



METROPOLE

Adaptive Capacity Index

Part I. Broward County, Florida

DRAFT

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Executive Summary

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- Broward County Environmental Protection and Growth Management
 - Broward County Environmental Planning and Community Resilience
 - Broward County Division of Emergency Management
- Broward County Public Works
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Introduction

Study Objectives

As climate change intensifies and accelerates the capacity to cope with impacts and the ability to adapt to opportunities will become critical attributes, to not only recognise but also augment where possible, across multiple sectors and organisations. Therefore, defining and understanding the mechanisms through which these attributes can be measured and potentially enhanced is a key on-going discussion. Adaptive capacity has been investigated through a range of systematic frameworks that differ by field, practice, scale and focus (Engle, 2011). For this particular framework the focus remains actor-centric and incorporates the influence of structure and agency as defining characteristics in an attempt to move the discussion away from simply measurement into a more practical niche where the study of adaptive capacity can be used as a stepping stone for action at a range of scales. Through the empowerment of actors, and using the Adaptive Capacity Index (Pelling and Zaidi, 2013) as a foundational basis for investigation, the conceptual framework of adaptation utilised here creates an actor-identified solutions mechanism through social learning upon which to create pro-active change in how climate change issues are addressed.

This framework therefore has three specific objectives: *i*) the establishment of an honest dialogue around adaptive capacity driven by actor reflection and vision *ii*) an investigation into organisational arrangements and learning networks that are best suited to enhancing adaptive capacity across and within a range of sectors *iii*) the identification of barriers to successful implementation of adaptation actions and the trade-offs necessary to create successful initiatives for effective adaptive management at a local scale. Developing adaptive capacity in order to be able to actually implement adaptation actions is a process of on-going adjustment in response to a range of drivers therefore it is important to be realistic in terms of expectations when considering the potential any framework to inspire behaviour change, especially in the short-term. However, providing the space for discourse and evaluation remains one of the most essential pathways for success and a key aim of this tool.

Adaptive Capacity

Adaptive capacity sits alongside resilience and vulnerability as a triplet of concepts that are often used interchangeably in analysis and policy, and at times overlap also with the objectives of sustainable

development. This is not in itself a problem, and it is appropriate to highlight relevant concepts for specific policy needs. So, for example, adaptive capacity sits alongside coping capacity and exposure in determining vulnerability within UNU's World Risk Index framework (Birkmann et al., 2011). This is useful when seeking to measure vulnerability to future hazards but adaptive capacity can also be measured as an independent variable (Welle et al., 2013, Engle, 2011). Adaptive capacity, therefore, indicates the potential for adjustment and is often indicated through past behaviour but should not be equated with power or capacity for self-determination. For instance, poorer sectors of society are often said to exhibit both high degrees of vulnerability (high exposure and susceptibility to harm) tempered through high adaptive capacity (Spires et al., 2014). Here, adaptation is not indicative of power to enhance life conditions through responding to risk but through the necessity for change to enable survival – those who cannot adapt and reach the limits of adaptation face even great risks either through loss and damage or through household collapse and migration or similar forced transformations (Dow et al., 2013). Similarly, low levels of vulnerability often associated with contemporary economic success do not always align with high levels of adaptive capacity (Magnan, 2010), but instead may result in industrial, technological, organisational/cultural and economic lock-in, such as those associated with land-use inhibit flexibility (Sovacool, 2011, Spires et al., 2014). Often such actions and initiatives can be chosen and justified so that a rush for economic gain is seen as providing for longer-run flexibility even if contemporary capacity is limited by a narrow economic base, for example in the tourism based economies of the Caribbean (Agrawal, 2003). Attempting to define a clear linkage between economic or technological status and adaptive capacity can therefore be limiting in its utility.

An alternative approach to measuring adaptive capacity sees it not so much as an outcome of resources (economic, technological) but as a characteristic of social institutions that empower a range of social actors to prepare and respond to impacts and change (Gupta et al., 2010, Zaidi and Pelling, 2013). Adaptive capacity conceived as a property of existing institutions can be cultivated either through planned measures or through spontaneous experiments from within society or organisations, both before and after specific impacting events. Focus upon the development of adaptive capacity at all scales can also be anticipatory and driven by Therefore, adaptive capacity encompasses the characteristics of existing social institutions, both formal and informal, that enable sectoral and organisational responses, as well as the inherent flexibility within those institutions that allow coping strategies to evolve and be deployed (Berman et al., 2012, Engle, 2011).

While, adaptive capacity influences the ultimate potential to implement successful adaptations and varies between different contexts and systems, it is not equally distributed (Adger, 2010, Adger et al., 2009). This means that adaptive capacity is contested with different actors holding contrasting viewpoints on the nature of loss and risk, the objects at risk and the underlying values that determine

what is privileged in society – what is to be lost or enhanced through acts of adaptation and their desired outcomes. It also introduces the concept of barriers and limitations of adaptive capacity that can impede both planning and implementation efforts as well as provide opportunities for innovation and experimentation (Eisenack et al., 2014, Moser and Ekstrom, 2010, Berkhout et al., 2006) and, more precisely, the trade-offs across all sectors needed to achieve relative success with adaptation efforts (Dow et al., 2013, Moser and Ekstrom, 2010).

Adaptation efforts must be recognised more than just a function of coping with climate impacts threatening the fundamentals that society values. Adaptation must also be viewed in terms of responsibility and capacity for action as well as power differentials within the actor landscape guiding decisions and dictating trade-off acceptability. By expanding the ongoing discourse beyond ‘the how do we cope’ mentality and including questions like who is responsible for meeting the costs of adaptation, who is entitled to adaptation aid, financially and technologically, and how to does society maximise adaptation effectiveness at a range of scales as elements of the discussion we provide a more realistic avenue towards the necessary social change needed to adequately address climate change challenges.

Adaptation action is inherently driven by the prevailing values and priorities of society and expressed as functions of the existing social, political, and economic systems through codification in laws and enabling legislation, established governance practices and anchored in social norms and cultural traditions. The process of adaptation must therefore be legitimized by these norms and values, along with the institutions and actors involved in carrying out said actions. However, the legal, political and social basis for the advancement of management alternatives and adaptation options are not always clear, especially due to the fact that the sheer scale of the threats and the potential cross-sectional impacts. This lack of clarity is also compounded by the fact that multiple agencies and organizations with various, and sometimes conflicting mandates, share responsibility for decision-making in the management process. This increases the need to understand the organisational architecture that exists with an adaptation space, where responsibilities lie in terms of critical planning and response decisions and what influences may affect that space.

Methodological Approach to Adaptive Capacity Assessment

Sample

The aim of the methodology and sampling protocol is to provide (1) a quantitative expression of the adaptive capacity for a community of practice for Broward County; (2) some quantitative expression

of adaptive capacity for sub-systems e.g. local government, private sector or local government, state/federal government; and (3) qualitative analysis of experiments, blockages, strategies used that explain the shape and value stakeholders award themselves for adaptive capacity.

Community of Practice

Since the focus of this study is on organisations with planning and practice responsibilities, including private sector utilities/land-owners, civil society (e.g. nature reserves) and Federal, State and Local government agencies active in Southeast Florida, the initial starting point towards the identification of relevant actors was to find an existing 'community of practice'. With the acknowledgement that most effort would likely be centred on local government, logic suggested that an existing list of statutory or voluntary stakeholders in the development of a land-use plan or comprehensive master plan would provide a reasonable first potential sample with the recognition that that sample could be augmented by other organisations in relevant sectors as necessary. For the purposes of the Broward County study the decision to use the [2012 Southeast Florida Regional Climate Action Plan](#) was straightforward.

Nested Analytical Frame

It is possible for opportunities for adaptive capacity along with barriers to adaptation option adoption to occur at both the political and sectoral scale. The landscape is often very complex and busy with multiple partnerships, initiatives and agencies that all have a stake in the issue of resilience and adaptation to environmental risk. To include every organisation in an adaptive capacity analysis would be unrealistic and virtually impossible. Therefore it is important to consider the best analytical frames at which to employ the ACI.

These analytical frames can be vertical in nature, i.e. the analysis looks adaptive capacity of organisations that make up a natural hierarchy such as levels of government from town to county to state to country. This allows the flows of responsibility and power to be more fully comprehended while identifying potential barriers or levels of governance where blockages to implementation may have formed. The analytical frames can also be horizontal, i.e. the analysis looks across sectors of society including public enterprises, private-public partnerships and civil society. This helps to elucidate the public-private dynamic and allows organisations with high adaptive capacity to be recognised along with areas of low adaptive capacity that may require potential increases in resources or additional assistance. In order to ensure the ACI is relevant across both of the analytical frames the identification of organisations within each frame is key to the potential success of the analysis. To this end, ensuring there is a mixture of organisations that are both theoretically and practically influential in the adaptation landscape as well as organisations that have responsibility for key infrastructure,

environmental risk management or flood management policy is also critical for guaranteeing an effective analytical frame for adaptive capacity research.

For the purposes of the Broward County component of the Metropole study an initial sample was developed for discussion within the project team and with project partners (Table1). This involved identifying actors within both the vertical and horizontal frames who have a responsibility for environmental risk management. Within each identifiable section of the sample there is a progression in either expected scale of influence or natural hierarchy from local organisations to county-wide, regional bodies such as the South Florida Water Management District, through state agencies to national level actors such as the Federal Emergency Management Agency and the US Army Corps of Engineers.

Sample Strategy

In order to maximise the potential for interviewee response, the Environmental Protection and Growth Management Department of Broward County was used as a communication broker. This allowed existing partnerships and relationships to be used as leverage when establishing initial contact with potential respondents. Interviews were preceded where possible by examination of organisational and strategy documentation to become familiar with core functions and capacity of the respondent's organisation. This allowed the interview to focus on the individual respondent's view of the organisation's ability to adapt – access information, challenge existing policy and practice, experiment, access new resources to then mainstream; and the organisation's interaction with other organisations and the legislative environment in achieving this.

Table 1. Initial Community of Practice Identified from the Southeast Florida Regional Climate Action Plan

<u>Community of Practice: Broward County Climate Change Action Plan</u>								
<u>Broward County Organisational Matrix</u>	Land Use/Planning/ Management	Environment	Emergency and Risk Management	Transport	Energy and Water	Economy	Social Structure	Health
ACTORS	Government (local, regional, state and federal agencies)	i. Broward County Environmental Planning and Community Resilience Division ii. South Florida Regional Planning Council	i. Broward County Environmental Protection and Growth Management ii. Florida Department of Environmental Protection	i. Broward County Emergency Management Division ii. Broward Sheriff's Office iii. Florida Department of Emergency Management ii. FEMA	i. Broward County Airport Division ii. Broward Metropolitan Planning Organization iii. Port Everglades Department iv. Florida Department of Transport	i. Broward County Water and Wastewater Services Division ii. South Florida Water Management District iii. Florida Power and Light	i. Greater Fort Lauderdale Convention and Visitors Bureau	i. Fort Lauderdale Division of Public Works
	Civil society	i. American Planning Association Florida Chapter	i. The Nature Conservancy ii. South Florida Audubon Society					i. Institute for Sustainable Communities
	Private sector				i. FLL Airport iii. Florida East Coast Railway		i. State Farm Insurance ii. Greater Fort Lauderdale Realtors iii. Council for Fort Lauderdale Civic Associations iv. Builder's Association of South Florida	

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Interview Methodology

The ACI is derived from a series of semi-structured, face-to-face interviews conducted with key stakeholders. Interviews typically last about an hour during which respondents are asked to assign a value of performance on a 5-point scale (Box 1) to each index indicator, and to discuss the conditions that shaped their capacity and that of their organisation to adapt to climate change. This combination of both qualitative and quantitative methods provides a greater amount of context and clarity and acts both to validate through example and to highlight potential policy recommendations.

