-range economic and social future [18,19]. Broad contours and specific details of land use plans and related regulations can help manifest local priorities, whether in the realms of economic development, smart growth, housing, or transportation. However, for long-term sustainability and equity, development priorities must not trump attention to differential vulnerabilities of land to natural hazards [18]. Acquiring flood-prone properties can reduce exposure of homes and business to floods while also creating open space that can serve as green infrastructure, provide habitat and protect biodiversity, and even provide recreational opportunities to enhance quality of life.

There are legal frameworks regulating local land use very widely across the United States in the absence of national planning framework [20,21]. Strong state mandates for local planning can have tremendous influence on communities' land use planning practices [20], exemplified in states like Oregon and Maryland, which require local alignment with state-identified goals, such as hazard risk-reduction. States with weaker mandates for local planning may miss opportunities to incentivize or compel more sustainable land use patterns, a dynamic evident in Florida, which was a national leader in state regulation of local land use planning before its planning framework was gutted in the 2010s [21]. The timing of reduction in state influence in Florida is ironic, given the annual questions communities there face of if, how, and where to rebuild after a hurricane. Many states navigate a middle ground between strong mandates and weak mandates, such as North Carolina, where policies like the Coastal Area Management Act engage land use regulations to guide local development in highly vulnerable coastal areas of the state, while requiring less local planning elsewhere in the state.

2.2.2. Hazard Mitigation Planning

Hazard mitigation planning aims to reduce the long-term risks of natural hazards like flood, hurricanes, and earthquakes through proactive, pre-event planning [12]. Hazard mitigation efforts can occur through structural measures, such as large-scale engineered projects like levees and dams and smaller-scale property protection measures such as elevating a home above the predicted flood levels. They can also occur through non-structural measures, such as conserving natural ecological features that reduce risk, like wetlands that can store flood waters, and land use planning, as described above. National consensus studies repeatedly emphasize that non-structural mitigation measures that steer development into safer locations are the most promising form of mitigation [22].

The national Disaster Mitigation Act of 2000 (DMA) establishes the legal framework for state, local and tribal hazard mitigation planning activities. With this framework, local jurisdictions can opt to develop stand-alone mitigation plans or create mitigation components as part of their comprehensive plans [23,24]. The requirements of establishing a DMA-compliant mitigation plan does not guarantee mitigation will be integrated in other planning practices, even in states with strong land use planning mandates; empirical studies indicate that the local mitigation planning has only met the basic requirements set by state and federal governments even though local governments have already given their best efforts [25].

In localities with intensified and frequent hazardous events each year, the short reacting time window between mitigation and recovery planning within a disaster response cycle becomes a particular point of concern. The shortened reaction time strains local planning capacity and renders the boundary between mitigation and recovery blurry. A successful hazard mitigation plan requires integration with recovery experiences to avoid repetitive and additional loss in hazard-prone zones. In so doing, mitigation efforts can be more efficient in incorporating post-disaster land use regulations [24,26].

2.2.3. Disaster Recovery Planning

Disaster recovery emphasizes the timely restoration and redevelopment of physical, social, and natural environment [27]. Cities and counties can engage in pre-disaster planning in anticipation of the myriad needs for long-term recovery after an event, although most pre-disaster planning tends to focus on shorter-term preparedness and response in the immediate aftermath of a disaster event [28]. Pre-event recovery planning can create a platform to recover from disasters more efficiently and equitably by anticipating how material and financial resources, human and social capital, and other kinds of capacities will be impacted in the post-event period [27,29].

A common refrain in disaster management is to "build back better", which requires not just returning to normal, but also ensuring equitable allocation of resources to long-term sustainability. Recovery planning must include the following: (1) in-depth engagement with public to learn from localized knowledge and vulnerability; (2) coordination with legal authority to ensure responsive change of zoning ordinances after a disaster; and (3) facilitation of resources' circulation like staffing power across different levels of government for seamless post-disaster support. Yet, there is no single uniform standard for recovery planning, as each disaster event and how it impacts communities can vary widely. Attending to local context through local planning is key.

National policy frameworks are found unclear about the appropriate expertise needed to advance local recovery [30]. The National Disaster Recovery Framework (NDRF)—aiming to promote policy coordination—does not provide specific requirements on who should participate in a recovery planning committee [31,32]. We believe the ubiquity of local mitigation planning since the adoption of the DMA in most communities can at least provide a mitigation planning committee that could pivot to also address recovery. However, calls for integration between mitigation and recovery are not new. A seminal piece revealed that better mitigation–recovery integration will result in better (re)development management after a disaster [33] with the expenses of strong leadership and accelerated integration process.

2.2.4. Climate Change Adaptation Planning

To date, there is no uniform, established legal framework for climate change adaptation planning efforts. Community-wide adaptation efforts generally entail all actions that reduce risks to climate-related impacts like heavy rains, drought, severe storms, increased heat, sea-level rise, and wildfires, among others [1,34,35]. Land use regulations are widely accepted as the core of climate risk reduction [17].

With the largely varied state and local context, planning for adaptation confronts enormous challenges. A major challenge comes from the lack of resources. Resources, funding, and staff power are highly dependent on a jurisdiction's leadership and commitment [34,36,37]. Empirical studies also show that cities with greater expenditure per capita are more likely to prepare climate adaptation actions [38], indicating that climate adaptation projects can become inferior when a city has tight budgets.

Climate change resilience building normally takes a regional approach. For instance, to combat the shortage of local capacity, the Southeast Florida Regional Climate Change Compact, a regional workgroup of county officials, applied for federal grants collectively to facilitate climate change adaptation for a list of small jurisdictions. Another example involves the collaborative efforts in building the Fire Learning Network regionally [39]. The regional planning and workshops—while reducing the learning costs of each jurisdiction—have greatly increased the technical support for local communities. Our study accounts for the regional and sometimes local efforts of addressing climate change adaptation as part of the risk-reduction framework.

2.3. Network Science and Plan Integration

Conceptual and empirical studies of networks have exploded across disciplines as varied as physics, sociology, business, and computer science in the last 30 years, including in planning [4,40]. Conceptually, a network uses a list of nodes and edges connecting nodes to describe relationships among the nodes [41]. Common examples of nodes in planning include material networks such as bus stops (nodes) linked by routes (edges) and social networks such as city departments (nodes) linked by communication such as email (edges). Here, we focus on social network analysis because our interest is in the social process of planning and its communicative outputs, especially plans.

