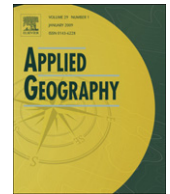


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Stakeholder perspectives on land-use strategies for adapting to climate-change-enhanced coastal hazards: Sarasota, Florida

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Sustainable land-use planning requires decision makers to balance community growth with resilience to natural hazards. This balance is especially difficult in many coastal communities where planners must grapple with significant growth projections, the persistent threat of extreme events (e.g., hurricanes), and climate-change-driven sea level rise that not only presents a chronic hazard but also alters the spatial extent of sudden-onset hazards such as hurricanes. We examine these stressors on coastal, long-term land-use planning by reporting the results of a one-day community workshop held in Sarasota County, Florida that included focus groups and participatory mapping exercises. Workshop participants reflected various political agendas and socioeconomic interests of five local knowledge domains: business, environment, emergency management and infrastructure, government, and planning. Through a series of alternating domain-specific focus groups and interactive plenary sessions, participants compared the county 2050 comprehensive land-use plan to maps of contemporary hurricane storm-surge hazard zones and projected storm-surge hazard zones enlarged by sea level rise scenarios. This interactive, collaborative approach provided each group of domain experts the opportunity to combine geographically-specific, scientific knowledge on natural hazards and climate change with local viewpoints and concerns. Despite different agendas, interests, and proposed adaptation strategies, there was common agreement among participants for the need to increase community resilience to contemporary hurricane storm-surge hazards and to explore adaptation strategies to combat the projected, enlarged storm-surge hazard zones.

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Introduction

The implications of potential climate change are far-reaching but not universal around the world. Intergovernmental Panel on Climate Change (IPCC) projections suggest that some locations may benefit from climatic shifts, such as increased agricultural production in areas where growing seasons could be lengthened (National Assessment Synthesis Team, 2000). In other areas, rising sea levels due to climate change may disadvantage coastal locations by moving shorelines landward and altering shoreline ecosystems. Local officials and planners in many coastal locations will be increasingly asked to minimize the potential effects of sea level rise in their jurisdictions while also continuing to manage ongoing population growth and development.

It is well-accepted that land-use planning is the most effective method for reducing vulnerability and increasing resilience to natural hazards (Burby, 1998). To improve land-use planning for such mitigation efforts, local decision makers need a clear

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understanding of potential impacts from hazards. Decision makers in many communities struggle to balance the demands of competing socioeconomic pressures and current hazard stressors, such as hurricanes, and, as a result, often place less emphasis on future stressors such as climate change. Climate change, however, could represent a significant stressor in many coastal locations, such as increasing the size of hurricane storm-surge inundation zones due to sea level rise (Frazier, Wood, & Yarnal, 2009; Frazier, Wood, Yarnal, & Bauer, in this issue; Kleinosky, Yarnal, & Fisher, 2007; Rygel, O'Sullivan, & Yarnal, 2006; Wu, Yarnal, & Fisher, 2002). If local planners are to develop truly comprehensive land-use plans, then they need information on the hazards posed by climate change to determine appropriate adaptation measures for their desired level of risk reduction and tolerance.

Addressing climate change and its effect on community resilience to hazards are difficult to achieve in long-term, land-use plans because of the high degree of complexity and uncertainty in climate-change predictions and because of the competing values and perspectives on potential adaptation strategies. Involving stakeholders that reflect the varied domain expertise, political agendas, and social interests of a community is one way of framing and negotiating competing perspectives in the land-use planning process (Berke & Campanella, 2006; Burby, 1998, 2006; Burby, Deyle, Godschalk, & Olshansky, 2000; Jankowski & Nyerges, 2001a). Stakeholder interaction in long-range comprehensive planning is well-documented (Berke & Campanella, 2006; Burby, 2006; Godschalk, Brody, & Burby, 2003; Jankowski & Nyerges, 2001a; Moser, 2005; Mitchell, 2006; Van Aalst, Cannon, & Burton, 2008) and is considered to be a critical element in vulnerability assessments and adaptation planning (Cronin et al., 2004a; Cronin, Petterson, Walker, & Biliki, 2004b; Moser, 2005; Rojas Blanco, 2006; Schröter, Polsky, & Patt, 2005; Sieber, 2006; Van Aalst et al., 2008; Welp, de la Vega-Leinert, Stoll-Kleemann, & Jaeger, 2006). Stakeholder involvement in scientific research that has profound societal impact, such as climate change, also provides local participants the opportunity to improve their understanding of the topic, which serves to validate and confirm the science in the minds of nonscientists (Moser, 2005; Rojas Blanco, 2006; Schröter et al., 2005; Van Aalst et al., 2008).

Although stakeholder involvement is beneficial, the process of involving them in planning efforts is not problem-free and can sometimes lead to overly social or emotional attachments to issues or judgments being made before problems are adequately defined (Ascough et al., 2002; Jankowski & Nyerges, 2001a, 2001b, 2003). Without proper design and facilitation, stakeholder meetings can be disorganized, inconclusive, and contain redundant or digressive conversation (Ascough et al., 2002; Burby, 2006; Godschalk et al., 2003; Jankowski & Nyerges, 2001a, 2001b, 2003). Therefore, careful consideration is critical on why and how stakeholders are to be involved and how gathered information is to be used.