To maximise the potential insight into adaptation practices, respondents are asked to comment on contemporary organisational capacities, along with two previously selected time points, ideally linked to recurrent threats or risks or events, in order to generate a trajectory of capacity over time. In this way the methodology provides scope for both direct and indirect elements of climate change and adaptation to emerge from the interview without directing as well as providing a longitudinal insight into adaptation. Respondents are encouraged to provide examples of inputs and outputs while assessing capacity for each of the identified sub-components of adaptive capacity (critical self-reflection, organisational structure, improving insight, resources to enable adjustments, and support for experiments). Multiple views are sought from each organisational unity – department, household, agency etc. to control for respondent bias in the interview process and provide greater insight. The model can be deployed to compare capacity between any social units - between departments within an organisation, between local and national organisations and across sectors or administrative-political regimes.

The 5-point scale (Box 1) employs five qualitative performance levels (Very limited, Basic, Appreciable, Outstanding, and Optimal), each is also assigned a numerical value of 1 (Very limited) to 5 (Optimal) to enable aggregation. The use of a progressive numerical scale to assess performance does not indicate the presence of a universal standard for each level; neither is it to imply that the

Box 1. ACI 5-point assessment scale

Very limited:

No formalised capacity. Activity is ad hoc, very infrequent and not planned or captured by strategy.

Basic:

A low level of formal capacity. Activity is planned. Action is infrequent and superficial, below the levels or intensity required to make a concrete difference to outcomes.

Appreciable:

A modest level of formal capacity. Activity is planned and strategic. Action is regular and outcomes can be identified but are limited in the depth of impact.

Outstanding:

Strong formal capacity. Activity is planned, strategic and integrated into all major sectors. Action is frequent, outcomes have made a clear difference to risk and its management.

Optimal:

Very strong formal capacity. Activity is planned, strategic, integrated and a part of everyday practice. Action is constant, outcomes have reshaped risk and its management and continue to do so in continuous cycles of activity.

distance between each increment is quantifiable or equal. In practice, the degree of adaptive capacity identified by each respondent is subjective to individual experience and assessment of performance targets for risk management. The establishment of this kind of scale of achievement levels provides the opportunity to determine the 'distance' between current conditions and an objective threshold or optimal condition at a selected scale. Asking respondents to place a numerical value forces comparative analysis and tightens results. The strategy of asking respondents to exemplify decisions allows some analytical triangulation between respondents and prevents wholesale strategic respondent bias.

Survey Instrument Sections

There are nine subcomponents in the ACI model that form the underlying conceptual framework for the survey instrument (Figure 1). This model can be used in multiple ways to elucidate a variety of interactions and dialogues within an overarching resilience/transformation narrative. The central pillar of the conceptual framework is a critical self-reflection component. This represents the ability of policy and implementing agencies to reflect on practice outcomes. Including critical self-reflection indicators in the ACI model increases the transparency and accountability of actors and institutions being assessed since they provide a gauge of the effects of an organizational capacity development intervention, not simply a record of activities undertaken. Critical self-reflection can be demonstrated through examples of how an organisation changed strategic direction or the tools or mechanisms used to meet an existing goal. A prerequisite of this indicator of adaptive capacity includes ensuring space for reflection that goes beyond questions of efficiency to include a testing of existing practices (Pelling and Zaidi, 2013, Brooks et al., 2005).

One investigative area of particular note is the role that social learning spaces within and between organisations are being utilised at different scales. Spaces for learning can either be cultivated in the formal or canonical system, or when this is closed off then within the more hidden shadow or informal systems of relationships, networks and spaces (Pelling et al., 2008). The interaction between the shadow and canonical and especially how far the canonical can tolerate the shadow without losing key performance goals such as transparency and efficiency is a key dilemma and threshold point for adaptive capacity.

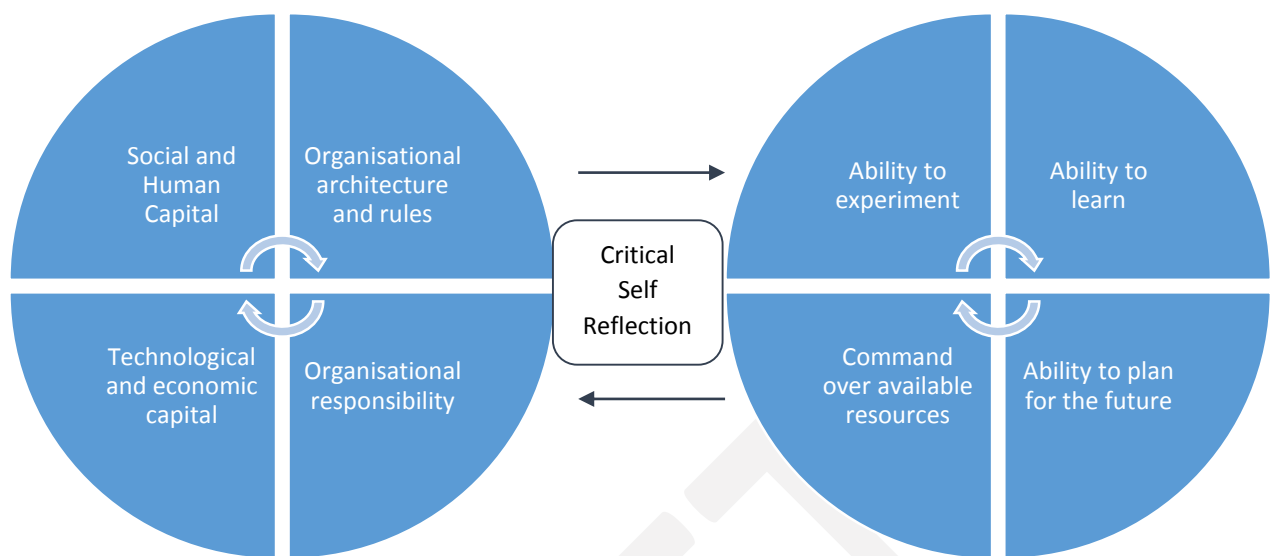


Figure 1. Conceptual model of adaptive capacity

The nine subcomponents of the conceptual model were mapped on to four main overarching survey sections in order to allow easy interpretation and relevance for interviewees. The survey sections were:

- Risk Identification
 - The availability of risk identification mechanisms and early warning systems in the overall system for risk impacts. These mechanisms can be the outcome of national or local initiatives that manifest at the city or county level.
- Risk Reduction
 - Refers to pre-event management activities designed to either directly enforce or empower actors to contain human vulnerability and hazard, and enhance adaptive capacity and actions in the long and short term.
- Learning
 - Willingness to incorporate lessons and reassess organisational goals
- Adaptive Governance
 - The degree to which the existing system has inbuilt mechanisms for flexibility (change within existing limits of practice) and reform (a timely changing of the limits of regimes, technical ability or underlying values and goals).

Analysis

Two analytical tasks are performed on the data collected from the interview process. Initially, a quantitative analysis produces a description of capacity from the viewpoint of respondents. This can be presented for each respondent, and in aggregate form. Weighting is kept neutral to enhance the transparency of the analysis and avoid data transformation issues. This task focused primarily on the right hand side of the conceptual model which primarily deals with agency.

Secondly, interview data is analysed and coded qualitatively to draw out processes, gaps and opportunities for to help draw out analytical clarity and focus policy recommendations. The four subcomponents on the left of the conceptual model, supplemented by additional questions, represent the structure of the organisation under investigation and were the main focus of these analyses.

The semi-structured nature of the ACI approach allows multiple perspectives and outlooks to be examined within individual interviews as well as across sectors. The examples of inputs and outputs provided by respondents supply crucial context which can elucidate strategies, approaches and mechanisms which organisations employ to increase adaptive capacity as well as underlying values that drive the how, what and where questions of actual implementation. Understanding the normative standards and base values of organisations playing a key role in climate change adaptation provides insight into how priorities are being set and what shifts in approach may be possible.

Analytical Themes

A foundational analytical approach provides the opportunity to map analytical efforts on to three main themes: i) trade-offs, ii) knowledge and technology transfer, and iii) responsibilities, decentralization and participation. All of these themes must incorporate both internal organisational decisions and character along with external drivers such as justice implications and adaptive limitations and will be viewed within the three organisational approaches, utility-maximising, behavioural, and institutionalist, as defined by Berkhout (2012).

- i) Looking at trade-offs between investment in adaptation efforts with other internal capacities and imperatives provides a key frame to discern the different capabilities of similar organisations in different sectors, landscape locations or geographical regions. The building blocks of organisational character, the processes of decision-making, experimentation and resource configuration, along with the level of investment in future planning (horizon scanning) all require trade-offs that play a defining role in not only how an organisation might adapt to change but also which barriers to adaptation may be the

most likely to be encountered. It also offers the opportunity to understand how constraints imposed upon organisations, for example through the reduction of financial and human capital in state agencies, influence the ability to invest in capacity development and what trade-offs are necessary to either formally or informally tackle these constraints, such as knowledge sharing.

- ii) Knowledge and technology transfer sharing includes the development and use of social networks, partnerships and social learning. This provides the opportunity to analyse the importance of shadow and conical spaces to organisations with the adaptive landscape as well as attempt to categorise opportunities that might be exploitable by other similar organisations in a different situation. The transfer of lessons-learned and the potential opportunity to co-produce and co-design solutions to overcome barriers is easy to justify in theory but often more difficult to apply in practice due to issues such as data sharing, patent restrictions, and costs. Highlighting this as a key theme provides the opportunity to increase transparency with the adaptation landscape as well as understand why the adaptive capacity agenda may be difficult to advance in some geographical or locational situations.
- iii) Changing responsibilities through efforts such as decentralization of authority or a greater demand for a wider participatory and integrated approach create both opportunities and constraints for organisations that provide extensive analytical prospects within the adaptive capacity discourse. These changes are usually more extensively felt at the state level and often impact, both positively and negatively, the state's ability to negotiate and collaborate with other sectoral actors to achieve adaptation objectives and targets. It is therefore key to understand how responsibilities are changing and the potential impacts of those changes may be on existing adaptation efforts as well as opportunities for future initiatives.

