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Climate adaptation and risk preparedness in Florida's East Coast cities: views of municipal leaders

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Cities along Florida's Atlantic coastline are particularly vulnerable to the effects of climate change, posing significant challenges for city planners. How cities see themselves in terms of developing or implementing their climate change adaptation action plans depends, in part, on the extent to which they perceive climate-related events as risks, and their city size. Data were obtained from city leaders (i.e. mayors, city/town managers, or their designees) from 86 cities along Florida's Atlantic Coast from January to May 2021 to quantitatively assess factors influencing city adaptation planning. Validity and reliability were obtained for the survey. Multiple regression analyses showed significant positive correlations between perceived risk, city size, and (self-assessed) climate change preparedness. A statistical interaction was noted; as city size increased, risk perception decreased.

Keywords: climate change adaptation; Florida Atlantic Coast; risk perception; city planning

1. Introduction

Human pressures from overpopulation and associated economic growth exacerbate stresses on coastal environments and threaten the ability of those cities to adapt to climate change (Wong *et al.* 2014). At many scales, the US lacks comprehensive strategies to assist cities with climate change adaptation measures; therefore, it is often up to the states and/or each city to address its issues individually (Kalesnikaite 2019). However, there are resources to assist in adaptation planning. For example, "the US Global Change Research Program coordinates federal research and investments on climate change and their impacts on society … the US Environmental Protection Agency provides information on adaptation strategies to assist water utilities and communities plan for climate change- … the National Research Council has published reports prepared by expert teams on various aspects of climate change" (Maliva, Manahan, and Missimer 2021, 522). In Central and Southern Florida, regional organizations are also helping cities to adapt to climate change (SFCCC 2021; ECFRPC 2021). The Southeast Florida Climate Change Compact has been lauded for translating national and state-level adaptation and mitigation actions to the local context (Vella *et al.* 2016). Meanwhile, the Fourth US National Climate Assessment, published in 2018, stated less than 1% of US municipalities had undertaken climate adaptation planning (Kim 2020).

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Some cities have developed plans for climate change adaptation and resilience, and those plans are in various stages of implementation (Broward County Demographics 2021; Miami-Dade 2016; Sandoval 2020). Some cities focus their resources on shorter term mitigation efforts over longer term sustainability action (Tenali and McManus 2022). Some local governments have access to information for their planning which can be formally acknowledged in planning or "mainstreamed" less explicitly (Dow *et al*. 2013), but useful grey-literature information is often not available in academic databases (Lindeman, Giannoulis, and Beard 2018). Therefore, it is important to learn directly from governments about their planning mechanisms and information drivers.

1.1. Adaptation planning that creates resilient/adaptive communities

The International Panel on Climate Change (IPCC) has stated with high confidence that extreme coastal storm events "can cause excess mortality and morbidity, particularly along the East Coast of the USA … " (IPCC 2014, 1444). Further, "observed impacts on livelihoods, economic activities, infrastructure, and access to services in North American urban and rural settlements have been attributed to sea-level rise, changes in temperature and precipitation, and occurrences of such extreme events as heatwaves, droughts, and storms" (IPCC 2014, 1444). North American ecosystems "are under increasing stress from rising temperatures, carbon dioxide concentrations, and sea-levels, and are particularly vulnerable to climate extremes," yet adaptation measures in the US tend to be reactionary and unevenly distributed around the US (IPCC 2014, 1443). Adaptation to climate change and resiliency are interlinked terms.

Adaptation to climate change is "the process of adjustment to actual or expected climate and its effects" (IPCC 2014, 5). Resiliency is "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identify, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (IPCC 2014, 5). A resilient community is one that can learn from extreme events and institute individual and institutional adjustments (Bohensky and Leitch 2014). Being resilient or adapting to change is "a process of linking a set of adaptive capacities to a positive trajectory of functioning and adaptation after a disturbance" (Norris *et al*. 2008, 130; Bohensky and Leitch 2014, 476).

Vulnerability (of a community) "occurs when resources are not sufficiently robust, redundant, or rapid to create resistance or resilience, resulting in persistent dysfunction. The more severe, enduring, and surprising the stressor, the stronger the resources must be to create resistance or resilience" (Norris *et al*. 2008, 130). Specific examples were provided by the USGCRP (2022): "590,000 people in South Florida face extreme to high risk from sea level rise, with 125,000 people living in these areas identified as socially vulnerable and 55,000 classified as medically vulnerable," and in addition, there are over 400 miles of interstate highways on the East Coast that are threatened by high tide coastal flooding.