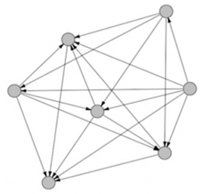
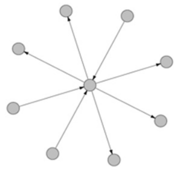
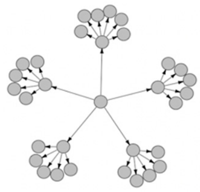
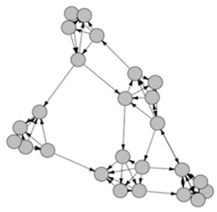
In social network analysis, constructed networks help scholars interpret how individuals and groups interact to affect certain social events or vice versa [42–44]. The analysis of relationships and network structures opens possibilities to address limitations of differently constructed networks evident from the patterns [41,45]. To study a planning process, we conceptualize the planning participants as actors and the interactions between participants as ties. The structure of a planning network depicts how various stakeholders attend planning meetings and task with planning assignments. The risk-reduction network should conceptually encompass four small networks—land use, mitigation, recovery, and climate adaptation practices.

Table 2 summarizes the four network archetypes used in environmental planning to interpret the dynamics of the planning processes [6,46,47]. Each network archetype entails advantages and disadvantages regarding functions, connection to the main network, information flow, trust building, or burdens placed on certain actors. The network typologies help understand if and how certain patterns of relationships enhance or constrain the overall planning network.

As Table 2 shows, complete networks offer high connectivity between all nodes, but incur high costs for relationship maintenance and can be highly inefficient for information flows and coordination. Star-shaped networks, in contrast, concentrate all ties on one central node, making coordination easy and centralizing information flow, but with the downside of limiting all functions not run through the central node, particularly widespread trust-building and collaboration among peripheral nodes. Hierarchical networks function as a scaling up of star networks and are very common in many organizations. Hierarchical networks offer high efficiency with the cost of fragmentation. A small-world network offers a balance of attributes of complete and hierarchical networks and typically consists of pockets of complete networks connected by bridging connections [48]. Small-world networks have been found to arise naturally in myriad physical and social contexts, with considerable advantages over hierarchical or complete networks. In planning contexts, the connectedness between each cluster of actors can represent inter-departmental or interpersonal collaborations and coordination [45,49].

Regarding node-level measures, degree centrality defines the extent to which a network or an actor is connected [50]. Scholars use degree centrality to examine the extent of collaboration [40]. Others use degree centrality to measure the number of links an actor receives to examine the popularity of a specific actor or planning document [6]. In our analysis, we extend the concept of degree centrality to uncover the critical actors or professionals in a local risk-reduction network. Actors with high degree centrality would reside in a center location of the network.

Table 2. Network archetypes for risk reduction planning.

Archetype	Relevance to Risk Reduction	Advantages	Disadvantages	Sample Network
Complete Network	Equal access to information for all actors because of similar distance to each other.	Good accessibility between all actors; the network is stable and will not fall apart due to the removal of any actor.	No obvious central actors who maintain the network; no obvious decision-makers may cause high communication costs.	
Star-Shaped Networks	Information/decisions can be delivered efficiently between the central actor and all other actors.	Highly efficient information consolidation and distribution.	The removal of central actors causes the network collapse. Peripheral actors have limited mobility.	
Hierarchical Network	The decision-making is responsive because actors with lower status only connect to their superiors.	Clear pattern of leadership that allows quick decision-making. Actors have close connection with their leading actors.	Limited ability to share information and resources; the network relies on the leader actor's presence.	
Small-World Network	Each small cluster acts as a function committee for risk reduction. The small world as a whole has potential and enhanced capacities.	The network serves multiple purposes towards goals, and it can be a result of integrated planning efforts. Actors have access to all clusters.	The connection between clusters heavily relies on key actors. It is costly to maintain such large networks.	

An actor's betweenness centrality defines the shortest paths between all pairs of actors that pass through the actor of interest [41]. Betweenness centrality also defines a group or an actor's ability to maintain a well-connected network. Fliervoet and colleagues (2016) [47] identified the critical role of specific actors (i.e., Governmental Service for Land and Water Management) in maintaining the connection of collaboration in an environmental management project in the Netherlands. Our study also leverages betweenness centrality of actors to identify the indispensable planning actors.

2.4. Empirical Application of Network Science to Plan Integration

In recent years, planning studies have begun to apply network principles to better understand the integration of planning policies [51,52]. The Planning for Resilience Scorecard, for instance, draws a connection between plan integration and community vulnerability to examine the hazard-vulnerable hotspots for better policy attention [5]. Plan integration is a practice wherein planners review and incorporate existing planning policies into the planning process for new planning policy. Plan integration oversees the available planning resources locally [42,53]. For our analysis, the network of plans directs our focus on advancing the knowledge and implantation of inclusive planning policies in each local jurisdiction. In analyzing the networks of plans, we can address issues like missing plans, which can potentially lead to conflicts between planning policies within a jurisdiction. For those well-connected plans, we may confidently conclude that their goals are aligned for risk reduction and long-term sustainability.

Likewise, hazard mitigation scholars have shown that local mitigation efforts need to be cross-scale, collaborative, and multi-disciplinary [25,40,45]. A major step during a planning process is to gather a team of experts with different backgrounds to combine knowledge and resources. Even though localities confront different challenges and varied priorities in hazard risk reduction, integrated planning enables the technical and political support essential for risk reduction. For instance, in the Fire Learning Network, local officials' participation in low-cost regional collaborative workshops helped each locality strengthen their fire protection knowledge and capacity, and improved overall regional integration [39]. Similarly, integrated planning promotes flood risk reduction and heat vulnerability reduction at both regional and community levels. Our study of planning integration aims to extend our knowledge on the networks engaged in hazard risk reduction, especially recovery.