The purpose of this paper is to present an approach designed to elicit stakeholder perspectives on how to address increasing development, hurricane storm-surge hazards, and climate-change-related sea level rise in comprehensive land-use plans. The approach involves the collection of qualitative input from focus groups engaged in participatory mapping exercises during a one-day workshop. To illustrate this approach, we worked with representatives of the public and private sector in Sarasota County, Florida (Fig. 1). This study area was chosen because public planning documents (e.g., *Sarasota County, 2008*) demonstrated an interest of elected officials in becoming more resilient to contemporary storm surge and improving adaptation to future storm-surge enhanced by sea level rise. This collaborative effort provided us with the opportunity to explore several aspects of knowledge transfer, societal implications of land-use plans that fail to address climate-change-related coastal hazards, and opportunities and constraints of long-range planning to increase community resilience to these hazards. Information and methods presented here further our understanding of the challenges involved in narrowing the gap between science and local decision making and in balancing the continued growth of coastal communities with their long-term resilience.

Study area

This study focuses on Sarasota County, located on the west-central coast of Florida (Fig. 1). Because of its desired coastal location and subtropical climate, the county has experienced significant growth in recent years, with a 17% population increase from 1990 to 2000 (U.S. Census Bureau, 2000). According to Sarasota County's historic preservation plan (*Sarasota County, 2008*), public officials face challenges of how to balance increasing population growth and development with the need to lower community vulnerability to natural hazards. Due to the ongoing storm-surge threats posed by hurricanes and the potential for significant sea level rise (National Assessment Synthesis Team, 2000), Sarasota County is an excellent case where growth and development will likely intersect with sea level rise to increase vulnerability to hurricane storm surge.

Sarasota County has a history of land-falling hurricanes and tropical storms (e.g., 1894, 1925, 1935, and 1960), although a major hurricane with significant storm surge has not struck Sarasota County since the category 3 Pinar del Rio Hurricane in 1944. The fact that no strong storm has made landfall in Sarasota County in recent history has led to complacency concerning hurricane preparedness among both the public and private sectors of the community (Howe, 2009) and caused some local managers to believe that there is a lack of political will to steer development away from coastal locations (Personal Communication, Sarasota County Disaster Recovery Coordinator, 2008). This complacency coupled with a desire by the county to promote traditional sustainability measures has contributed to the development of an urban services boundary (USB) that serves to restrict development to the western half of the county (Fig. 1) in the county's 2050 comprehensive land-use plan (referred to as *Sarasota 2050*).

According to Sarasota County's long-range comprehensive plan, the primary goals of *Sarasota 2050* are to preserve "the county's cultural and physical resources and making all neighborhoods, both old and new more livable" (*Sarasota County, 2008*). Absent from these primary goals is the desire to maximize community resilience or sustainability in light of natural

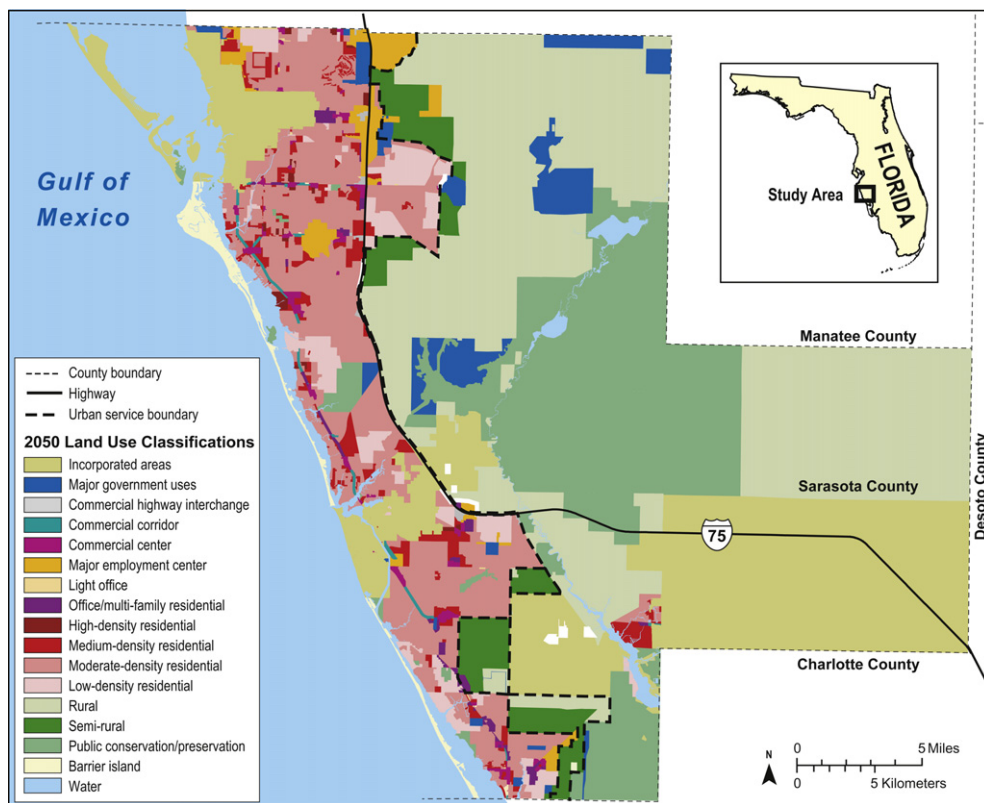


Fig. 1. 2050 Comprehensive land-use plan for Sarasota County, Florida.

hazards that threaten the county. In this plan, the county determined there was sufficient capacity for the projected growth in population and development to 2050 to be housed west of the county's USB -- a line intended to concentrate new development. Consequently, the county has limited development to the east of the USB with the exception of high-density residential development northeast of Sarasota.