1.2. Perceptions of climate change risks

US public perception of the risks associated with climate change influences the public policy response (Bolsen, Kingsland, and Palm 2018). Researchers have found that, in general, the US public has a weak understanding of climate change and the potential impacts we might face (Albright and Crow 2019), and as a result may not fully comprehend the risks. Risk perception refers to judgments made by people experiencing threats posed by a particular hazard (e.g. Bhattachan *et al*. 2019).

By analyzing what people think about risk, we can begin to evaluate how a community might respond to climate adaptation strategies. Risks (e.g. biological, economic, physical) associated with climate change are often now as understandable to laypeople as they are to scientists because people often do not have training in data analysis, highly non-linear geophysical processes, and the long-term behavior of their metrics. Events that are immediate and close to home are seen as more relevant and of greater concern than those risks that are longer term and not associated with local environmental issues (Carlton and Jacobson 2013). When people can experience impacts from climate change directly, they are more likely to believe the science (Akerlof *et al*. 2013; Spence *et al*. 2011). Spatial distance theorists in psychology note that people can lack concern for those things that are further distanced from their own experiences (Williams and Bargh 2008).

Understanding of risk aside, Tang *et al*. (2010) found that local communities were more likely to move from planning to implementation of climate adaptation measures if there was a state mandate to do so. Risk perception about climate change is especially important because it can motivate and mobilize people into action in terms of designing and implementing climate adaptation plans. The higher the risk perception, the more climate change action, though there may be other moderating factors such as belief in climate change (Wang, Geng, and Rodríguez-Casallas 2021).

1.3. Population size and human pressures exacerbated by climate change

The IPCC emphasized that most of the coastlines in the world are influenced by human pressures and that "population growth in many of the world's deltas, barrier islands and estuaries has led to widespread conversion of natural coastal landscapes to agriculture, aquaculture, silviculture as well as industrial and residential uses" (Nicholls *et al*. 2007, 319). Further, "rapid urbanization has many consequences … enlargement of natural coastal inlets and dredging of waterways for navigation, port facilities, and pipelines … " that cause saltwater intrusion into surface and groundwater sources (Nicholls *et al*. 2007, 319). In addition, direct impacts from human influences on coastal zones also contribute to, including but not limited to: wetland drainage, fertilizer and sewage contamination of waterways that in turn negatively impact plant and marine life, the introduction of invasive species that crowd out native species, damming or channeling waterways, alteration of freshwater and brackish water circulation systems, and ecosystem disruptions from beach nourishment and dune reconstruction (Nicholls *et al*. 2007).

Florida's Atlantic Coastline, from Miami-Dade County north to Nassau County, faces varying threats, not only from sea level rise, but also saltwater intrusion into fresh water supplies, increased risk of erosion, storm surge, and extended periods of inundation. Climate change is not only impacting the cities in counties along the Atlantic Coast. Low-lying inland cities in those counties face increased flooding that can lead to waterborne, foodborne, and vector-borne diseases, especially in South Florida (Heimlich *et al*. 2009; Bloetscher *et al*. 2016). The low-lying coastal alluvial plains and barrier islands along Florida's East Central coastal counties are "dynamically influenced by climate change, and the negative effects include, but are not limited to, shoreline erosion, wetland inundation and migration, saltwater intrusion, and alterations of the distribution and productivity of vegetation communities (shifts in species composition possibly from less salt tolerant species to more salt tolerant species)" (Xiao *et al*. 2016).

From 2010 to 2020, Miami-Dade County, Florida's most populous county, increased in population by over 14% and Broward County, the second most populous county in Florida, increased by over 11% (Miami-Dade County Statistics 2020; Broward County 2020; US Census Bureau 2021). As cities grow, human pressures on the natural environment increase, thereby reducing the ability of the ecosystems to recover naturally. These pressures on the ecosystem, compounded by the continued trend of increased climate change influences, result in greater heat stresses on humans as well as plant and animal metabolisms; increased incidence of diseases; stresses on freshwater supplies; availability of land for agriculture and waterways for aquaculture, to name a few challenges (Nicholls *et al*. 2007). Often, with increased populations come reductions in green spaces and increases in impervious surfaces (i.e. pavement), ultimately increasing the heat stress and urban heat island effects in cities (Chapman *et al*. 2017).