Bias and Limitations

The project was resource bound and therefore attempted to focus on generating depth in study that could drill down from the national to local level along a vertical horizon. Additionally key actors in a variety of sectors were used as counter-balances to populate the horizontal axis and provide greater context for governmental actions. Alternative sample frames could have highlighted differences in perceived adaptive capacity by geographical region (e.g. coastal/interior) or the urban-rural axis. The

final sample does include indicative viewpoints from several productive and critical urban and rural sectors.

Respondent bias was primarily controlled for through the use of a structured questionnaire tool administered in person by same principle project researcher. If in-person interviews were not possible, Skype was used as an alternative in order to retain non-verbal interaction. It was felt that given the complexity of the information required this would be more fruitful than an internet or postal survey. This resulted in detailed and careful consideration being given to the interview questions by the respondents.

Strategic bias introduced by respondents is always a possibility. This was perhaps confounded further by the use of a communication broker to identify respondents which may have resulted in a narrow sample due to their own community of practice limitations. This highlighted the importance of building a discursive approach around the core questionnaire further which provided scope for respondents to explain their quantitative judgements of capacity and acted a control on unsupported views.

Study Context

The promotion of planning and business decisions and legislation that embrace avenues to cope with risk and change is becoming increasingly more essential as environmental, social and economic conditions continue to change rapidly. The aim of this research is to supply organisations in Broward County in the USA, Selsey in the UK, and Santos in Brazil with better guidance on elements of internal and external capacity that can enable them to go beyond raising awareness and, instead, to undertake efforts that will lead to the implementation of practically focused adaptation actions and decisions.

A series of interviews with managers, technical professionals and thought leaders in a variety of organisations that actively play a role in the economy and viability of each of the regions will provide a quantitative and qualitative assessment of the adaptive capacity. By involving a wide range of risk managers and practitioners with a both a macro and local level of understanding, experience and influence the results will contrast existing political economy, wider institutional contexts and the organisational landscape within which decisions must be made while also providing adaptive capacity profiles to assist in this transition.

These interviews create an environment where self-critique of risk management practice, and capacity to change values, behaviour and outcomes are used as indicators of adaptive capacity alongside a review of

existing practices and capacities. The tool that is being used, The Adaptive Capacity Index (Pelling and Zaidi, 2013), provides a mechanism through which existing management priorities, organizational structures and governance can be reviewed at multiple scales with a view to identifying efficient pathways for mainstreaming adaptation. The results can be used in a variety of ways including improving information flows, re-orienting disaster management to a more proactive and developmental footing, and revising institutional and legal frameworks to balance capacity and responsibility between national and local or sector specific actors. The process will enable local decision makers, policy makers, and key sector representatives to share experience and insight about adaptation efforts and initiatives, as well as the difficulties that hinder efforts.

Study Site Overview

This report focuses on the research efforts in selected areas of Broward County, Florida. Broward County is located on the south eastern coast of Florida. The County's main socio-economic drivers include tourism and industrial activities with agencies such as Port Everglades, Aviation and the Greater Fort Lauderdale Convention & Visitors Bureau leading the development of international and national trade. According to the 2010 Census, the population of Broward County was estimated at 1,748,066. This number represents an increase of 7.7% over the 2000 Census estimate of 1,623,018. In 2015, the total population of the County is over 1.8 million inhabitants with less than 15% living within 3 miles of Sunrise Blvd and NW 32st Avenue, the Centre of Population.

Three cities within Broward County, Fort Lauderdale, Dania Beach and Hollywood (Figure 2) were selected as the main focus for this study. These cities were selected by Broward County officials as key to the COAST Modelling component of the Metropole Project because the study site overlaps:

- a) Areas of the County determined to be most vulnerable to sea level rise based on assessments conducted by the County and the Southeast Florida Regional Compact
- b) Sites where the County is currently rendering 3D visualization of flooding in an urban area
- c) Areas where County agencies are focusing efforts to improve community resilience and focus redevelopment strategies
- d) A mix of critical County infrastructure (port, airport), high value and commercial/residential properties that really capture the diversity of areas at risk to flooding

It is also recognised that Florida is considered one of the most vulnerable areas in the United States to climate change with Southeast Florida at high risk to sea level rise.

The City of Hollywood is a beachfront community located in south-eastern Broward County about midway between Miami and Fort Lauderdale. Founded in 1925, Hollywood is approximately 30 square miles in size and is Broward's third-largest municipality with a population of roughly 145,000 residents. Dania Beach is smaller, 21 square miles with a population of approximately 30,000, and Fort Lauderdale is

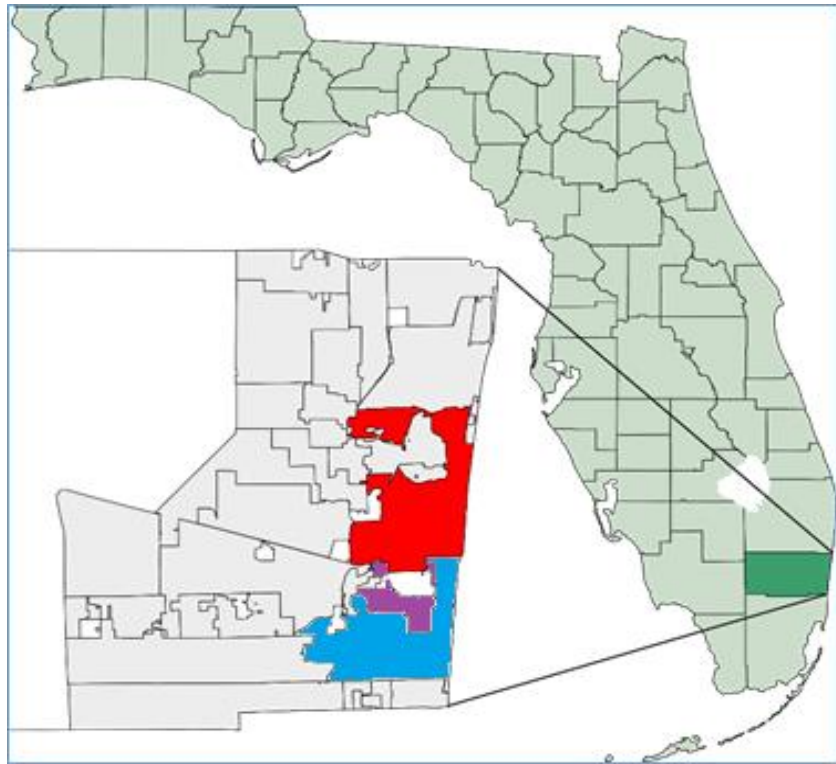


Figure 2. Study area within Broward County, Florida, covering Fort Lauderdale (red), Dania Beach (purple) and Hollywood (blue)

larger encompassing more than 33 square miles with a population of 176,000 inhabitants (US Census Bureau 2010). Fort Lauderdale is the largest of Broward County's 31 municipalities and the eighth largest city in Florida. Key economic assets such as the Fort Lauderdale/Hollywood Airport and port Everglades are encompassed by the study area.

Physical Description

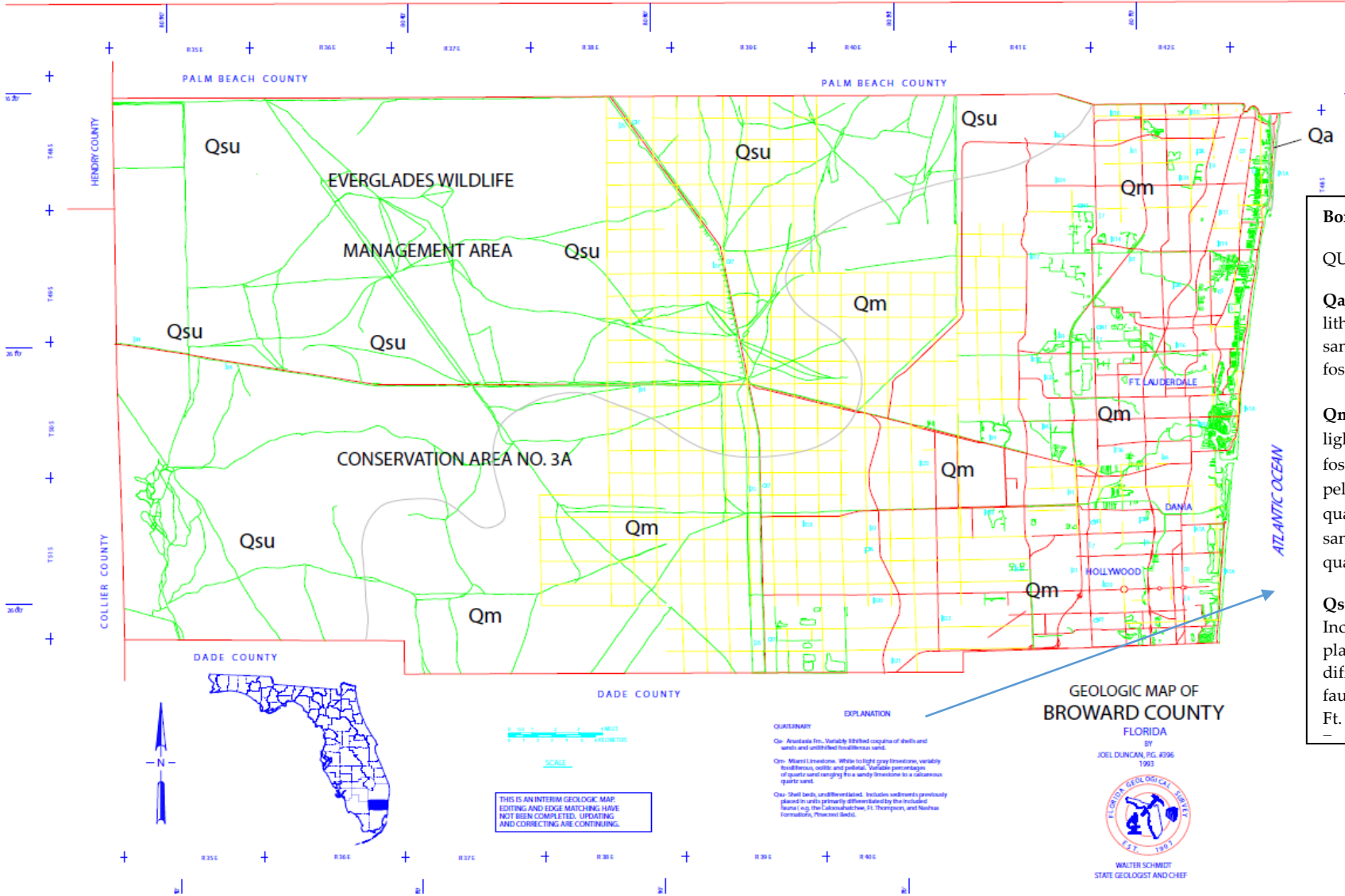
Geology

The combination of populous coastal counties, subtropical environment, porous geology and low topography is particularly vulnerable to the effects of climate change, especially sea level rise. This is illustrated by the fact that Broward County straddles three major formations of bedrock (Figure 2) including the eastern Atlantic ridge of Miami oolitic and very permeable limestone (Qm), the less permeable marl in the far western part of the County underneath the Everglades (Qsu) and a third formation consists fingers of a more permeable stone sand combination lying in a north-western to south-eastern direction (Qa) (Myers and Ewel, 1990, Veri, 1976). Due to the nature of these substrates the topography of the county is flat with an average of between 2-6 feet above sea level (Fish, 1988).