Methods

This study employed a sequential explanatory mixed-methods strategy of inquiry that includes the collection and integration of quantitative and qualitative data (Creswell, 2003). In our case, quantitative analysis included spatial analysis using geographic-information-system (GIS) software to assess socioeconomic exposure to various hazard scenarios (see Frazier et al., 2010, this issue, for detailed explanation of this analysis and these scenarios). We then built on the results of the quantitative analysis with qualitative data collected in a hybrid session of focus groups and participatory mapping exercises. Focus groups are used often in decision-making policy concerning climate change (Peterson, 2004) because of their ability to gather information that provides a deeper, more nuanced, and more contextualized understanding of value-based human dynamics than quantitative models alone (Creswell, 2003; Kitzinger, 1994; Krueger & Casey, 2000; Morgan, 1998; Stewart, Shamdasani, & Rook, 2007). Participatory mapping exercises with stakeholders intimately familiar with their communities provide researchers a mechanism for integrating local knowledge and scientific expertise to produce a comprehensive understanding of community issues (Chambers, 1997; Duvail, Hamerlynck, Nandi, Mwambeso, & Elibariki, 2006; Herlihy & Knapp, 2003; Mascarenhas & Kumar, 1991; Sieber, 2006). In participatory mapping sessions, stakeholders provide information by collaboratively drawing on study-area maps, and in so doing they validate scientific research through personal familiarity with their community (Brewer, 2005; Keith & Brophy, 2004; MacEachren & Brewer, 2004).

Focus groups and participatory mapping exercises were conducted for this project during a one-day workshop, held on 8 July 2008 at the Sarasota County Emergency Operations Center in Sarasota, Florida. The purpose of the workshop was to discuss the implications of hazard scenarios on a map showing planned land use and land cover (LULC) for Sarasota County in the year 2050. Workshop invitees included representatives from five sectors and interest groups traditionally considered critical to community preparedness and hazard reduction efforts, including local government, land-use planning, the business community, emergency management and infrastructure, and environmental interests. Invitees were contacted by phone or email and, upon acceptance, were used to identify additional participants. The workshop was attended by 33 individuals from the community (Table 1) and facilitated by six members from the project team.

The workshop began with a presentation summarizing the results of the GIS-based analysis of socioeconomic exposure to two hazard scenarios (Frazier et al., in this issue). The scenarios used in this workshop were current hurricane storm-surge hazard zones (ranging from category 1 to category 5 hurricanes on the Saffir-Simpson Hurricane Scale) and future storm-surge hazard zones that included sea-level-rise scenarios of 30, 60, 90, and 120 cm. The GIS analysis was based on output from the Sea, Lake and Overland Surges from Hurricanes (SLOSH) model provided by the U.S. National Hurricane Center, National Oceanic and Atmospheric Administration for estimations of contemporary hurricane storm-surge inundation. To delineate the effect of sea level rise, the output from the SLOSH model was draped over a digital elevation model (DEM) and the elevation of the DEM adjusted by 30, 60, 90, and 120 cm. The resulting output for both contemporary and sea level rise enhanced storm-surge inundation zones was then overlaid with various socioeconomic data categories – resident-population counts from the 2000 U.S. Census, employee-population counts and business types from the 2007 infoUSA Employer database, Sarasota County tax parcel data, and county land-use data. Workshop participants were shown results that indicate population and asset exposure to hurricane storm-surge hazards increases significantly when sea-level-rise scenarios are added to hazard zones (Frazier et al., in this issue).

Following the overview of the GIS-based analysis, participants were divided into five focus groups to discuss implications for the increase in socioeconomic exposure and potential adaptation strategies in relation to future land-use plans. Focus groups were organized based on the following domain expertise (Table 1):

- *Business*, including representatives from local chambers of commerce, insurance companies, restaurants, tourist accommodations, and retail trade;

Table 1

Workshop participant list, by focus group.