Six of the 12 counties in the study area border the Indian River Lagoon (IRL), more correctly termed an estuary. Estuaries are especially sensitive to climate change-driven weather events such as extreme flooding, stormwater runoff, and high temperatures. Designated an Estuary of National Significance by the US EPA, the IRL comprises "27% of Florida's eastern coastal wetlands and is home to more species than any other estuary in North America, including some 4,300 plant and animal species" (Parkinson *et al.* 2021, 216). The effects of years of major flooding and runoff have caused increased levels of nitrogen and phosphorous loading from residential and business use of fertilizers, agricultural lands, and leaky septic systems (Trefry and Fox 2021; Barile 2018). Rising temperatures can impact "water quality and clarity (i.e. salinity, dissolved oxygen (DO), and chlorophyll-a (Chl-a)) in response to evaporation" (Parkinson *et al.* 2021, 221). These water quality issues have also contributed to the die-off of seagrass, a primary food source for manatees (MRC 2022).

Coastal cities of eastern Florida are facing a challenging array of potential threats over the coming decades. This study used a survey instrument that was validated, reliability obtained, and regression analyses conducted to quantitatively estimate the relationships between the dependent variable, Florida Atlantic Coast city self-assessed preparedness for climate adaptation, and the following independent variables: a) city leader perceptions of risk associated with climate change and b) city size.

2. Methods

2.1. Overview

This research was based on data collected from two sources, 1) a survey instrument where city and leader confidentiality were guaranteed and 2) publicly available information on city size obtained from the Florida Association of Counties (2020) and the Florida Cities by Cubit (2020). Of the cities targeted to receive the survey (158), city sizes ranged from 16 to over 800,000 people, with the average size at about 37,000 people (FAC 2020; Florida Cities by Cubit 2020). Of the 158 cities queried, 86 responded with completed surveys. Responses were received from cities in all the

Table 1. Cities receiving and responding to survey.

County (1)	Pop of Cities Surveyed per County (2)	# Cities that Received Survey (3)	# Cities that Responded to Survey	Response Rate per County (rounded)
Nassau	15,748	3	0	0
Duval	869,729	5	4	80%
St Johns	19,366	3	2	67%
Flagler	83,951	4	3	75%
Volusia	381,328	16	8	50%
Brevard	339,935	16	13	81%
Indian River	47,068	5	3	60%
St Lucie	209,483	3	2	67%
Martin	19,773	4	2	50%
Palm Beach	742,488	38	21	55%
Broward	1,678,557	28	15	54%
Miami-Dade	1,388,494	33	13	39%
Overall Totals	**5,795,920**	**158**	**86**	**54**%

Notes:
1. Counties are listed in geographic order from north to south along Florida's Atlantic Coast.
2. Florida Cities by Cubit (2020).
3. Surveys were sent to the list of cities in the Atlantic Coast counties that were listed with the Florida Association of Counties in 2020 (FAC 2020).

surveyed counties except Nassau County Table 1). The population of the 86 respondent cities ranged from 220 to 414,751 people, with a mean of 36,177.

Analysis of the data was conducted using multiple linear regression in SPSS (ver 27.0.1.0) to answer the following research questions:

RQ1: What perceptions of climate change risk do eastern Florida's coastal city leaders hold?

RQ2: To what extent are Florida coastal cities implementing adaptation measures to address the impacts from climate change?

RQ3: To what extent does the size of the city correlate with the extent to which cities adopt climate change adaptation measures?

2.2. *Survey instrument*

Reliability and validity analyses of the survey instrument took place in June and July 2020. Reliability was calculated in SPSS using responses from cities of similar socioeconomic characteristics to those cities in the main study. Cronbach's alpha of 0.828 was obtained, achieving sound reliability of the internal consistency of the survey items (Field 2013). Validity included subject matter expert review and comments to improve technical content.

The survey was sent to leaders in 158 cities in the 12 Atlantic coastal counties (i.e. Nassau, Duval, St. Johns, Flagler, Volusia, Brevard, Indian River, Martin, St. Lucie, Palm Beach, Broward, and Miami-Dade) that border Florida's Atlantic coast (Table 1). A city leader was either a mayor or city/town manager. Smaller cities generally had a

Table 2. RQ 3 list of adaptation measures.