2.5. Conceptual Framework in Long-Term Risk Reduction

In extending the research on planning integration in long-term risk reduction, we focus on the disaster response cycle (see circled part in Figure 1.). The hazard mitigation and long-term recovery aspects of the cycle have indistinguishable boundaries due to the shared responsibilities in disaster prevention and sustainability. To understand risk-reduction efforts, we must also acknowledge the community's longstanding land use practices and emerging climate change adaptation practices. As discussed above, land use has essential consequences on land vulnerability and community resilience [18,54]. Likewise, climate change adaptation practices are highly localized, and speak to local government's commitment to climate impacts relief [38].

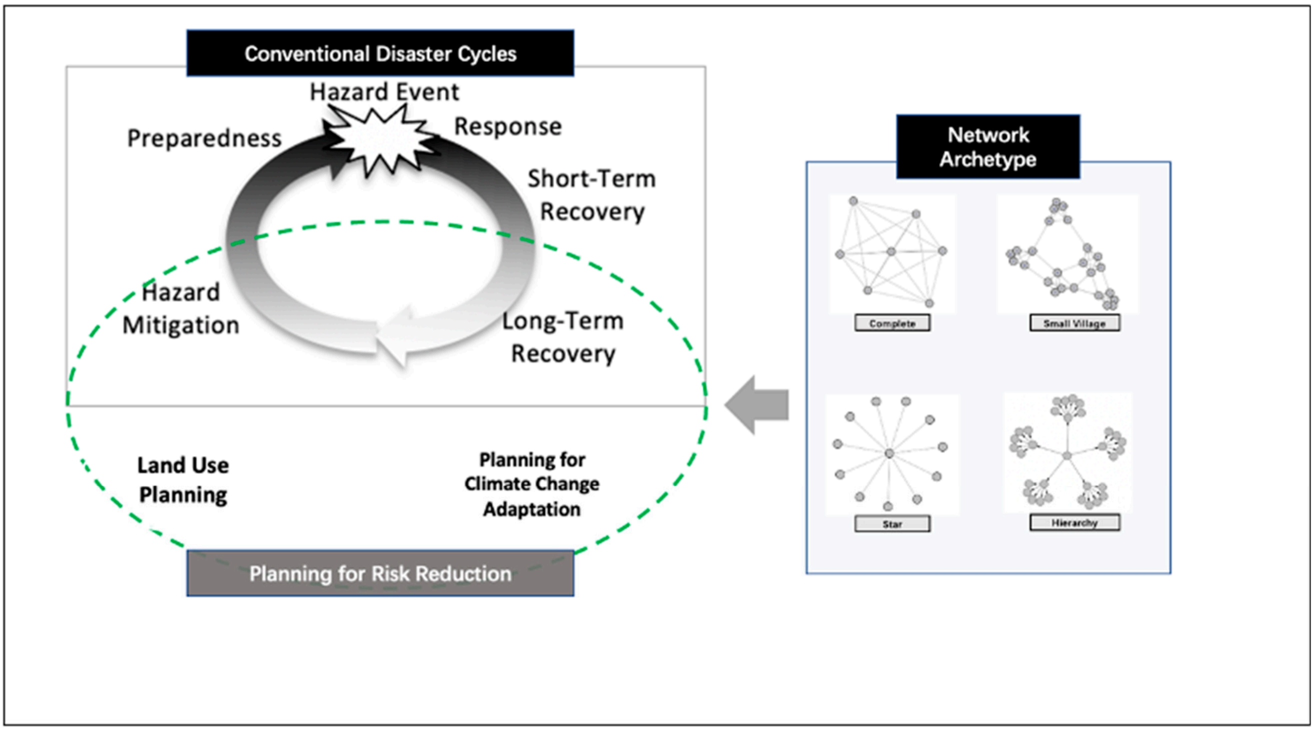


Figure 1. Conceptual framework.

Each domain of planning practice is used for various localized reasons, but there has not been a study accounting for all planning practices relevant to hazard risk reduction. Our study fills in this gap by answering the following research questions:

1. To what extent are local hazard mitigation and recovery planning documents integrated?
2. To what extent are local hazard mitigation and recovery planning processes integrated?
3. What institutional factors explain the variations in the integration of mitigation and recovery efforts?

3. Research Design and Methodology

Our research design provides a comparison of detailed case studies of five county-level risk-reduction planning efforts in three southeastern states in the United States. Within each case study, we conducted content analyses and network analyses of plan documents and developed a visualization of plans and key stakeholders involved in planning processes. Comparative analyses allow us to identify commonalities and divergences between different planning processes, highlighting the nuanced state and local factors that shape plan integration. Supplemental information was provided via responses to a web-based survey of local risk-reduction officials and secondary data.

3.1. Case Selection

In selecting our cases, we sought variation in state and local contexts, both of which have been repeatedly shown to influence planning, while also ensuring enough commonalities between cases to support cross-case comparison, including geography and vulnerability to specific hazards. To achieve these selection aims, we selected five counties in three southeastern states. (Table 3). The three states—Florida, Georgia, and North Carolina—provide a balance of commonalities and differences well suited to cross-case comparison in the realm of hazard planning. They share similar hazard risk profiles, most obviously from hurricanes and tropical storms. All three states have also recently undergone mitigation and recovery processes from Hurricanes Matthew (2016), Irma (2017), and Michael and Florence (2018). All states are subject to the same federal hazard policy framework, including the Disaster Mitigation Act of 2000.

Table 3. Demographics of selected counties.

County	Population 2019	Population Growth Rate (10 yr)	Poverty Rate 2019	Education Obtainment Bachelor 2019	Median House Value 2019
Palm Beach County (FL)	1,465,027	12.7%	12%	16.6%	USD 283,600
Chatham County (GA)	288,496	12.51%	14.40%	13.9%	USD 194,500
Glynn County (GA)	84,470	8.81%	17.87%	12.6%	USD 179,000
Craven (NC)	102,491	2.49%	14.41%	10.6%	USD 157,900
New Hanover County (NC)	227,938	15.55%	15.53%	18.3%	USD 243,600

The states also share similar long-term growth pressures as millions of people have migrated to the southeastern United States seeking economic opportunities and retirement locales. The states diverge in important ways, however, as Florida historically had the strongest land use planning framework, followed by North Carolina and then Georgia. And, in Florida, state-level hazard mitigation planning has typically steered local planning toward preparing to secure FEMA grants, leading to plans highly focused on property protection projects and purchasing. By comparison, North Carolina's state level mitigation efforts have tended to steer local planning towards land use approaches, including buying out flood-prone owners, while Georgia has taken more of a mixed approach.