Business

- Director Government/Community Relations, Sarasota Chamber of Commerce
- Chair, Sarasota Chamber of Commerce
- Insurance Agent, Ludwig-Walpole
- Business Owner, Sarasota Chamber of Commerce
- Quality Assurance, Sarasota County Planning and Development Services Business Center

Emergency Management and Infrastructure

- Public Works Technical Services Manager, City of Sarasota
- Emergency Management Chief, Sarasota County
- Manager, Infrastructure, Sarasota County Public Works
- Capital Projects Coordinator, City of Sarasota
- Senior Director of Preparedness & Response, American Red Cross
- Operations Supervisor, Sarasota Public Works
- Section Chief, Sarasota County Emergency Management
- Intern, Sarasota EM, Sarasota County
- Plans Chief, Sarasota County Emergency Management
- Director Damage Assessment, Sarasota County

Environment

- Deputy Director, Mote Marine Policy Institute
- Environmental Health Director, Florida Health Department
- Intern, Mote Marine Policy Institute
- Scientist, Mote Marine Policy Institute
- Scientist, Sarasota Bay Estuary Program
- Public Outreach Coordinator, Sarasota Bay Estuary Program
- Environmental Lawyer, Environmental Defense Fund

Government officials

- City Commissioner, City of Sarasota
- Commissioner, City of Sarasota
- Principal Engineer, Wilson Miller
- Sustainability Initiatives Coordinator, City of Sarasota
- Sustainability Manager, Sarasota County

Planners

- Sarasota County Planner, Sarasota County
- Project Services Manager, Southwest Florida Regional Planning Commission
- Deputy Director of Planning, City of Sarasota
- Planner, City of Venice
- Planner, City of North Port
- Building Official, Sarasota County

- *Environment*, including estuary program coordinators and marine researchers;
- *Emergency Management and Infrastructure*, including public works managers, county health officials, recovery planners, and county emergency managers;
- *Government Officials*, including city managers, vice mayors, city commissioners, and sustainability officers; and
- *Planning*, including city, county, and regional planning officials.

We grouped participants into these five focus groups to ensure that the perspective of each of the various knowledge domains was captured. We assumed that groups with mixed domain expertise would result in similar responses instead of five responses from unique perspectives. We also believed that individuals from certain knowledge domains such as planners and public officials would have a disproportionate and possibly dominating voice in the discussions based on their familiarity with public speaking and public meetings.

In the first of two breakout groups, participants were asked first to review 2050 land-use projections for Sarasota County (Fig. 1) and maps showing contemporary storm-surge hazard zones ranging from category 1 to category 5 hurricanes (Fig. 2a) to determine if and how they would reallocate land-use based on knowledge of these hazard zones. To be consistent with hurricane storm-surge designations chosen by Sarasota County officials, we grouped category 4 and 5 storms together into one category. This practice is consistent with many coastal counties where emergency managers have chosen not to differentiate between storm-surge hazard zones for SLOSH category 4 and 5 storms in their evacuation planning. Focus group members were asked to document on their maps any concerns, changes, or suggestions related to future land use (Fig. 3a). After an hour of discussion in these focus groups, each group was asked to display their maps to the entire workshop and spend approximately 15 min presenting their group's findings (Figs. 3b and 4). These reports and subsequent discussions among all workshop participants provided a means for integrating information along various knowledge domains and exploring complementary or conflicting perspectives, values, or adaptation strategies.

In the second round of focus groups, participants were asked to review the 2050 land-use plans and hurricane storm-surge hazard zones that delineated modeled storm-surge output of a category 3 hurricane enhanced with 30, 60, 90, and 120 cm of sea level rise (Fig. 2b). The purpose was to see if and how climate change scenarios would alter participants' land-use decisions. We decided to focus on category 3 hurricanes because of time limitations and the fact that category 3 hurricanes with only 30 cm of sea level rise presented the single largest increase in asset exposure for all of the modeled surge zones. We also wanted to provide a discussion scenario that would require opportunities for mitigation and/or adaptation while not exposing as many assets as would be exposed to a category 4–5 storm. Due to close proximity of Sarasota County's urban footprint to the shoreline, most development is already in the category 4–5 zone and the addition of sea-level-rise scenarios does not significantly increase hazard exposure.

As with the morning session, a plenary session was held after the second round of focus groups to provide the opportunity for participants to view all focus group maps and discuss findings from each group (Fig. 4). All focus group and plenary sessions were audio recorded and transcribed later. The ten maps constructed by participants during the workshop (i.e., two rounds of mapping done by 5 focus groups) supplemented the focus group transcripts. These data form the basis of the following results and discussion.

Results

This section summarizes the results of the discussions during the one-day community workshop on 8 July 2008 in Sarasota County, FL, on the interaction of 2050 land-use plans, hurricane storm-surge hazards, and climate-change-related sea level