○ Climate Change Vulnerability Assessment (CCVA). (1)
□ Plans for strategic withdrawal (retreat) (1)
□ Rolling easement plans. (1)
□ Population density assessments and regulations. (1)
□ Building codes that include energy efficiency measures. (1)
□ Creation of urban (city) parks. (3)
□ Stormwater drainage improvements. (2)
□ Wastewater treatment system upgrades. (2)
□ Identification of new freshwater (drinking water) sources. (1)
□ Protection of current freshwater (drinking water) sources. (2)
□ Protection from power disruptions from intense storms (hurricanes). (2)
□ Wildfire prevention and management. (2)
□ Conservation of water for agriculture irrigation use. (2)
□ Protection of existing wetlands or creation of new wetland areas. (3)
□ Purchase of vulnerable properties in repetitive loss areas. (3)
□ Other, please insert response (1 or 2 points depending on whether the item was for planning or implementation.)

(1) = Planning; (2) = Reactionary; (3) = Anticipatory.
(IPCC 2001; Mimura et al. 2014; Heimlich et al. 2009).

mayor, while larger ones often had a city or town manager in addition to a mayor. City leaders were selected as the recipients of the survey based on subject matter feedback that these are the appropriate individuals within a city to respond on behalf of the city. Cities in all counties were selected for several reasons: 1) the unique (to Florida) environmental factors along the coastline due to wave action that causes erosion and saltwater intrusion and 2) the policy benefit of addressing whole watersheds that comprise several counties at a time.

Below are examples of risk perception items (RQ1) from the survey.

- "What is the risk of climate change exerting a significant impact on PUBLIC HEALTH in your community?"
- "What is the risk of climate change exerting a significant impact on the ENVIRONMENT in your community?"
- "What is the risk of climate change exerting a significant impact on ECONOMIC development in your community?"
- "Sea-level rise poses an economic threat to my city."
- "Maintaining green spaces, parks, and wetlands is not related to climate change adaptation."

Research question 2 (Table 2) contained a list of possible climate change adaptation measures that could be present in the cities surveyed. The items were selected from a variety of sources to capture the breadth of city characteristics (i.e. rural vs. urban, small vs. large, inland vs. coastal) that could be found along Florida's Atlantic Coast. It was not meant as a comprehensive list of all possible adaptation measures for all cites.

2.3. Scoring

There were 15 questions for research question 1 (risk perception). Possible scores ranged from one to four per question. An average score was used in the analysis.

RQ2 regarding city size simply listed the population.

The (self-assessed) climate change preparedness question was scored based on the following: 1 – 3 points were issued based on whether the item was reactionary or anticipatory of a climate change impact (Table 2). If a city did not indicate they had any of the adaptation items listed, they received a zero.

3. Results

Of the 158 cities queried, 86 responded with completed surveys. Responses were received from cities in all the surveyed counties except Nassau County. The population of the 86 respondent cities ranged from 220 to 414,751 people, with a mean of 36,177.

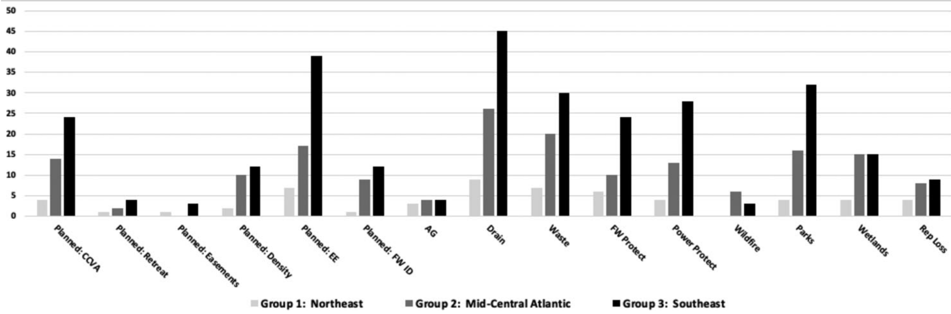
3.1. Survey respondents

The target audience for the survey was City Leaders (i.e. mayors, city managers, town managers); however, they were also offered the opportunity to delegate that survey response. If not responding directly, city leaders were asked to forward the survey to someone within the city administration who had the know-how to answer the questions on behalf of the city. The survey required that respondents list the name of the city for which they were responding and the title of the respondent, thereby ensuring that only one response per city was received. Respondents included 47 city leaders and 39 delegates. The official titles of the delegates were varied (e.g. city planner, resiliency officer); fifty respondents indicated they had fewer than 5 years in their current position, twenty stated they had served for between 5 and 10 years, while 16 individuals stated they had held their positions for more than 10 years.