For local-level case selection, we focused on county-level planning, as that is the dominant level of hazards planning in each of these three states and the nation. Due to a widespread lack of recovery planning—in and of itself a problematic finding that we discuss later—we determined an opportunity sample of five counties. As detailed in Table 3, US Census data indicate that the counties vary widely in population, from under 100,000 people to nearly 1.5 million people. All but one county has experienced population growth rates between 8% and 16%, each county is in the 12% to 18% rate of impoverished residents, and each county has between 10% and 20% of its adult population with a college-level education. Median home values vary widely, from roughly USD 150,000 to nearly USD 300,000. While these variations introduce importance nuance into the comparisons that must be accounted for, the cases in Georgia and North Carolina divide nicely into matched pairs: Chatham and New Hanover Counties are highly similar, as are Glynn County and Craven County.

3.2. Data Collection

Our data collection efforts focused on obtaining official hazard mitigation, disaster recovery and other plan documents, gathered from the public websites of county governments. These plan documents typically include the core goals and actions for the community, as well as documentation of who was involved on the steering committee and planning meetings. The plans obtained for analysis were adopted by the communities between 2015 and 2019, making them the most up-to-date plans at the time of data collection.

Our process for generating data from the plan documents consisted of systematic plan coding per [55,56]. Two graduate researchers conducted content analysis on the five counties' mitigation, recovery, and land use plans. Double-coding plans, including reconciling coding disagreements, improve data reliability for binary measures of whether something of interest is present or not, while also allowing each coder to record qualitative insights about the plans. Our coders used the hermeneutic software package Atlas.ti 9.0.3 to conduct the analysis. Plan coders first pre-tested the coding protocols on randomly selected plans outside of the sample to test the protocols, and ensure the intercoder agreement rate was well above the acceptable baseline [57].

Our coding protocol is based on previous plan evaluation studies of hazards planning [58,59]. We targeted specific sections of the plan document for content analysis. To code the plan integration with other plans, we focused on (1) whether various plans were simply mentioned (i.e., we coded as 1), and (2) whether the cross-referencing was detailed discussions of policies in other plans (i.e., we coded as 2). For instance, if a hazard mitigation plan was coded and it provided detailed cross-referencing of a recovery plan, that connection would be recorded as 2, whereas a different hazard mitigation plan, when coded, would be recorded as 0 if it failed to mention a recovery plan. In the sections of plans documenting the planning process, we focused on (1) the composition of planning committees, (2) the type of agencies (i.e., local, state, federal level agencies, nonprofit, and private firms) involved in the planning processes, and (3) shared responsibilities of involved agencies in the planning processes (e.g., plan writing, technical support for plan development, or plan implementation).

To supplement the plan analysis, we conducted a web-based survey of local officials with responsibility for mitigation and recovery. The creation and implementation of the survey followed procedures based on the established survey-design standards [60]. We recruited county emergency managers or planners to take the survey. The surveys posed questions complementary to the aims of this study that could not be assessed through our plan coding, including the frequency with which the officials have used the various plan documents and the frequency with various officials involved in risk-reduction planning activities (survey questions are attached in Table S3 in Supplementary Materials).

3.3. Data Analysis

To answer research questions 1 and 2 on the level of integration across plans and the level of integration across planning stakeholders, we first calculated the values of nodes and edges for both plan networks and stakeholders' networks based on the data collected from systematic content analysis and the survey. Leveraging the nodes and edges, we constructed visuals of the networks using an R package igraph. Then, we analyzed the network archetypes based on the generated visuals and networks' statistics (i.e., degree centrality and betweenness centrality).

Regarding the plan network, a node represents a plan integrated in the four types of plans analyzed. We assigned value 1 to the node of the plan being mentioned, and we assigned value 2 to the node of the plan being mentioned and discussed in detail. When a plan is mentioned and discussed multiple times throughout the four plans analyzed, this plan is well integrated into other plans and has a large-sized node. Additionally, we aggregated the survey results to the size of nodes based on the planners' perceptions on how frequently each plan was used. For instance, we aggregated values based on usage frequencies (i.e., 0, 1, 2, and 3 to represent plans used less often than monthly, monthly, weekly, or daily). The edges of the plan networks are directional. An arrow from Plan A to Plan B means that Plan B incorporated elements of Plan A.

Regarding the stakeholders' network, each node represents a specific stakeholder's presence in planning activities as coded in the plan documents. We assigned value 1 to the node at the base level for their presence, and for each additional planning activity (i.e., planning meetings, implementation activities, and appearances in the plan development processes) the stakeholder was involved with, we assigned an additional value of 1 to the node of the stakeholder. Hence, the node size indicates a stakeholder's level of involvement in the planning processes. A large node size indicates a stakeholder's frequent appearance in planning processes. For the edges, we incorporated the survey results, recording the mitigation planners' perceptions on the frequency of co-worked experiences with other key stakeholders. The survey data demonstrated stakeholders' in-depth relationships measured at the ordinal level (i.e., values 0, 1, 2, and 3 are used to represent the co-worked frequency including less often than monthly, weekly, or daily bases).

We used the package *igraph* in R to calculate the network statistics including degree and betweenness centrality. The computational algorithm of *igraph* helps identify the shortest path between two nodes to make the network parsimonious and aesthetic. When two stakeholders are located close to each other, it means the two stakeholders share more tasks in the planning processes.

4. Findings

Collectively, the findings provide answers to each of our three main research questions. First, local hazard mitigation and recovery plan documents vary in the level of integration observed. Overall, mitigation plans are well integrated into the recovery plans as the arrows are pointing towards the recovery plans from the mitigation plans (Figure 2), meaning that all five counties have incorporated elements of mitigation plans in their recovery plans. However, the recovery plans are not well integrated into the mitigation plans the other way around, for instance, in the cases of Chatham (Figure 2c), Craven (Figure 2d), and New Hanover (Figure 2e) Counties. Second, regarding the planning process integration between hazard mitigation and recovery, the counties show varied levels of integration, although integration is low in most cases (Figure 3). We observe that most counties have small-sized recovery planning networks, preventing counties from integrating recovery planning processes into the mitigation planning processes. Third, the cases point to multiple institutional factors that may explain these variations, including elements of the state and local policy context, risk profiles, local capacity, and county demographics. Before elaborating on these cross-cutting findings, we first present short case vignettes, accompanied by network diagrams that illustrate the patterns described.