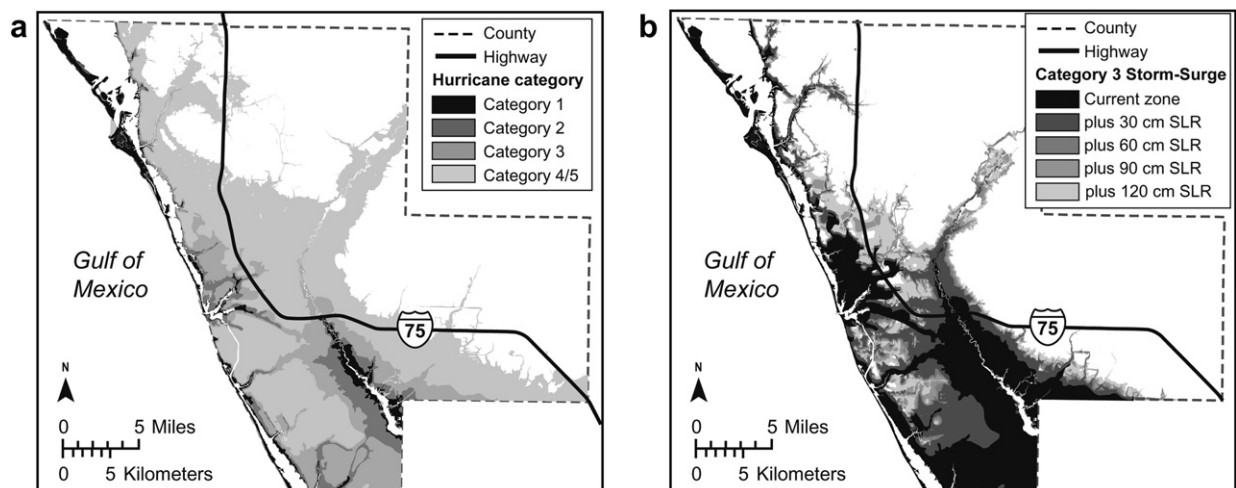


Fig. 2. Maps of hurricane storm-surge zones for (a) hurricanes of various category levels and (b) a category 3 hurricane plus various sea-level-rise scenarios.



Fig. 3. Photographs of workshop, including (a) the government breakout group engaged in discussion and mapping and (b) a plenary session with a representative from the emergency management and infrastructure focus group presenting the group's results and map.

rise. We summarize the results from each of the five focus groups, the plenary sessions, and our observations of the workshop process. We observed that discussions within the groups ended up being similar for storm-surge hazard zones with and without sea level rise scenarios; therefore, the comments from all breakout and plenary sessions are combined for each group.



Fig. 4. Example of map results from discussions in business-community focus group. The urban-services-boundary line is in white on the map. The hazard zones reflect a category 3 hurricane storm-surge zone plus various sea-level-rise scenarios.

Business focus group

In both breakout sessions (i.e., discussions related to contemporary and climate-change-related hazard zones), the Business group (Table 1) recognized that existing coastal hazards and future sea level rise could significantly impact the county's largely tourism-based economy. As a long-term adaptation strategy, the group expressed interest in the county aggressively seeking other industries to supplement tourism and diversify the economy. Realizing that broadening local economies takes time, the group's discussion focused primarily on current development. Because of the current county economy is focused largely on tourism, the group believed it is necessary to maintain businesses, services, and supporting infrastructure close to the shore, which are also prone to hurricane storm-surge inundation.

The Business group had concerns that government would impose heavy restrictions on the business community in order to begin hazard mitigation and adaptation efforts for problems associated with sea level rise and hurricane storm surge. The group was also concerned that adaptation-oriented restrictions would not be cost-effective from a business perspective and would therefore serve to damage current profitability in an effort to address a problem that might not emerge for fifty years or more. An additional worry was that Federal Emergency Management Agency post-disaster redevelopment restrictions, such as building-elevation minimums, would inhibit some businesses from rebuilding and limit the profitability of coastal businesses that were able to rebuild.

The Business group offered several strategies for adapting to climate change in Sarasota County. The group acknowledged that not all businesses are water-dependent or water-related and suggested offering incentives to those businesses to locate in or relocate to less hazardous locations. This could be facilitated with land swaps to trade ownership of developed land near the coast for land owned by the county in areas outside storm-surge zones. Another proposed adaptation strategy involved relaxing or redrawing the USB boundary to allow development east of the current boundary. To spur this new development, the group suggested the county could focus new infrastructure projects to areas outside of the storm-surge hazard zones. A third strategy was for the state and federal government to evaluate the insurance industry's coverage of the coastal zone to ensure that insurance is affordable and offers sufficient coverage should an extreme event occur. The group also suggested that the county, state, and federal government work together to develop a plan for post-disaster financial assistance for businesses to facilitate redevelopment. The group thought that forming an advisory group with a central goal of implementing sustainable development decisions from a business perspective could achieve sustainability without sacrificing profitability.

Emergency management and infrastructure focus group

The Emergency Management and Infrastructure group (Table 1) noted that the majority of the county's facilities and infrastructure are located within the current and future storm-surge hazard zones. They expressed concern that existing water systems, electrical grids, medical facilities, and emergency services could all fail should a hurricane pass over the county. They also discussed the possible inadequacy of the current evacuation plan because of the lack of road network capacity and a possible lack of shelter capacity outside the storm-surge hazard zones, especially given the increase in the number of evacuees if sea level rise expanded potential storm-inundation areas. Another evacuation concern was the additional numbers of elderly residents in sea-level-rise enhanced storm-surge hazard zones that would require special evacuation vehicles and special-needs shelters that currently are not provided in the existing evacuation plans.