3.2. Self-Assessed climate change adaptation preparedness

City Leaders indicated which adaptation items they either had already planned or were implementing (Table 3). Table 3, shows the list divided into three groupings based on where the city was geographically located along the coast. Group 1, the Northeast Counties of Duval, St. Johns, Flagler included 16 plans and 35 implementation actions. Group 2, the Central-Atlantic Counties of Volusia, Brevard, Indian River, St. Lucie, and Martin, contained 52 plans and 118 implementation actions. Group 3, the Southeast Counties of Palm Beach, Broward, and Miami-Dade contained 94 plans and 190 implementation items. Out of a total possible score of 30, with plans receiving 1 point each and implementation measures receiving 2-3 points each depending on whether they were reactionary or anticipatory (Table 2), only 28 of the 86 cities received scores above the 50th percentile. The average city score for planning and implementation measures combined was 11.4. These scores were lowest in the Northeast Atlantic Counties and highest in the Southeast Atlantic Counties. One city received zero points because it did not indicate any planning or implementation measure, while the highest score for this self-assessment was 23.

Table 3. Self-assessment of climate change adaptation measures: planned and implemented.



Notes:
PLANNING: CCVA = climate change vulnerability assessment; Retreat = plans for strategic withdrawal; Easements = rolling easement plans; Density = population density assessments and regulations; EE = energy efficient building codes; FW ID = identifying new freshwater (drinking water) sources.
IMPLEMENTING: AG = water conservation for agriculture use; Drain = stormwater improvements; Waste = wastewater treatment upgrades; FW Protect = protection of freshwater (drinking water) sources; Power Protect = protection from power disruptions (e.g. from hurricanes); Wildfire = wildfire prevention; Parks = creation of urban (city) parks; Wetlands = protection of existing wetlands or creation of new wetland areas; Rep Loss = purchase of vulnerable properties in repetitive loss areas.
Northeast Counties: Duval, St. Johns, Flagler; Mid-Central: Volusia, Brevard, Indian River, St. Lucie, Martin; Southeast: Palm Beach, Broward, Miami-Dade.

Table 4. Coefficients.

	Standardized Beta	*t*	Sig.
(Constant)		1.207	0.231
Risk Perception (IV1)	0.225	2.154	0.034
City Size (IV2)	0.285	2.720	0.008

Note: confidence intervals at 95% and dependent variable is preparedness.

3.3. Multiple regression analysis

The 86-sample size of this study exceeded the minimum number needed to maintain power (0.80), with a medium effect (G*Power 2020). The descriptive statistics show the dependent variable (Preparedness) mean of 11.41 out of a possible 30. Confidence intervals were 95%, alpha of 0.05. IV 1 (Risk Perception) had a mean score of 2.91 out of 4. IV2 (City Population) had a mean score of 36,177.

The model summary results showed an R^2 of 0.169 ($p= <0.001$). F^2 (R^2/1- R^2) was calculated as 0.20, a medium effect (Keith 2015). The results of the ANOVA output showed an F value of 8.470 ($p = < 0.001$).

The coefficients table (Table 4) showed risk perception standardized beta was 0.225, a medium effect, ($t = 2.154$, $p < 0.05$). The city size standardized beta was 0.285, a large effect size, ($t = 2.720$, $p < 0.05$).

Risk perception scores ranged from 1.4 to 3.93 (out of a maximum of 4), with a mean of 2.91. There was a clear pattern of higher risk perception leading to better climate change preparedness in most cases. There were a few city officials who listed risk low while also scoring high in terms of preparedness, and vice versa.

3.4. Independent variable interaction

An interaction was identified between the IV city size and the IV risk perception, ($t = -2.1975$, $p = < 0.05$, at 0.0308) (Hayes 2018). Thus, city size is moderating the effect that risk perception had on climate change preparedness, and given that the interaction coefficient is negative, as city size increases, the risk perception effect decreases (SPSS. 2021).