The Atlantic Coastal Ridge, 5 miles or less in width, forms the highest ground in the county from 10 feet above sea level in the south to 22 feet in the north. However, large critical infrastructure as such Port Everglades and the Fort Lauderdale-Hollywood International Airport are at elevations below sea level. This means that even a rise of 1 foot in sea level over time will result in serious impacts to both commercial and residential areas of Broward County. The geological foundation demonstrates the potential difficulty for more traditional coastal defences such as sea walls due since the porous nature of the substrate allows for water seepage under hard structures.

Hydrology

The current hydraulic and hydrologic system of South Florida is composed of lakes, impoundments, wetlands, canals, and water control structures that are managed under various water management schedules and operational decisions taken by a range of fourteen state and federal actors including the Office of Everglades Restoration Initiatives (personal communication, S.Estenez, 2015). Hydrologic extremes are exemplified by flooding and excess water during wet years and wildfires and water shortage during drought years which has resulted in the development of a complex water management system to manage flooding, occasional drought, and hurricane impacts. Broward County is largely influenced by Lake Okeechobee and the Everglades system (Figure 3) and the area is dominated by a series of nine major canals that have been built for long-distance transport of water eastward from the water-conservation areas or from Lake Okeechobee for flow augmentation, or for discharge of excess water either by gravity drainage to the ocean or by pumping to water-conservation areas. These major canals, in conjunction with secondary canals and ditches, are used for rapid removal of excess water from the region during flooding and pre-flood events (Figure 4). The network of canals in Florida range from a few feet to hundreds of feet wide and can be up to 35 feet in depth depending on location and necessity



Box 1. Geologic Map Legend

QUATERNARY

Qa- *Anastasia Fm.* Variably lithified coquina of shells and sands and unlithified fossiliferous sand.

Qm- *Miami Limestone.* White to light grey limestone, variably fossiliferous, oolitic and pelletal. Variable percentages of quartz sand ranging from a sandy limestone to a calcareous quartz sand

Qsu- *Shell beds, undifferentiated.* Includes sediments previously placed in units primarily differentiated by the included fauna (e.g. the Caloosahatchee, Ft. Thompson, and Nashua

THIS IS AN INTERIM GEOLOGIC MAP. EDITING AND EDGE MATCHING HAVE NOT BEEN COMPLETED. UPDATING AND CORRECTING ARE CONTINUING.

EXPLANATION


QUATERNARY

Qa- Anastasia Fm., Variably lithified coquina of shells and sands and unlithified fossiliferous sand.

Qm- Miami Limestone, White to light grey limestone, variably fossiliferous, oolitic and pelletal. Variable percentages of quartz sand ranging from a sandy limestone to a calcareous quartz sand.

Qsu- Shell beds, undifferentiated. Includes sediments previously placed in units primarily differentiated by the included fauna (e.g. the Caloosahatchee, Ft. Thompson, and Nashua Formations, Pleistocene).

**GEOLOGIC MAP OF
BROWARD COUNTY
FLORIDA**
BY
JOEL DUNCAN, PG. #396
1993



WALTER SCHMIDT
STATE GEOLOGIST AND CHIEF

Figure 3. Geologic Map of Broward County, Florida (Source: [University of Florida George A. Smathers Libraries](#))

DRAFT

Historically, two major aquifer systems have been identified in Broward County. The lower aquifer system, the Floridan aquifer, is composed of two or more distinct aquifers. This system occurs throughout all of Florida and parts of adjacent states. In Broward County, the top of the Floridan aquifer system is about 950 to 1,000 feet below sea level. The upper part of the system contains confined water with 30 to 60 feet of head above sea level (Fish, 1988). Overlying the intermediate confining unit is the surficial aquifer system, the traditional source of freshwater supplies for Broward County and for most of southeast Florida, however the Floridan is now being used more extensively for local water supplies (personal communication, S. Joseph, 2015).

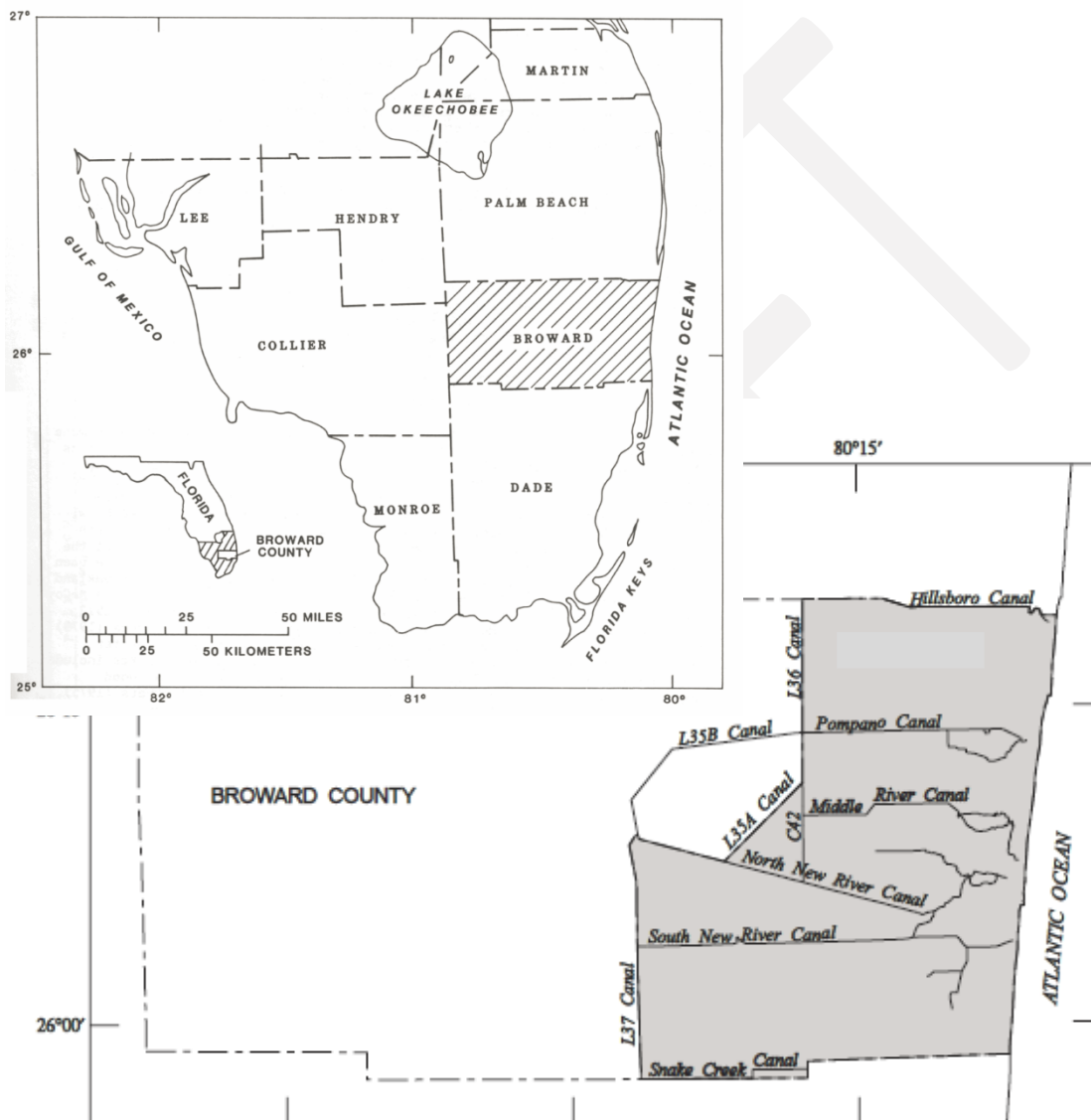
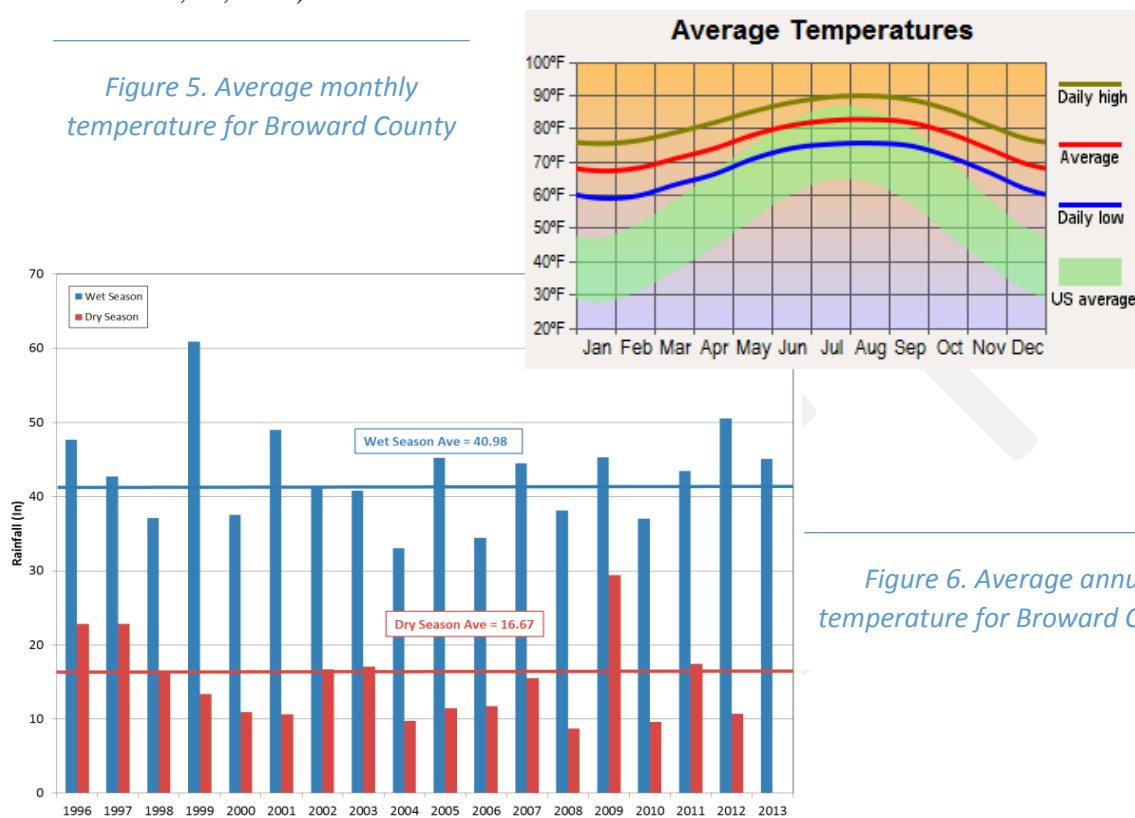