The Emergency Management and Infrastructure group offered several strategies for adapting to climate change in Sarasota County. A guiding principle of each strategy was to base decisions on storm-surge modeling and flood mapping. Their primary strategy was to move facilities and infrastructure, when possible, out of hazard zones or at least in hazard zones with lesser frequency (e.g., category 3 zone instead of a category 1 zone). If relocation is not possible, the alternative recommendation was to harden these facilities and systems against the effects of storm surge. The group discussed placing all new major facilities outside the category 3 sea level rise-enhanced storm-surge hazard zone and to do this by forging cost-sharing partnerships with municipal, county, and regional governments to build large, high capacity, well-connected, and standardized facilities. They believed early identification of future sites was important even if the county does not build the new facilities in the next several decades. Early identification allowed the managers to plan for the placement of infrastructure transmission lines (e.g., water, wastewater), which is cost effective to do now while performing other routine maintenance.

Environment focus group

The Environment focus group (Table 1) discussed infrastructure, shelters and evacuation, and post-disaster redevelopment, with an overarching perspective focusing on environmental and agricultural preservation. With regards to the USB, the group noted the delicate balance between development and the natural environment in Sarasota County and the need for the county to carefully consider development outside the USB, since land-use modifications could negatively impact protected and agricultural lands. The group discussed the importance of healthy dunes, marshes, and mangroves to assist in storm-surge hazard mitigation and the inability of the natural environment to respond to sea level rise because of shoreline hardening and intense development in coastal areas.

The Environment group offered several strategies for adapting to climate change in Sarasota County and all related to incorporating sea level rise and storm-surge hazards into county sustainable-development policies and plans. To maintain

and reestablish natural habitats in the coastal zone, the group discussed a ban on shoreline hardening, encouraging coastal retreat for development, phasing out current beach re-nourishment programs and not instituting them in new areas, and increasing restrictions to steer development away from coastal wetlands. Because the group believed it was necessary to also maintain the agricultural land located east (outside) of the USB, the group discussed increasing residential density in the already-developed northern portion of the county to accommodate new growth and relocate development away from the coastal zone. To do this, the group discussed land swaps to move south-county residents away from the coast and into the developed northern part of the county and promoting in-filling development inside the category 4–5 storm-surge hazard zones inside the USB (which are less likely to suffer inundation from less frequent storms).

Government officials focus group

Discussion in the Government Officials group (Table 1) centered on hot-spots of development across the county, housing densities, and inadequate infrastructure to support increasing demands for housing and evacuation potential. With regards to development hot-spots, the group expressed concern about the amount of recent growth in the southern part of the county, particularly because it is a lower-lying area that is more likely to be inundated by storm surge. Compounding their concern for this area was the belief that the east-west road network is insufficient for handling transportation demands, an issue that could be amplified during a hurricane evacuation. Likewise, the group was concerned that the north-south transportation network was also poor in the county and could hinder hurricane evacuations. For example, they noted that storm surge from a category 3 hurricane and further enhanced by sea level rise would inundate much of Interstate 75, thereby cutting off the primary transportation route for the county. Related to potential transportation issues, the group also identified two bridges that were likely to collapse under this storm-surge scenario effectively splitting the county into three parts. If these bridges collapsed, several evacuation shelters would be isolated with limited routes available to get supplies in and people out. Based on this discussion, the Government Officials group suggested the need to begin increasing the carrying capacity of the road network and mitigate potential deficiencies in their evacuation plans. Another issue of carrying capacity that the group raised was their concern for the approximately 400 sewage lift stations serviced by the county and the countless others serviced by various municipalities inside the storm-surge hazard zones that could go offline in a category 2 or smaller storm.

The Government Officials group offered several strategies for adapting to climate change in Sarasota County. To address access issues of Interstate 75, the group discussed reallocating funds from a large capital improvement project slated to widen the highway and instead using the funds to build a highway spur that would redirect traffic to eastern portions of the county where flooding from hurricane storm surge is unlikely. With regards to land-use planning, the group discussed rezoning flood-prone areas (particularly in southern Sarasota County) to have lower residential densities as a way to help reduce potential exposure of resident populations and ease evacuation issues. There was also discussion of moving or relaxing the current USB to diffuse development to areas less prone to inundation, if the county deems it a principal goal to grow in a more hazard-resilient manner. Related to future development, the group discussed the desire to relocate existing infrastructure and facilities outside contemporary storm-surge hazard zones, while conceding that they would reluctantly place new infrastructure and facilities in hazard zones if there was a demand. Finally, the group noted a need for additional cost-benefit analyses and educational programs to help their constituents understand the trade-offs associated with living in coastal hazard zones. They felt this information would help government officials gain the political and financial capital necessary to mitigate contemporary hazards and adapt to climate change.

Planning focus group

The Planning group (Table 1) discussed their concerns with the high concentration of development along major coastal roadways and along inland waterways that could be flooded during future events and with the large number of older mobile homes in the county that are more sensitive to flooding than other construction types. The planners did note that much of the recent development in southern Sarasota County, although located in storm-surge hazard zones, was built in an era of stricter building codes, thereby making the area more hazard-resilient.

One strategy discussed by the planners to reduce community exposure to current and future storm-surge hazards involved modifying the 2050 land-use plan to increase the number of high-density developments located outside all the storm-surge hazard zones east of the USB in northern Sarasota County. Planners noted that this area can accommodate forty to fifty thousand residents under the current plan, but increasing the number of high-density settlements could significantly increase these numbers. The group also suggested that the county could couple aggressive land acquisitions with incentives to private developers to steer development to the limited areas inside the USB but outside the storm-surge hazard zones.