4. Discussion

In terms of the climate change preparedness scores for the cities, more than 50% of the cities scored in the lower 50th percentile for the (self-assessed) adaptation preparedness variable. This indicates that more cities need to move from adaptation planning to implementation. Cities that ranked higher in terms of preparedness had more implementation measures than planning measures. Inclusive of all cities, energy efficiency codes ranked highest among plans (i.e. 63 of 86) and stormwater drainage improvements (i.e. 80 of 86) ranked highest among implementation measures. There were far more adaptation plans or implementation measures in the Southeastern counties of Palm Beach, Broward, and Miami-Dade, than in the other two regions studied. Some reasons for lack of implementation of plans may range from a lack of a local environmental champion or lack of financial resources to political influences or a lack of understanding of the risks to a community (Tenali and McManus 2022; Carlton and Jacobson 2013).

The extent to which a city self-assesses its preparedness for climate change-related events can depend on a lot of other factors, including but not limited to where the city is located in relation to the ocean, whether it contains a large city with many impermeable surfaces, and the size of the population. Cities that received lower climate change adaptation preparedness scores could have been in the early stages of planning, or they simply might not have the resources for implementation. One study stated that unless there is a clear mandate to move from planning to implementation, people may be less likely to do so (Tang *et al*. 2010). There are no mandates in Florida to implement climate change adaptation measures. Many cities in this study, especially those in Southeastern Florida, are leading the way in terms of climate adaptation planning, if not implementation (Vella *et al*. 2016), but more remains to be done in both planning and implementation throughout Florida's Atlantic Coast.

The multiple regression results show that risk perception and city size also help to explain the extent to which cities in Florida's Atlantic coastal counties assessed themselves in terms of climate change preparedness. Although city leaders' (i.e. mayors, city managers, town managers) or designates' views on risk explain, in part, the extent to which a city had adopted climate change adaptation measures, not everyone views those risks in the same way (Carlton and Jacobson 2013). That can be seen in the risk perception results in this study, whereby some cities scored risk high while scoring low in terms of preparedness, and vice versa. While there were these few examples of cities that ranked risk high while ranking low for preparedness, in general, cities that ranked higher in terms of preparedness scores also had higher average risk perception scores. Wang, Geng, and Rodríguez-Casallas (2021) found that risk perception drove climate action indirectly, with belief in climate change itself a direct driver of climate change action. This study found that risk perception had a direct impact on climate change preparedness, with city size acting as a moderator on risk perception. That is, city size increased as risk perception decreased. Reasons behind the moderator effect were not further explored.

Climate change is often an abstract idea for many people; therefore making it relatable to localized events is key to helping people understand risks (Bergquist, Nilsson, and Schultz 2019). Scientists have an opportunity to share information with cities about localized, relatable risks to their communities because of climate change-related events, and feasible adaptation measures to reduce those risks. Increasing understanding of localized climate change-related threats would, in turn, increase risk perception, which would also increase preparedness.

The larger the city, the higher the climate change preparedness score, in most cases. In the study area, approximately 63% of the cities had fewer than 20,000 people, explaining, in part, why more than 50% of the cities in the study area scored at or below the 50th percentile in terms of preparedness. Often smaller cities do not have the resources to implement all necessary activities to protect their cities from the effects of climate change, and many cities face not only lack of resources but also competing priorities for scarce funding (Tenali and McManus 2022). Working with regional organizations may provide smaller cities with needed resources in terms of understanding the threats to their areas, sharing draft plans, identifying strategies for implementation measures that might be most effective for their areas, among other resources. As previously mentioned, other research has shown that working in groups builds organizations' efficacy that they can achieve the desired results (Heald 2017; Bandura 2012).

Many of the respondent cities with the largest populations are in Southeast Florida, a location extremely vulnerable to climate change (Nicholls *et al*. 2007). The Southeast Florida counties of Broward, Miami-Dade, and Palm Beach have a long track record of addressing climate change impacts and acting on their vulnerabilities partially through participation with the Southeast Florida Climate Change Compact. Further, Southeast Florida counties and cities have devised many policies to address climate change, such as Miami-Dade's new strategy to build back further from the sea (SFCCC 2021). Larger cities tend to have a greater tax base, and therefore financial resources, to address adaptation measures than do smaller cities. Interestingly, however, not all cities in these Southeast Florida counties scored well, and not all large cities scored well, in terms of climate change preparedness.