4.1. Palm Beach County, FL (Figures 2a and 3a)

The plan network of Palm Beach County centers around mitigation and emergency operation plans, meaning that these two plans are frequently consulted during risk-reduction planning. The larger-sized nodes—mitigation, emergency operation, and land use plans—indicate that local planning officials have frequently used these plans. The arrows centered around land use, mitigation, recovery, and resilience plans demonstrate a balanced plan integration among all plans relevant to hazard risk reduction. However, with a smaller node size, the recovery plan is less integrated into other plans in the network.

The stakeholders' networks for mitigation and climate resilience planning appear complete and are connected through university partners, the county stormwater department, and the state emergency management office. There is a high level of planning process integration across a diverse set of stakeholders from various types of agencies (i.e., public, private, state, local, and nonprofit), among which, the county planning office has a central role in working with most other stakeholders. With a large node size, the county planning office had the highest number of co-working experiences with stakeholders for all planning processes.

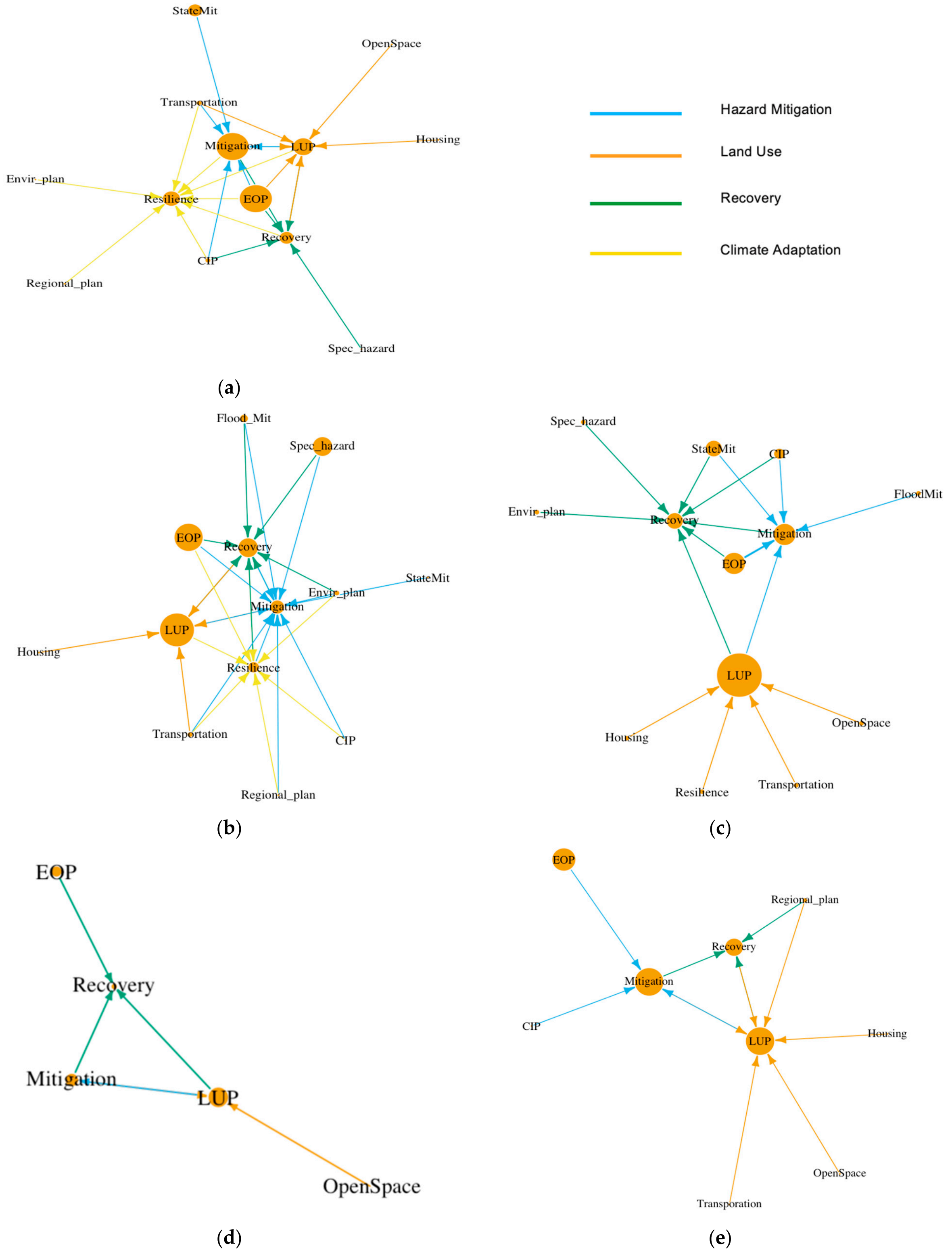


Figure 2. Plan networks: (**a**) Palm Beach County, Florida; (**b**) Glynn County, Georgia; (**c**) Chatham County, Georgia; (**d**) Craven County, North Carolina; (**e**) New Hanover County, North Carolina. Note: the node size indicates the frequency of the plan being used and cross-referenced.