Despite these options, the Planning group in general believed there is little the county can do to steer development out of the hazard zones. Without significant changes to local land-use policies, the group agreed that the county's 2050 comprehensive plan would continue to concentrate development inside the storm-surge hazard zones. They discussed the need for education campaigns to highlight issues raised during the workshop if residents were to ever support relaxation of the USB to steer development to the east. In general, they believed residents would be more likely to desire elevated structures in hazard zones instead of relocating inland of the USB. They discussed the use of financial incentives to elevate new and existing structures inside the storm-surge hazard zones, especially for structures that are located within the category 2 storm-surge hazard zone.

Plenary session results

Results of the plenary sessions indicate that participants all recognized the need to adapt planned land use and development practices for 2050 to adjust to current and future coastal hazards. Although all groups seem to agree that action was needed, the groups varied in their proposed approaches to dealing with the triple threat in their county of increasing urbanization, hurricane storm-surge hazards, and potential sea level rise due to climate change. For example, the Business group advocated for hardening of the coastline, maintaining and expanding the role of disaster-recovery insurance, whereas the Environment group instead encouraged a retreat from the coast and allowing natural habitats to prosper and act as buffers.

Consensus did emerge on the topic of increasing density for new development in the areas immediately inside the USB but outside the hurricane hazard zones. All five focus groups recognized that most development in Sarasota County is located within the hurricane storm-surge hazard zones and that the county's USB is serving to restrict growth to these hazard zones even before the addition of sea level rise. However, given this recognition, the Planning group believed that changes in the USB would be difficult to adjust given political and economic constraints. Participants from several groups also noted that these constraints also limited the ability of the county to move existing infrastructure out of hazard zones. In addition, the Government Officials group informed other participants that much of the land to the east of the USB has a high propensity for non-hurricane-related riverine flooding. In light of the difficulties of moving the USB and potentially unsuitable land elsewhere, the Planning group proposed a strategy of increasing housing and development density in areas outside of storm-surge hazard zones to deal with future sea level rise scenarios (Fig. 2b).

Results of workshop process

Several observations can be made concerning our process to elicit stakeholder input on potential adaptation strategies to storm-surge and sea-level-rise-related hazards. First, discussions for current storm-surge hazards and future storm-surge hazards plus sea-level-rise scenarios did not vary dramatically. Participants noted that increasing resilience today would also serve to increase resilience in the future to the additional threat sea level rise could bring. We did observe, however, that the addition of sea level rise seemed to create an air of urgency to adopt mitigation or adaptation strategies and to provide a setting in which groups discussed an increased number of alternatives for mitigation and adaptation strategies that had previously been thought too radical. Second, while discussions didn't vary dramatically between current and future hazards, we did observe that adaptation options varied based on domain expertise and philosophies in each group. For example, although faced with the same hazards, the Business group proposed insurance and coastal hardening, whereas the Environment group proposed coastal retreat and habitat restoration.

With regards to the participatory mapping exercises, we observed that most of the groups (Business, Environment, Government Officials and Emergency Management and Infrastructure) primarily used the provided maps to identify assets in hazard zones and to initiate mitigation discussions but did not delineate any specific adjustments to the 2050 land-use plan. The Government Officials moderately participated in participatory mapping through their use of altering roadways and highlighting areas where zoning code changes might be enacted to assist in evacuation. The Planning group was the only group to use the provided scenarios in a participatory mapping manner. The Planners used the contemporary hazard scenario map to discuss and display constraints to altering the county's 2050 land-use plan and employed the sea level rise-added scenario map to determine, discuss, and display areas where modification opportunities existed to the 2050 land-use plan. This observation is not surprising, given the fact that members of the Planning group had domain expertise in land-use planning opportunities and constraints, had developed the 2050 land-use plan and therefore aware of how to modify it, and otherwise were comfortable with the use of maps.

Discussion

Land-use planning policy in the United States has historically focused on facilitating private business and residential development with less regard to promoting community resilience to hazards (Burby, 1998). Prompted by a string of recent disasters, a reversal in conventional thinking is beginning to occur, as evidenced by the passing of the Stafford Mitigation Act in 2000, and planners at the local, state, and federal levels are starting to see the value of land-use planning as a tool for risk reduction (Burby, 2006). Although land-use plans are beginning to recognize natural hazards, the inclusion of climate change scenarios, such as potential sea level rise, in these plans is in its infancy. Because climate change scenarios include significant uncertainty and potentially large socioeconomic consequences, it is likely that the development of land-use plans that include these scenarios will increasingly involve stakeholders, which is already believed to critical in the development, vetting, and defense of long-range comprehensive land-use plans (Berke & Campanella, 2006; Burby, 2006; Godschalk et al., 2003; Jankowski & Nyerges, 2001a; Moser, 2005; Mitchell, 2006; Van Aalst et al., 2008).