Figure 4. Canal Network of Broward County (Source: http://fl.water.usgs.gov/PDF_files/wri92_4061_sonenshein.pdf)

Weather and Climate

Broward County's climate is divided into two distinct seasons, wet and dry. The average annual temperature in Broward County is 74.4°F with a mean winter temperature of 66.5°F and a mean summer temperature of 84.2°F. The County averages 62 inches of rainfall each year (Figures 5, 6) (National Weather Service, NOAA, <http://www.nws.noaa.gov/view/states.php?state=FL&map=on> accessed June, 7th, 2015)



Demographics

The population density of Broward County is 4,300 persons per square mile (excluding the Everglades National Park Conservation Area), and nearly all of the 1.7 million residents live in municipal jurisdictions. Average household size is 2.59 people. Based on population projections for Broward County (Figure 7), it is expected that approximately 934,932 housing units will be needed by 2035 to accommodate the growing population (U.S Census, 2010, BC Planning Services Division <http://www.broward.org/PlanningAndRedevelopment/DemographicsAndEconomics/Pages/Default.aspx>, accessed June 11th, 2015). These population numbers refer permanent residents but there are significant seasonal variations.

As the permanent population grows, more development and infrastructure is needed to accommodate the increasing number of residents. Broward County has experienced an increase in development over

the last decade as the population has increased, and this trend is expected to continue. This trend of urbanization will continue to convert rural acres to urban acres, likely increasing population density within municipal jurisdictions. It is possible that Broward County will experience build-out within the next decade, which will require planning for redevelopment and redistribution to make best use of limited land resources (Feliciano and Prospero, 2011).

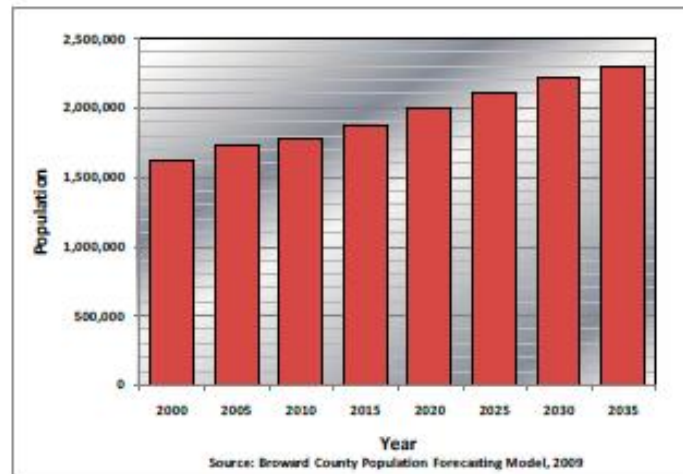


Figure 7. Estimated Population Growth Model Broward County

Environmental Risk Overview

Climate change will have profound impacts on the viability and longevity of the low-lying communities of Southeast Florida. The combination of impacts including rising temperatures, ocean acidification, frequency and intensity of hurricanes, storm surge flooding, extreme precipitation events and sea-level rise pose unprecedented risks, including substantial damage to complete loss of urban and natural systems (Doney et al., 2012, Knutson et al., 2010, Vermeer and Rahmstorf, 2009, Mousavi et al., 2011). These impacts will also have short and long term effects on the levels of available government disaster assistance and recovery costs, insurance rates, and financial risks to public and private insurers (Anthoff et al., 2010, Moser, 2005, Hallegatte, 2009). For example, by virtue of its geographic location in South Florida, all areas of Broward County are highly susceptible to hurricanes and tropical storm-force winds. According to statistical data provided by the National Hurricane Center, the annual probability of a hurricane and tropical storm affecting the area is between 48 and 54 percent per year. Additional data made available through National Oceanic and Atmospheric Administration (NOAA) indicate that the return period for a Category 3 hurricane in Broward County is between 9 and 15 percent per year. The immediate coastal zone and areas along the canals of Broward County are extremely susceptible to potential storm surge inundation resulting from hurricanes and tropical storms.

The main list of hazards facing the region include:

- Severe tropical storms
- Temperature extremes
- Severe wet/dry seasons
- Increasingly strained water supplies
- Sea level rise
- Inland and coastal flooding
- Coastal erosion impacts
- Pressures on natural systems

Box 2. Sea Level Rise Impacts in SE Florida

Sea level rise is expected to have four major impacts in the region that need to be considered in comprehensive planning efforts at a variety of scales, particularly when dealing with the management of public infrastructure:

- (1) Inundation and shoreline recession;
- (2) Increased flooding from severe weather events;
- (3) Saltwater contamination of ground water and surface water supplies;
- (4) Elevated water tables.

Policy and Planning Landscape

The policy and planning landscape of South Florida is complex and busy with multiple actors, responsibilities, decision-making processes, capital programmes, and priorities that are, at times, in direct conflict. The landscape is further confounded by the addition of self-managed entities such as Port Everglades and the Fort Lauderdale/Hollywood International Airport as well as the obvious economic drivers of private sector organisations. The examination of city level planning efforts demonstrate existing tensions between scales as well as disparity in resources currently available for adaptation efforts.

City Level Planning Efforts

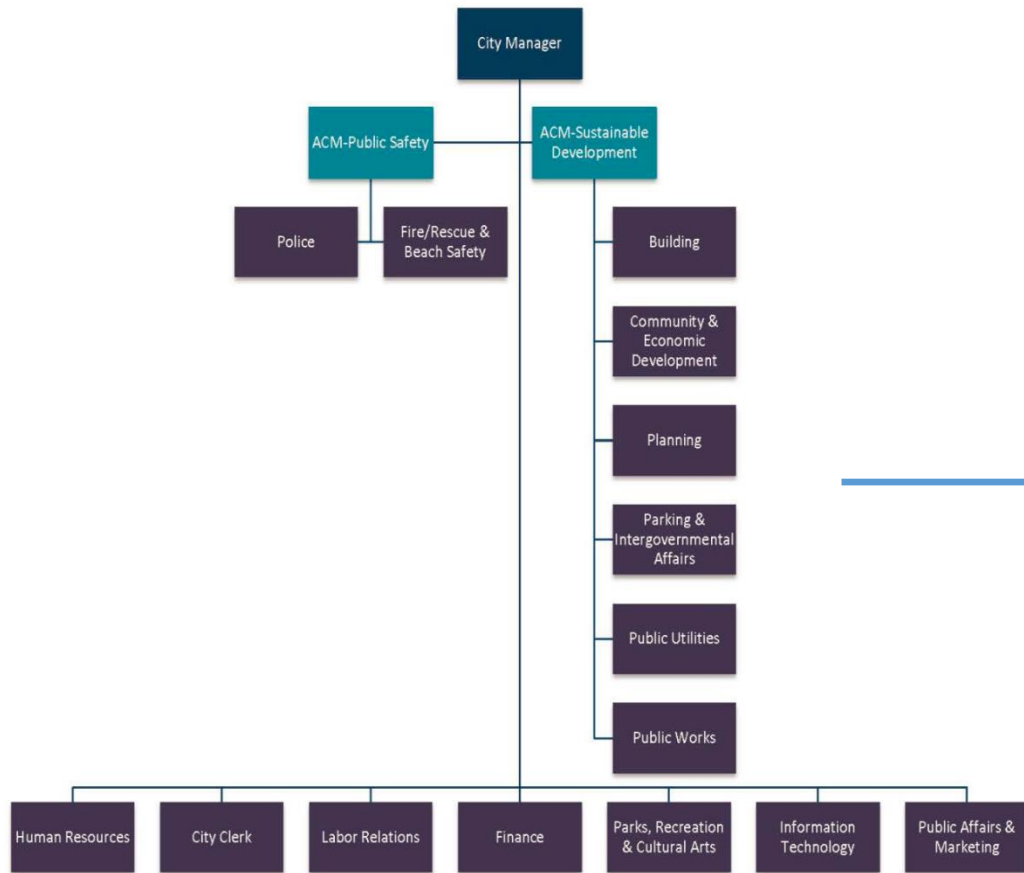
Hollywood

The main planning focus of the City of Hollywood City Manager's Office is a transition plan focusing on sustainable prosperity with the tag line of 'Building on the Past with a New Vision.' This transition plan *'promotes responsible commercial, industrial and office development and redevelopment while enhancing residential quality of life, the preservation of open space and the emergence of a quality, citywide community aesthetic based on sustainability'* and is an important step in Hollywood's economic recovery after having to declare financial urgency in the wake of the 2008 global economic downturn (personally communication, W. Ishmael, 2015). The vision plan aims to align priorities across a range of action areas and enhancement programmes:

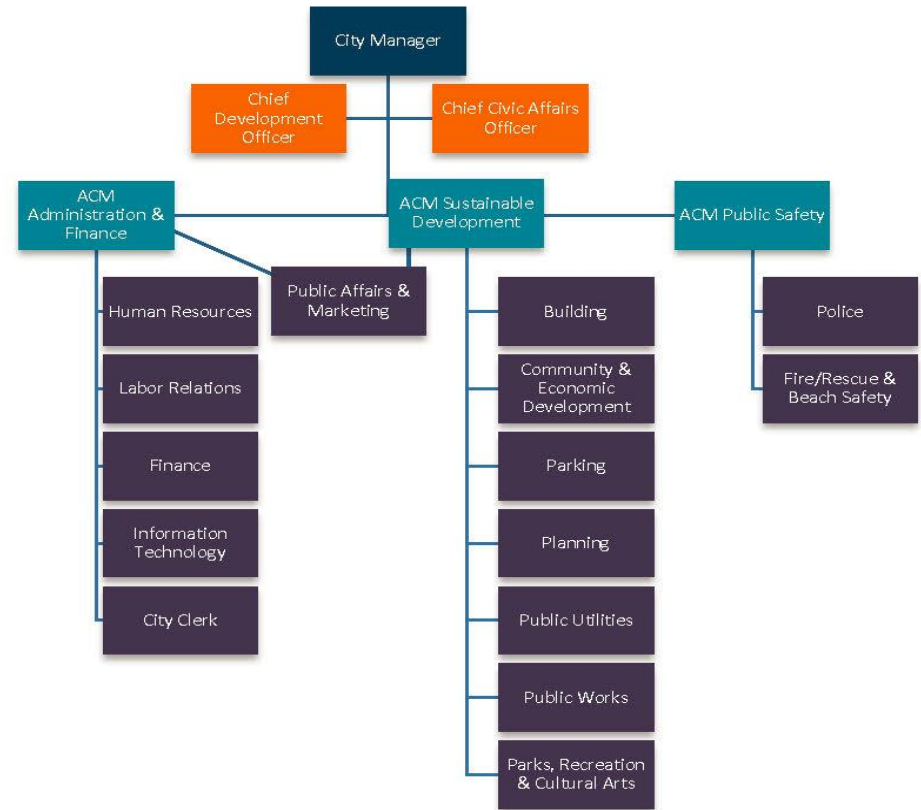
- Business and economic development initiatives
- Property standards and building code enforcement improvements
- Capital improvement projects

Figure 8. Proposed Reorganisation of Administration Structure in the City of Hollywood

Current Structure



Proposed Structure



- Public safety enhancements
- High quality recreation programming
- User-friendly technology for operational efficiency and accountability
- Employee learning, development, and retention
- Succession planning

By its own admission, Hollywood is in a rebuilding phase and has limited financial and human capital to invest in a concerted adaptation agenda although some key actors and organisations recognise the potential opportunity to invest in long term programmes if funding can be secured (personal communication – add quote here). One example of changes that are being proposed in the vision plan can be demonstrated in anticipated changes to the organisational structure of the City Manager’s Office (Figures 8). The new structure represents investment in two additional high level employees within the City Manager’s Office to provide the necessary focus and leadership in the area of finance and administration.