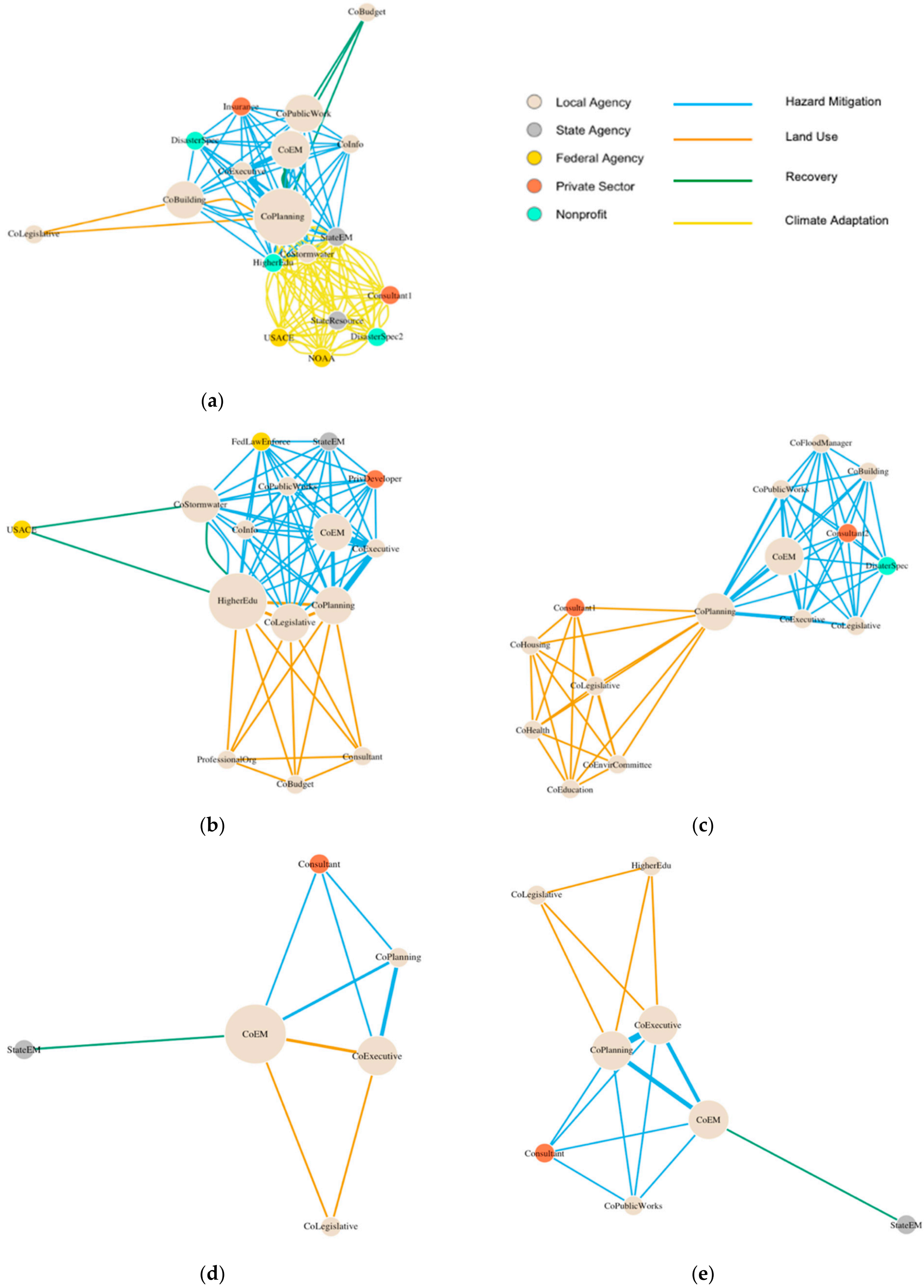


Figure 3. Stakeholder networks: (**a**) Palm Beach County, Florida; (**b**) Glynn County, Georgia; (**c**) Chatham County, Georgia; (**d**) Craven County, North Carolina; (**e**) New Hanover County, North Carolina.

4.2. Glynn County, GA (Figures 2b and 3b)

The two most frequently used plans are land use and emergency operation plans. However, the land use plan did not have the same level of plan integration as compared to mitigation and recovery plans. Both recovery and mitigation plans had high levels of plan integration.

In line with the plan network, the stakeholders' network consists of several planning committees, including a land use planning subnetwork, a mitigation subnetwork, and a recovery subnetwork; among those, the mitigation stakeholder network appeared to be the most complete. Even though we observed a missing role of climate resilience planning processes in the overall risk-reduction network, the stakeholders' network is well integrated through the three entities frequently working together, including university partners, county commissioners, and the county planning department.

4.3. Chatham County, GA (Figures 2c and 3c)

The plan network of Chatham County has frequently utilized the land use plan in daily planning activities, as indicated by the largest node of the land use plan. The mitigation plan is integrated in the recovery plan, but the mitigation plan does not integrate any elements of the recovery plan. Additionally, the climate resilience plan was not ready at the time of data collection.

There are only two subnetworks—the hazard mitigation and land use planning—that were integrated for the overall risk-reduction planning network. Although the recovery plan was made publicly available, we were not able to find any evidence of planning process integration. The absence could be the result of missing parts of the recovery plan by the plan authors, or simply because the recovery planning was a standalone planning practice.

4.4. Craven County, NC (Figures 2d and 3d)

Craven County has basic plan and stakeholder networks. We found limited evidence of plan integration among the plans analyzed. There is a lack of plan integration for local risk reduction. For the stakeholders' network, we noticed an external consultant's involvement in mitigation planning, and the county emergency management office played a central role in facilitating multiple planning processes (i.e., recovery, land use, and hazard mitigation planning). Based on the edges, county emergency managers, county planners, and county managers have maintained frequent communications in facilitating local risk-reduction activities.

4.5. New Hanover County, NC (Figures 2e and 3e)

Similar to Craven County, New Hanover County has basic plan and stakeholders' networks. Given the limited plan integration without a climate resilience plan, the stakeholders' network includes a few participants attentive to the planning processes. We observe stronger ties between county planners, county executive officers like county managers, and county emergency managers, meaning that they have frequently worked together. The larger-sized nodes of county emergency managers, planners, and managers indicate their high levels of involvement in planning activities.

4.6. Question 1: To What Extent Are Local Hazard Mitigation and Recovery Planning Documents Integrated?

Our five case counties demonstrated vastly varied and dynamic plan networks for climate risk reduction overall. Specifically, most recovery plans referenced mitigation plans but not the other way around. We found that having both recovery and climate resilience plans adds tremendous value to a county's overall plan network. For instance, counties with resilience and recovery plans, like Glynn and Palm Beach, are more likely to have robust plan networks, meaning more cross-referencing among plans (Figure 4) and the frequent use of plans by local planners.