Another reason, apart from larger cities having more resources, that some cities assessed themselves as more prepared than others could also be attributed to them having directly experienced an extreme weather event. When people experience extreme weather events, and the impacts thereof (e.g. flooding, drought, salt-water intrusion, nutrient runoff) they tend to be willing to pay more in taxes to safeguard against future events (Bergquist, Nilsson, and Schultz 2019). A future study could investigate the types and frequencies of extreme events and their impacts, along with whether cities associate those events with climate change.

It should be noted there was a wide range of adaptation measures in the dependent variable to capture the possible range of items that cities would need to protect themselves against the adverse effects of climate change-related events. The adaptation measures listed herein were not meant to be a comprehensive list of every possible item needed in each city in the study area. What this study provided was a general idea of actions cities could take to adapt to climate change events.

City leaders and planners can use this research in several ways. First, given risk perception is linked to better planning, cities can host events that help city councils, constituents, and county boards understand the risks associated with their communities. Research shows that people understand climate change better when the effects of it are linked directly to something relatable to them, such as water shortages, flooding, heat stress, wildfires, coastal erosion, among other impacts (Carlton and Jacobson 2013; Akerlof *et al*. 2013; Williams and Bargh 2008).

Second, cities can participate in regional climate change or resiliency planning efforts. This research showed that cities depend, in part, on the support of regional organizations in their planning and implementation processes. Doing this will build collective efficacy on the part of the participants, thereby encouraging the idea that planning goes beyond plans and into implementation (Bandura 2012; Bieniek-Tobasco *et al*. 2019). In addition, regional organizations often bring to the forefront additional knowledge resources to assist cities in their individual efforts, such as sharing climate impact experiences from one community that may be impacted by the actions, or lack thereof, of another community (Meerow and Woodruff 2020). Finally, working with regional organizations can help some cities to understand where they might be able to obtain financial resources to assist them in their efforts or how to overcome other obstacles that might impede action (Bieniek-Tobasco *et al*. 2019).

Third, cities can develop strategies and focus on discussions that are rooted in science and make them relatable to their own contexts. Climate change strategies and discussions that relate climate-driven events to the local context help people to understand the importance of necessary actions to protect their cities, as people have shown a tendency to lack interest or motivation to act on issues far from home (Carlton and Jacobson 2013; Akerlof *et al*. 2013). Cities can seek information indirectly through online sources (i.e. NOAA, NASA, the IPCC) and peer-reviewed journals and books, or directly from knowledgeable scholars in the field from local universities as well as through their own in-house staff who need to be given the chance to remain on top of their fields by obtaining continuing education in this area. It is especially important to counter misinformation from non-scientific sources, as these sources can sway public opinion against any productive climate change adaptation strategies (Feldman 2015). One way to do this may be by creating, and maintaining, a citizen committee that could support planning efforts, discuss progress on the plans and implementation of those plans, and to help identify ways to counter misinformation. Finally, research has shown that people are more likely to support climate change plans and actions when they see how threats relate to their own communities.

5. Conclusions

This study demonstrated the extent to which cities in counties that border Florida's Atlantic coast see themselves as being prepared for climate change by adopting certain adaptation measures. The study further determined that both risk perception of climate change and city size help to explain city preparedness. These results can be considered foundational, and more research into these issues would be beneficial. Importantly, cities can use this research now to take actions to move beyond planning into implementation by building awareness in their communities about the risks related to their communities and how to overcome those risks; working within groups to build collective efficacy on the part of cities; and, relying on scientific sources for information related to climate change.

There are several possible areas for future research, including, but not limited to: the reasons behind risk perceptions; which cities belong to which regional organizations and what planning information is shared; and, reasons behind larger cities being more prepared for climate impacts.

This study was constrained in ways that included: 1) the Covid-19 pandemic limited the time available for personnel to respond to additional tasks such as this survey, reducing the number of responses received; 2) some cities in the population were very small compared to others and, therefore, those cities may not have the same level of services and adaptation measures as larger cities; and, 3) some cities indicated to the primary researcher that they did not want to respond to the survey because they feared their individual response would be made public. We hope this research provides ideas for cities to move beyond planning and into implementation to protect themselves from climate change-induced impacts by increasing communication with constituents about risks, collaborating with regional planning organizations, and continuing reliance on science personnel and organizations to aid in their understanding of vulnerability and adaptation measures available to them.

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