The purpose of our study was to involve local planners, emergency managers, and stakeholders of varied knowledge domains in the review of Sarasota County's long-range land-use plan in light of scientific information on existing coastal hazards and the potential for new hazards related to climate change. Workshop results indicate that all participants recognized that most development in Sarasota County is located close to shore, an area that during non-storm periods provides significant social and economic benefits but that is also prone to hurricane storm-surge inundation. The addition of sea-level-

rise scenarios did not alter the discussions dramatically in terms of societal vulnerability to these physical threats but did seem to add a sense of urgency and willingness to explore adaptation strategies. As in other hazard-related, stakeholder-based efforts (e.g., Buckle, Marsh, & Smale, 2000; Moser, 2005), there were differing views on what these adaptation strategies should be – business representatives discussed efforts to alleviate negative impacts (e.g., insurance) and environmental representatives discussed efforts to minimize exposure (e.g., coastal retreat).

A great deal of discussion during the workshop centered on the county's Urban Service Boundary, which was designed to concentrate most future development west of Interstate Highway 75 (Fig. 1) and in doing so, would result in greater exposure to hurricane storm-surge hazards. Much of the discussion was on strategies to steer future development to less hazardous areas, which is similar in other stakeholder-based efforts (e.g., Tol, Klein, & Nicholls, 2008; U.S. Environmental Protection Agency, 2009). Proposed strategies included relaxation of the USB to allow development east of the boundary and alteration of land-use codes to lower densities in hazard zones and raising densities in areas outside of the zones. Several studies have discussed how shifting development to less hazardous locations is often the most important but most difficult process to achieve in vulnerability reduction and resilience enhancement (Burby, 1998, 2006; Burby et al., 2000; Godschalk et al., 2003; Moser, 2005; Pearce, 2003; Tol et al., 2008). Likewise, participants in our workshops said that relaxing the USB would likely be problematic for political, economic, and environmental reasons and that changes in densities of existing land-use designations would be easier to implement.

Part of the economic limitations in shifting development inland relates to the costs of moving critical facilities and infrastructure (e.g., as gas, water, sewer, and electrical lines), a common constraint voiced in stakeholder-based studies (Moser, 2005; U.S. Environmental Protection Agency, 2009). In our workshop, both the Government Officials group and the Emergency Management and Infrastructure group highlighted the higher cost of mitigating existing development rather than strategically locating new infrastructure. Chang (2004) documents, however, that many community managers falsely believe that it is only when the life expectancy of infrastructure is near its end that it makes economic sense to reposition it in a more hazard-resistant location. Whether correct or not, the perceived greater costs of mitigating infrastructure networks before a disaster can often erode the public's will to act – a sentiment raised by the Government Officials group.

Another perception-related factor that influences tolerance for risk-reduction efforts is a community's experience with past disasters, where mitigation planning tends to be more difficult in areas that lack recent disasters (Drabek, 1986; Moser, 2005; Pearce, 2003). Insufficient or incorrect knowledge of risks and potential consequences has been cited as a factor in delaying mitigation efforts and in slowing negotiations (Moser, 2005; Tol et al., 2008; Tribbia & Moser, 2008; U.S. Environmental Protection Agency, 2009). To correct these deficiencies, programs to educate both the general public and elected officials on societal risks and adaptation strategies related to current and future hazards can be developed – a need expressed by several of our workshop participants. Education of officials provides them with the tools to change their jurisdictions. Education of the general public will ideally lead to a well-informed public that gives officials the social and political support to implement difficult land-use decisions.

Changing land use in communities to deal with current hazards and those in the future that may be enhanced by climate change is a difficult process. Local planners must balance the continued growth of their communities with a desire to be resilient to threats. This balancing act requires planners to understand the physical, social, economic, and political realities of the landscape. Although much can be gleaned from the scientific literature and through interaction with technical experts, a great deal of a community's design, limitations, and priorities can only be learned through interaction with the individuals that comprise the community. Stakeholder involvement can help develop and prioritize land-use plans but can be cumbersome endeavors, especially for small jurisdictions with limited human and financial resources devoted to land-use planning. It is our hope that processes like those outlined in this paper provide land-use planners with insight and methods for effectively engaging the public as they begin to include climate change in their plans.

Conclusions

Stakeholder perspectives on land-use plans and sea level rise-enhanced storm-surge scenarios can serve to enhance and confirm knowledge of local planners who must balance decision of short-term growth with long-term sustainability. The integration of hazard modeling and stakeholder perspectives in a workshop environment can identify competing opportunities and constraints to mitigate and adapt to current and future hurricane hazards. Through our workshop, stakeholders realized that the urban service boundary designed to promote sustainable development by concentrating development may also be amplifying the county's vulnerability to coastal hazards. In essence, efforts to make the county more sustainable with regards to resource use may be making the county less resilient with regards to natural hazards. Our grouping of stakeholders first by domain expertise and then collectively in plenary sessions ensured that multiple perspectives on risks and adaptation options were captured, sometimes leading to common ideals (e.g., interest to relax the urban service boundary) and other times exposing philosophical differences (e.g., shoreline hardening versus coastal retreat). Overall, the workshop provided a forum for local officials, managers, and interested parties to collectively discuss how a community can begin to develop plans to adapt to a changing world and to make their county more resilient and better adapted to future storm surge.

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