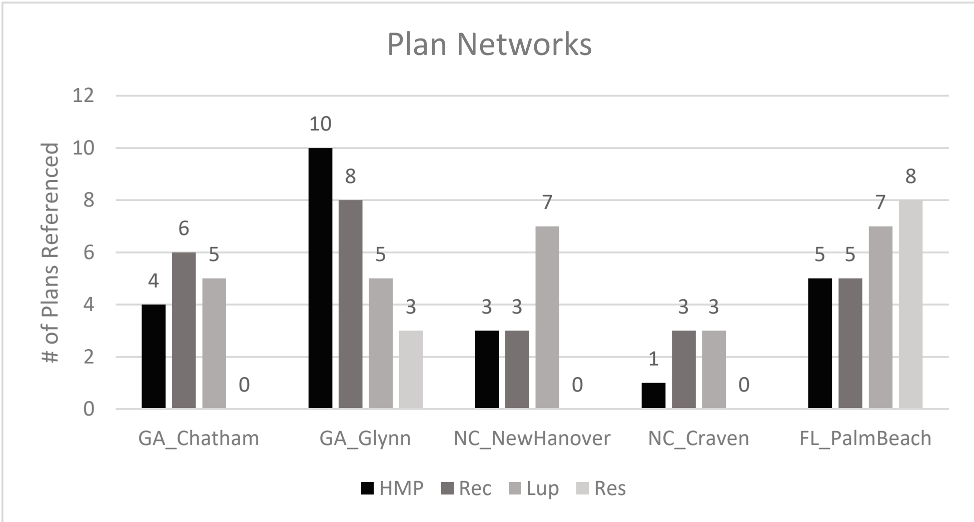


Figure 4. Number of plans integrated. Note: HMP = Hazard mitigation plan, Rec = Disaster recovery plan, Lup = Land use plan, Res = Resilience plan.

Regarding plan integration, a land use plan should theoretically play a central role in risk reduction [18,61]. However, our plan network visuals indicate otherwise in reality (e.g., Chatham County and New Hanover County). The plan network of Chatham County suggests that land use planning offered insights for mitigation and recovery but not the other way around. Land use plans did not incorporate insights from mitigation and recovery plans. For the highly varied plan integration practices, communities with more plans available tend to have more cross-referencing [6]. The number of plans available corresponds to the level of planning process integration. We notice this consistency between plan integration and planning process integration across case counties. A prerequisite of climate resilience planning means that typically there is enough staff capacity and previously established plans to support the work. Counties like Palm Beach and Glynn showcase the importance of previously established plans for advancing localities' plan integration.

4.7. Question 2: To What Extent Are Local Hazard Mitigation and Recovery Planning Processes Integrated?

There is limited evidence of solid planning process integration between mitigation and recovery planning because fewer stakeholders participating in the recovery planning. Specifically, the average number of stakeholders participating in recovery planning is lower than three, making it difficult for planning integration from recovery to any other type of planning. Regarding the network archetype, mitigation networks are complete overall, meaning that the average number of stakeholders is greater than seven, which allows for easy information flow among stakeholders. However, the recovery networks are underdeveloped. The emergency management office has the highest betweenness centrality in North Carolina (Table 4), meaning that the emergency managers made the most inter-organizational coordination. However, based on the small average degree centrality, counties in North Carolina had smaller stakeholders' networks, limiting their ability to promote planning process integration. We consider that the agencies with the highest betweenness centrality are the ones who contributed the most in planning integration efforts.

More broadly, there is synergy between land use and mitigation networks. For instance, counties in North Carolina and Georgia have similar stakeholder network compositions. These counties prioritized land use and mitigation planning but had less focus on climate resilience and recovery planning. But again, counties vary widely. For instance, the planning integration in Glynn County is better than in Chatham County; the removal of the County Planning Department would cause the collapse of the whole network in Chatham, while in Glynn County, other actors like county commission and university partners strengthen the overall network connectivity. Table 4 identifies the number of actors and those with highest betweenness centrality, indicating their roles as connecting actors.

Table 4. County's stakeholder network statistics.

County	Number of Actors	Avg Degree Centrality	Agency with Highest Betweenness Centrality	Network Descriptions Based on Archetypes
Palm Beach County (FL)	14	10.86	County Planning	One complete network with two hierarchical networks attached.
Chatham County (GA)	15	7.60	County Planning	Two complete networks connected by one actor; or this is overall a small-village network.
Glynn County (GA)	15	9.33	Higher Education	Two complete networks connected by three actors; or this is overall a small-village network.
Craven (NC)	6	3.00	County Emergency Management	One small and incomplete network
New Hanover County (NC)	8	4.00	County Emergency Management	Two small complete networks connected by two actors, or one small-village network

The stakeholders' networks that are in a complete network archetype are generally good at producing planning integration. For instance, the two counties in Georgia had more integrated planning processes because of their complete subnetworks, allowing them to include more stakeholders in both mitigation and land use planning. The level of planning integration is represented by the average degree centrality, as shown in Table 4. The sizes of stakeholders' networks can influence the amount of support received from various levels of government. Larger networks usually involve various types of agencies across government and private partners. Palm Beach County of Florida involves federal-level agencies like the National Oceanic and Atmospheric Administration and US Army Corps of Engineers that we do not often observe in small and rural counties.

4.8. Question 3: What Institutional Factors Explain the Variations in the Integration of Mitigation and Recovery Efforts?

The answer to this question requires nuance. We recognize the substantially varied planning committees and the ways they are linked. For instance, Glynn County's stakeholders' network is connected through multiple actors including university partners, county commissioners, and county planning department. However, Chatham County's network is connected only through the county planning department.

The overall linkage between mitigation and recovery is low. Previous planning efforts like the federally mandated hazard mitigation plan make up a big part of current planning integration. But localities have limited actors participating in the recovery planning process as recovery planning is not mandated nationally and local communities are still navigating their own ways to plan reactively in response to any incoming disastrous events. Various plan documents of Palm Beach, Glynn, and Chatham Counties had set up the foundation of plan integration. Specifically, these counties had 13 plans integrated in their plan networks.