Dania Beach

The main focus of recent planning efforts in Dania Beach have been the promotion of urban development and energy conservation therefore key elements of the current Comprehensive Plan include new land use plans and new zoning regulations. Economic development is highlighted as the most important issue by the Dania Beach leadership team in the wake of the 2008 global downturn which had a large negative impact on the city.

Efforts to incorporate adaptation into city planning documents have focused on the potential use of the [PACE](#) (Property assessed clean energy) legislation although legal restrictions current exist in the State of Florida which is reducing the possible employment of this programme framework. Dania Beach’s efforts to incorporate specific adaptation efforts into legislation have been severely limited by available resources (personal communication, M. LaFerrier)

Fort Lauderdale

Fort Lauderdale, in contrast to the two other study cities, have been very active in the recent past in terms of adaptation planning. Two main documents have been developed recently: i. Fast Forward Fort Lauderdale (Vision Plan) and ii. Press Play Fort Lauderdale (Strategic Plan) and form the basis for a concerted effort to re-evaluate and redesign adaptation efforts on a broad level.



Figure 9. Fort Lauderdale Plan Document Overview (Source <http://www.fortlauderdale.gov/departments/city-manager-s-office/structural-innovation-division/strategic-plan-press-play>)

The *Press Play Fort Lauderdale 2018* strategic plan has been organized within the city’s Cylinders of Excellence and Internal Support Platform, a set of strategic area teams, all of which bring focus and coordination to everyday activities. This framework enables City Manager’s Office workforce to collaborate and innovate. The plan defines a set of [12 aspirational goals](#) and 38 objectives that include 191 strategic initiatives, which are specific, time-bound projects with a five year horizon. As a results-oriented organization, the measurement of performance has been identified by the Manager’s Office as of critical importance. A monitoring framework has been devised that focuses on 142 key performance indicators for both the [2035 Vision Scorecard](#) and the strategic goals. These performance indicators support the budget process by guiding decision-making and resource allocation. Fort Lauderdale have consciously attempted to include and formalise climate change adaptation within the city through concerted efforts, legislation and action items since 2013.

State and County Level

While US national policy on climate change has focused largely on a cleaner energy economy (REF), Broward County has established itself as a leader within the State of Florida for progressive climate adaptation focused legislation and policy (Figure 10) as demonstrated by some of the key initiatives, policies and outcomes over the last nine years.

Planning efforts in Broward County are currently focused on the [Broward Next Initiative](#) as well as maintaining the success of the 4 County Compact. The main focus of Broward Next is a comprehensive review and overhaul of the existing Broward County Land Use Plan to ensure it is more reflective of current conditions and priorities as well as and more responsive to anticipated changes (personal communication, C. Chambers, 2015).

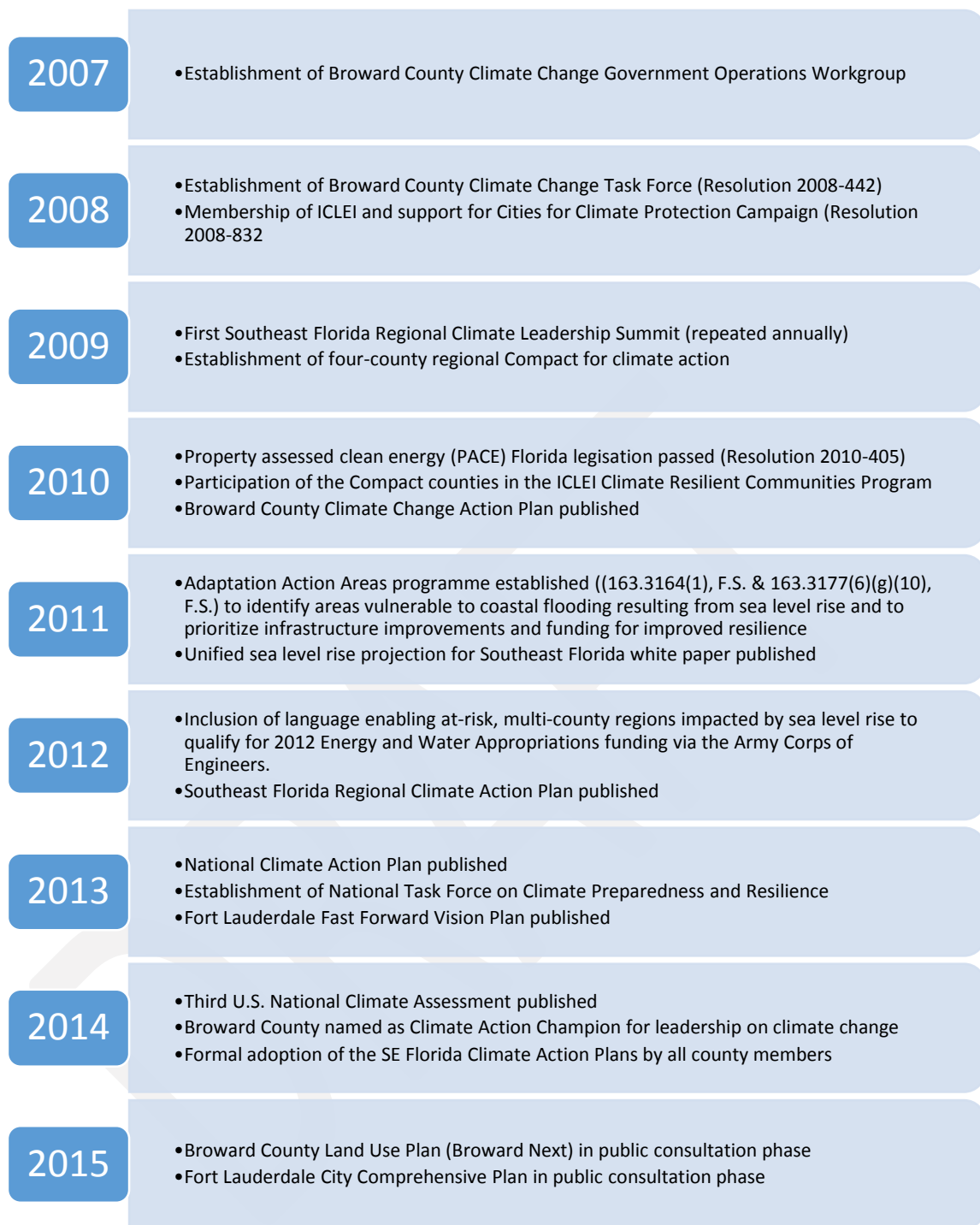


Figure 10. Legislative and Policy Review Timeline for Broward County, Florida

The review will seek identify and ultimately implement more effective policies to facilitate a countywide planning program consistent with the challenges and opportunities of a dynamic community. This goal focused on re-establishing a more balanced relationship among and between municipal and county governments and agencies on issues such as: transit and mobility, affordable

housing, climate change mitigation and adaptation, regional economic development, environmental protection, enhancement and protection of recreation and open space areas, and disaster preparedness. Mechanisms for planning and change being incorporated into the plan include Adaptation Action Areas, a state policy initiative.

Adaptation Action Areas

In 2011, the Florida Legislature adopted the Community Planning Act, HB 720 that provides for a definition of Adaptation Action Areas (AAAs). Subsequent to state action, the concept of Adaptation Action planning moved to the federal level. In that same year members of Congress signed onto a letter supporting the definition of AAAs in federal law and requesting funds to study, define and designate several AAAs. The 4-County Compact members requested consideration by Congress to fund AAAs through the Interior and Environment and Related Agencies Appropriations bill.

The adaptation action area is an optional comprehensive plan designation for areas that experience coastal flooding and that are vulnerable to the related impacts of rising sea levels for the purpose of prioritizing funding for infrastructure needs and adaptation planning. The designation is made on a local government level to improve resilience to coastal flooding. Criteria for the adaptation action area may include:

- Areas below, at, or near mean higher high water•
- Areas which have a hydrological connection to coastal waters
- Areas designated as evacuation zones for storm surge

In 2012, the Florida Department of Economic Opportunity (DEO) used the AAA legislation as the basis for a state focused five year project to integrate sea level rise adaptation into current planning mechanisms, including local comprehensive plans, hazard mitigation plans, and post disaster redevelopment plans (personal communication, J. Murley, 2015). The DEO, in conjunction with additional funding from NOAA, engaged the South Florida Regional Planning Council as the regional coordinating body for the project and the Council is working with Fort Lauderdale, which is serving as one of the state's Adaptation Action Area pilot communities, and Broward County to test adaptation policy options through the Broward Next Initiative.

Southeast Florida Regional Climate Compact

In 2009, the need for regional coordination across counties and cities in Southeast Florida was highlighted by a series of realisations. It was noted by local agencies that the use of different baseline emissions figures at different points of time and different sea level rise planning scenarios was

diluting both message and influence of the region when advocating for climate policy at higher scales (personal communication S. Adams, 2015). This led to a coordinated response by four counties: Broward County, Palm Beach County, Miami-Dade County, and Monroe County. With 5.6 million residents within the geographic boundaries of these four counties (US Census, 2010) representing 30 percent of Florida’s population and Gross Domestic Product, there was an obvious strength in the both the region’s size and economic influence. The [Southeast Florida Regional Climate Compact](#), a voluntary and cooperative partnership among governing bodies, was formed. The Compact targeted and focused collaborative effort on defining a vision and framework for regional resilience.