Normally, we would expect that a county's demographic characteristics would dominate the planning integration because wealthier communities tend to have higher planning capacity [38]. Our findings suggest this is not always the case. Glynn County had the lowest population and the highest poverty rate among our cases, but Glynn County's planning network appeared complete and it included more than 15 stakeholders across various levels of government. For communities with small planning networks like Craven County, a single agency like the county emergency management agency can be overly burdened with responsibilities in mitigation, recovery, and sometimes land use planning at the same time, making it hard to carry out collaborative planning processes.

The state planning context matters, too. When a state has strong planning mandates and more resources to help localities, the localities tend to have stronger linkages between mitigation and recovery [20]. Our finding at Palm Beach County confirms that a weak land use mandate statewide can be a cause of small land use planning committees. However, other factors have accelerated Palm Beach County's planning for climate resilience, resulting in a climate planning committee consisting of actors coming from state-, county-, nonprofit-, and federal-level agencies.

5. Discussion

Climate resilience relies on multiple coordinated and overlapping efforts in hazard risk reduction. Planning integration offers a sound pathway toward expanding our climate resilience efforts in the United States, especially for localities facing financial and/or political uncertainty and constrained resources. Ideally, we expect four complete subnetworks in each planning process (i.e., mitigation, recovery, land use, and localized climate adaptation), with all subnetworks connected to form a small-world network. However, our findings indicate a lack of integration in mitigation–recovery networks mainly because of incomplete and deficient recovery planning. The variations in local planning networks underline the varied state planning mandates and different levels of recognition and commitment to hazard and climate risk reduction.

As expected, the land use and mitigation planning committees are moderately consistent across counties because of the well-established state-wide mandates. However, we found nuanced results regarding the networks' connectivity. Chatham County's heavy reliance on the county planning department showcases the importance of the planning department in connecting land use and mitigation practices. On the contrary, with three actors (i.e., university partners, county stormwater management team, and state emergency managers) with high betweenness centrality, Palm Beach County has stronger risk-reduction networks in terms of well-connected recovery, mitigation, and climate resilience practices. We recommend local planning committees to use the planning integration techniques to roughly depict their planning integration networks and understand which other partners should also be integrated in risk-reduction planning processes.

One possible explanation of varied planning networks is attributed to the lead agency of planning networks. Mitigation and recovery planning in North Carolina were carried out by outsourced planners, who may have limited connections with local governmental agencies. Additionally, planning led by county planning departments tends to include more diverse professionals (e.g., Palm Beach and Chatham County). However, planning processes led by a county emergency manager can have smaller and basic planning committees. In small planning committees like in Craven and New Hanover Counties, we spotted strong ties between actors, evidenced by frequent communications and collaborations. We believe further studies with more qualitative inquiries are needed to uncover whether small planning committees and privately hired planners are more efficient in leading better-quality plan development.

Moreover, mitigation planning committees had more diverse professionals in general. We believe the strong planning mandates had significant impacts on the composition of planning committees and how localities plan for hazard risk reduction [21]. The lack of mandates on sustainable recovery and climate change adaptation further enforces our opinion that localities need strongly coordinated task forces to support stronger recovery and adaptation plans.

Using the network approach, we gained valuable insights, especially when conceptualizing the salience of planning actors. By evaluating a stakeholder's betweenness centrality, we recognize the irreplaceable roles of some actors. On the other hand, the small values of betweenness centrality helps identify the actors less involved in planning activities. For the network of plans, we notice various patterns of plans referenced. Through the network of plans, planners can check what plans they have used and missed. The planning archetypes help elaborate on answering our third research question. Glynn and Chatham County had complete hazard mitigation and land use subnetworks. Understandably, state mandates incentivize localities to conduct mitigation and land use planning. However, Palm Beach County's extraordinary complete network is based on urgent needs and regional efforts. Like participating in Regional Climate Action Planning, the institutional mechanism makes resilience planning a successful prototype [35,39]. Conversely, lagged climate resilience planning is inevitable in localities less affected by sea level rise, which also have no coordinated efforts.

6. Conclusions

Despite the relevance of mitigation–recovery integration in risk reduction efforts [5], our findings are mixed and indicate weak linkages between mitigation and recovery planning. Regarding the networks of plans, we have varied networks, with some being interconnected and complex, while some are basic and parsimonious. Regarding the networks of people, localities have distinct configurations depending on multiple factors, such as leading actors, state planning context, and available resources. Overall, the state of practice in mitigation–recovery integration needs to be improved. We recommend that local governments leverage the concepts of plan and planning process integration to initiate the actions of climate-related planning. For communities lacking a climate resilience plan, for instance, it is beneficial for community leaders to leverage other existing planning efforts like the hazard mitigation plans to initiate planning for climate resilience.

Our study echoes the need for intergovernmental and regional efforts of integrated planning. For understaffed communities, integrated planning provides a pathway to leverage resources outside of a community. For local decision-makers, integrated planning and planning networks provide essential analytical tools to evaluate available resources and partnerships locally. More importantly, integrating land use, mitigation, climate resilience, and disaster recovery holds the potential of generating positive impacts when dealing with major hazard events like floods and fires. For coastal communities like Palm Beach County, even without strong support from the state land use mandate, our findings of the integrated climate resilience planning process have proven that local communities leverage the resilience planning to mitigate the impacts of sea level rise. Later, Palm Beach County can integrate sufficient planning efforts from resilience plans to the recovery and land use plans.

Hazard mitigation plans have laid out foundations for hazard risk reduction per the *Disaster Mitigation Act*, but these are often neglected. For instance, local communities have not integrated their mitigation efforts into their land use plans (Figure 2c). Additionally, the mitigation plans that have small node sizes (Figure 2b–d) underline the limited usage of mitigation elements in other plans. However, when disaster recovery is built upon hazard mitigation, or vice versa, it will help formulate more effective risk-reduction policies. For a locality that has yet to initiate disaster recovery planning, an incentive program can kick off the momentum for building an inclusive planning cohort. Alternatively, we recommended participating in regional planning workshops for cost purposes and collective intelligence building.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16103999/s1, Table S1: Degree Centrality of Plan Networks; Table S2: Stakeholder Network Statistics Specifics; Table S3: Survey Questions.

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