‘Everything that we do really has been quite frankly driven by local government and has been voluntary. It hasn’t been some sort of mandate from the state or the feds. And I think that, in the beginning, if you have heard about the Compact, that leadership in 2009, I think it was driven by maybe a few individuals and really got the attention and grew from that’

Respondent from the Office of the City Manager, Fort Lauderdale, personal communication, March 2015

The mission of the Climate Compact is to develop a county-wide Climate Change Program to mitigate the causes and adapt to the impacts of climate change and, if appropriate, advise State and County authorities on its implementation. The Task Force is made up of 25 core members, with representatives from Broward County Government, at-large members appointed by the County Commission, Broward County School Board, Broward League of Cities, the Water Advisory Board, Hospital Districts in Broward County, Broward Sheriff’s Office, South Florida Water Management District, academic institutions, environmental organizations, Florida Power and Light, Florida Department of Transportation, South Florida Regional Planning Council, and business and economic interests in Broward County. In terms of structure the Climate Compact has defined seven subcommittees (Figure 12).

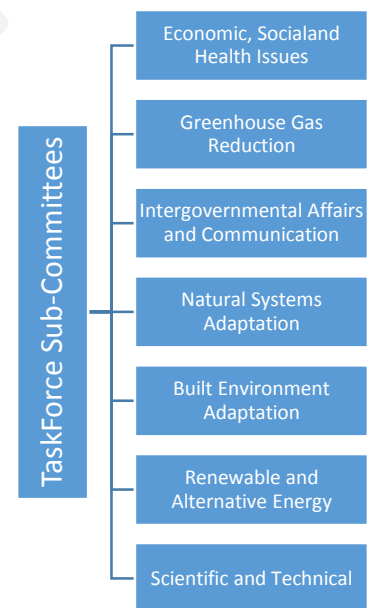


Figure 11. Southeast Florida Regional Climate Change Compact Subcommittees

The Compact committed the four counties to three main actions: i) coordination in development and advocacy of climate legislation at the state and federal level; ii) developing a Southeast Florida Regional Climate Action Plan; iii) hosting an annual summit to document progress and coordinate future activities. In addition, the Compact identified three main types of information that were critical as the foundational basis for regional cooperation: a projection of sea level rise that might be anticipated over time in Southeast Florida, a community-wide greenhouse gas inventory to

understand the main sources of emissions in Broward County and an analysis of the vulnerability of the coastline to sea level rise should no action be taken to address this issue. For planning purposes, all four counties have adopted a projection of 3–7 inches of sea level rise from the 2000 level by the year 2030, a projection of 9–24 inches of sea level rise from the 2000 level by 2060 and 24–48 inches by the year 2100 (Southeast Florida Regional Climate Change Compact Technical Ad hoc Work Group, 2011) (Figure 12).

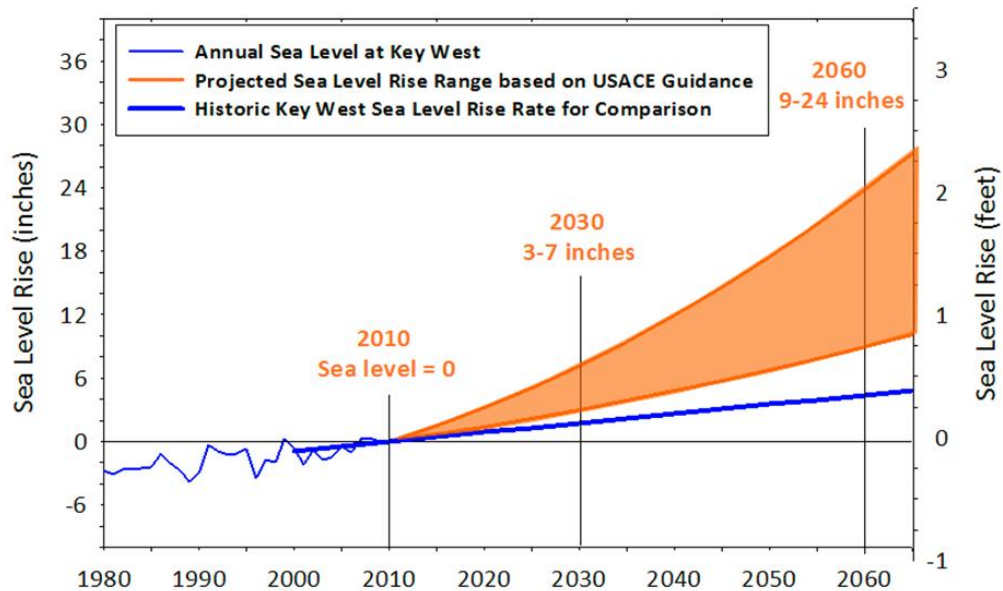


Figure 12. Unified Southeast Florida Sea Level Rise Projection for Regional Planning Purposes. (Source: Southeast Florida Regional Climate Change Compact Technical Ad hoc Work Group)

Southeast Florida Regional Climate Action Plan

Southeast Florida Regional Climate Action Plan recognises the diversity of Southeast Florida and provides a common framework for seven goal areas (Table 2). The Plan contains actionable recommendations related to public policy and outreach in recognition of the fact that a continued commitment to collaboration with local, state and federal policy makers, as well as the non-profit and private sectors, is fundamental to long-term success of the Compact. Additionally, the continued and enhanced role of policy advocacy through regional collaboration, especially during economic and political change is recognised as a critical component of success.

Table 2. SE Florida Climate Action Plan Goal Areas
Sustainable communities and transport planning
Water supply, management and infrastructure
Natural systems
Agriculture
Energy and fuel
Risk reduction and emergency management
Public outreach
Public policy

The plan makes 110 action items that call for concerted action in reducing greenhouse gas emissions and adapting to regional and local impacts of a changing climate. These recommendations were developed through a collaborative process involving subject matter experts from a range of professions representing both public and private sectors, universities and not-for-profit organisations. The recommendations also aim to protect the assets of the region's quality of life and economy, guide future investments, and foster more sustainable and resilient communities (Moger, 2014). The 110 action items have a planning horizon of five years and are to be implemented through several approaches including:

- existing legal structures, planning and decision-making processes;
- the development of new policy guiding documents by local and regional governing bodies; the development of operational guidance documents;
- the development of consistent goals and progress indicators throughout the various governments in the region;
- a coordinated multi-disciplinary outreach and education program; and
- processes for focused and prioritized investments

The development of the Regional Action Plan is expected to be a first step in a process designed to create a more comprehensive policy and action agenda across the Compact County Members on several fronts including resilience and adaptation to climate related impacts.

State Challenges

In March 2015, extensive negative press was generated surrounding the ban of use of the term 'climate change' in government agencies in State of Florida allegedly based on Governor Rick Scott's demands (e.g. http://www.huffingtonpost.com/2015/03/12/rick-scott-climate-change_n_6855006.html, <http://www.miamiherald.com/news/state/florida/article13576691.html>).

This press highlighted a potentially large-scale disconnect between efforts at the County and city level and the larger scale State level which could have longer term impacts on financial and human resources as well as greater restrictions being placed formal collaborations and relationship development. The possibility of such barriers, although as yet unrealised at the time of this research, emphasises the importance of role that informal networks and spaces (shadow spaces) may need to play in the future of adaptation in Broward County. The interaction between the shadow and formal (canonical) spaces, especially how far the canonical can tolerate the shadow without losing key performance goals such as transparency and efficiency, is a key dilemma and threshold point for adaptive capacity (Pelling et al., 2008).

Adaptive Capacity Index

While it is easy to point to a range of climate and resiliency policy initiatives and actions that are ongoing in South-East Florida in general and Broward County in particular, understanding the adaptive capacity of the actors within this crowded landscape is key to generating a picture of the potential success of regional adaptation. The ability of local governments to implement these policies, and for public and private organisations to create opportunities for adaptation, is directly tied to the adaptive capacity of that actor. Therefore understanding potential limitations and barriers at the organisational and agency scale is also critical especially as it has been argued that this is the scale that societal responses to climate related impacts will be driven and implemented (Berkhout, 2012, Eisenack et al., 2014).

The ACI results presented here have been obtained from detailed semi-structured interviews conducted with a sample of 23 experts and representatives of different institutions and organisations that currently populate the environmental risk/climate change management arena in Southeast Florida (Table 3). This index therefore reflects the performance of climate risk reduction and adaptation based on the evaluations of academic, professional and official actors in the region.

Results for 2005, 2010, and 2015 are shown initially in aggregate by framework subcomponent (Table 4) and have been disaggregated by location and sector in further analyses where appropriate. Two of the subcomponents, social & human capital and technological & economic capital, were aggregated for the analysis due to the fact that almost all of the respondents were reluctant to divide these categories during the interview process. Any division of responses would therefore be subjective and an inaccurate representation of the collected data.

The total ACI shows a continuing and persistent trend of progression over the last decade. From 2005 to 2015, all sub-components. Respondents associated this trend primarily with the establishment of the South Florida Regional Climate Compact through which, sub-components such as the ability to learn and the ability to plan for the future were significantly enhanced off the back of such as initiatives as the annual [Climate Leadership Summits](#). The Compact also created more regional certainty in terms of enabling legislation and policy focus which had knock on effects on organisational architecture in the wider context. The establishment of key relationships in the region, having the ability to observe each other, was suggested as the primary reason for the ability to experiment being one of the sub-components that consistently increased over the three time periods. The influence of the Compact has been most notable in the last time period, 2015, as the institutional values become more established and successes are realised in the region.

Table 4. Final Organisational Function Matrix

		FUNCTION							
<u>Broward County Final Sample</u>									
<u>Broward County Organisational Matrix</u>	Land Use/Planning/Management	Environment	Emergency and Risk Management	Transport	Energy and Water	Economy	Social Structure	Health	
ACTORS	Government (local, regional, state and federal agencies)	i. City of Hollywood City Manager ii. City of Fort Lauderdale City Manager iii. Broward County Environmental Planning and Community Resilience Division iv. South Florida Regional Planning Council v. Army Corps of Engineers	i. Broward County Environmental Protection and Growth Management ii. DOI Office of Everglades Restoration Initiatives	i. Broward County Emergency Management Division	i. City of Hollywood Office of Parking and Intergovernmental Affairs ii. Port Everglades Department	i. City of Hollywood Department of Public Utilities ii. Broward County Water and Wastewater Division iii. South Florida Water Management District	i. Greater Fort Lauderdale Convention and Visitors Bureau	i. City of Dania Beach Community Development Department	
	Civil society		i. City of Hollywood Green Advisory Team ii. The Nature Conservancy				i. Institute for Sustainable Communities ii. Shepard Broad Law Center	i. Health Foundation of South Florida	
	Private sector						i. Hazen and Sawyer ii. Advanced Roofing and Advanced Green Technologies		

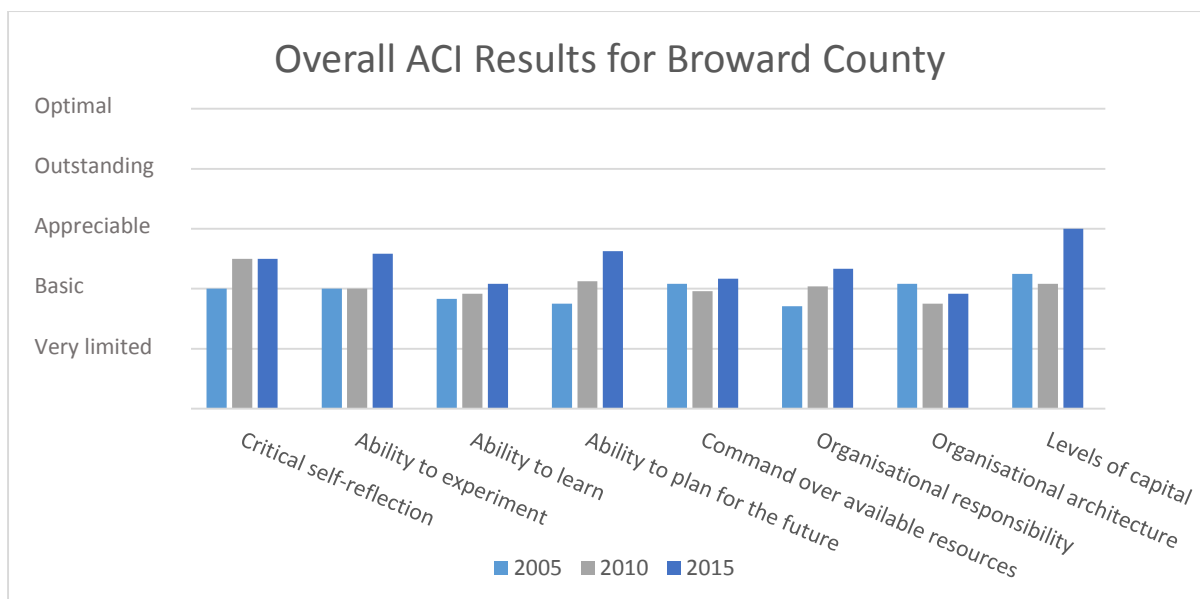


Table 4. Overall Adaptive Capacity Sub-Components Scores

	<i>2005</i>	<i>2010</i>	<i>2015</i>
Critical self-reflection	2.62	2.89	3.18
Ability to experiment	2.66	3.08	3.55
Ability to learn	2.16	2.70	3.08
Ability to plan for the future	2.33	2.90	3.33
Command over available resources	2.39	2.76	3.05
Organisational responsibility	2.26	2.60	3.16
Organisational architecture	2.33	2.72	3.21
Levels of capital	2.61	2.81	3.18

Cross-cutting factors

All respondents regardless of scale or sector noted that access to financial resources, and by extension human and social capital, was as the biggest limiting factor to implementing adaptation actions throughout the region over the decade under investigation. A large part of the restriction on financial investment in adaptation and environmental risk management can be linked back to the 2008 global economic downturn which had major impacts on the economy of the region and Florida in general, an economy with a large tourism influence. The stretched economic climate reportedly made it difficult for politicians at all scales to justify investment in long-term risk planning activities especially in the 2010 time period. Other issues like re-development, quality housing and transport were identified as having a greater degree of urgency and immediacy especially in the smaller cities of Hollywood and

Dania Beach and so investment was made there, at times with detrimental effects to the adaptation agenda at a broader level. The prioritisation of more visible, short term, high political value actions has knock-on effects on several sub-components of adaptive capacity at all scales especially command over available resources which is reduced due to political pressure to deploy existing human and financial capital on specific issues. Efforts to re-invigorate the economy has primarily taken the form of development and construction especially in cities like Hollywood where \$1.5 billion new builds are either currently in progress or scheduled to begin in the near future. Since the need to create investment opportunities was so great, land use planning was compromised in some areas. This led to efforts to revisit and overhaul the Broward County Comprehensive Land Use Plan through the Broward Next Initiative.

The ability to experiment sub-component provided interesting insight with several respondents detailing how the economic downturn actually increased the ability of their organisations to experiment since they were forced to seek out partnerships with both private and public actors that would not have normally been considered prior to a change in conditions. Although this was not always the case, the importance of partnerships and relationships with other organisations and agencies was reiterated by all respondents as critical to successful environmental risk reduction. It was also recognised that relationship between Broward County Offices and the cities were not always as productive as they could or perhaps should be. Specific issues, such as the belief that the County has overstepped boundaries in terms of attempting to influence local land use decisions, were raised by several respondents. This however, has led to a shift in the social contract with the County leadership re-aligning their priorities to focus on regional policy and county land-use planning along with larger scale mapping, hydrologic modelling efforts and risk analyses work that can feed into local decisions rather than the decisions themselves.

City Level ACI Indices

City level indices were generated for both Hollywood and Fort Lauderdale. A lack of sufficient data inhibited the ability to generate a robust index for Dania Beach although these results were included in the overall ACI (Table 3).

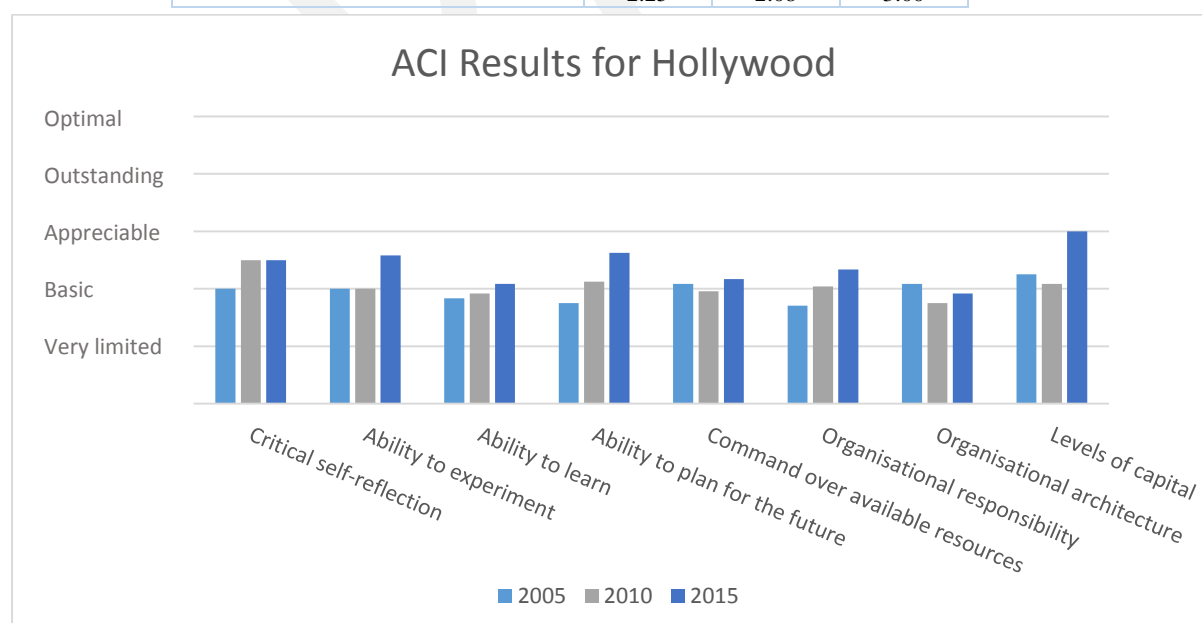
Hollywood

The disaggregation of data for Hollywood showed a reduced level across the sub-components of adaptive capacity in comparison to Broward County as a whole. Part of this can be explained by the fact that the levels of capacity were restricted by financial urgency measures that were employed at the City level in 2011. This obviously would have had implications for the City for several years

before the 2011 implementation of financial urgency. Despite this, the ACI assessment shows that respondents in Hollywood still determined that levels of adaptive capacity were reasonably high in 2005 and 2010. Financial urgency resulted in restructuring of several aspects of organisational structure and architect being restricted and modified in order to maintain a functional working basis. This stagnated results for the capacity sub-components between the first two time periods. The results of the restructuring are starting to be realised in 2015 and this has resulted an increase of financial and human capital as well as an increased autonomy over resources that is reflected in the increasing levels of the most recent time period sub-components.

Table 5. Adaptive Capacity Sub-Components for Hollywood

	2005	2010	2015
Critical self-reflection	2.00	2.50	2.50
Ability to experiment	2.00	2.00	2.58
Ability to learn	1.83	1.92	2.08
Ability to plan for the future	1.75	2.13	2.63
Command over available resources	2.08	1.96	2.17
Organisational responsibility	1.71	2.04	2.33
Organisational architecture	2.08	1.75	1.92
Levels of capital	2.25	2.08	3.00



Hollywood is connected in some aspects to the Southeast Florida Regional Climate Compact although their ability to influence the Compact outcomes is considered relatively limited. As mentioned previously, development, regeneration and prosperity has been the main focus of the Office of the City Manager recently. However, with economic recovery now being felt in the area, the opportunity to look at longer-term issues is beginning to appear:

‘It is the immediacy of our problems. We are here, we are taking care of these things and now we need to look at where we need to go. How do we have that sustainable prosperity and what actions do we need to take to get there? One of those actions is the sustainability coordinator and developing a sustainability action plan’

Respondent from the Office of the City Manager, Hollywood, personal communication, March 2015

There is an expectation in Hollywood that the majority of the planning, risk and vulnerability assessment work should be done at either the County level or Regional Planning Council level as opposed to the City level. This reinforces the desire and need to be part of a larger, more comprehensive effort that incorporates critical initiatives that are ongoing within the Hollywood boundaries but that the City has no authority over such as the [South Turning Notch Extension](#) at Port Everglades and the [Green Airport Initiative](#) at the Fort Lauderdale-Hollywood International Airport. Relinquishing responsibility and authority for planning efforts to a higher scale agency potentially reduces the influence and voice of the city itself but may be a more appropriate scale at which to tackle wide-spread, large impacts such as climate change. This series of trade-offs and expectations must be carefully at both County and the City scales to ensure expectations and implied social contracts are not violated.

Fort Lauderdale

The disaggregation of data for Fort Lauderdale revealed an increasing trend over the three time periods with a marked difference between the years of 2010 and 2015 for all measures of adaptive capacity (Table 6). There is some variation in the rates of improvement across the sub-components with ability to experiment, critical self-reflection and organisational architecture being the strongest aspects and the levels of capital being the weakest. The ability to plan for the future and the organisational architecture demonstrate the greatest improvement over time. It should be noted that for the 2015 time increment the respondents indicate a greater than ‘appreciable’ score of the 5-point scale for all ACI sub-components signifying that activity is planned and strategic. This increase was continually attributed to two specific actions i) involvement in, and development of, the Southeast Florida Regional Climate Compact and ii) strategic hiring of individuals with a specific resilience/sustainability based mind-set and qualification background. While recent efforts have been driven by individuals and through more informal channels and shadow spaces, the desire to institutionalise both mentality and action through planning changes is strong with the City hierarchy.

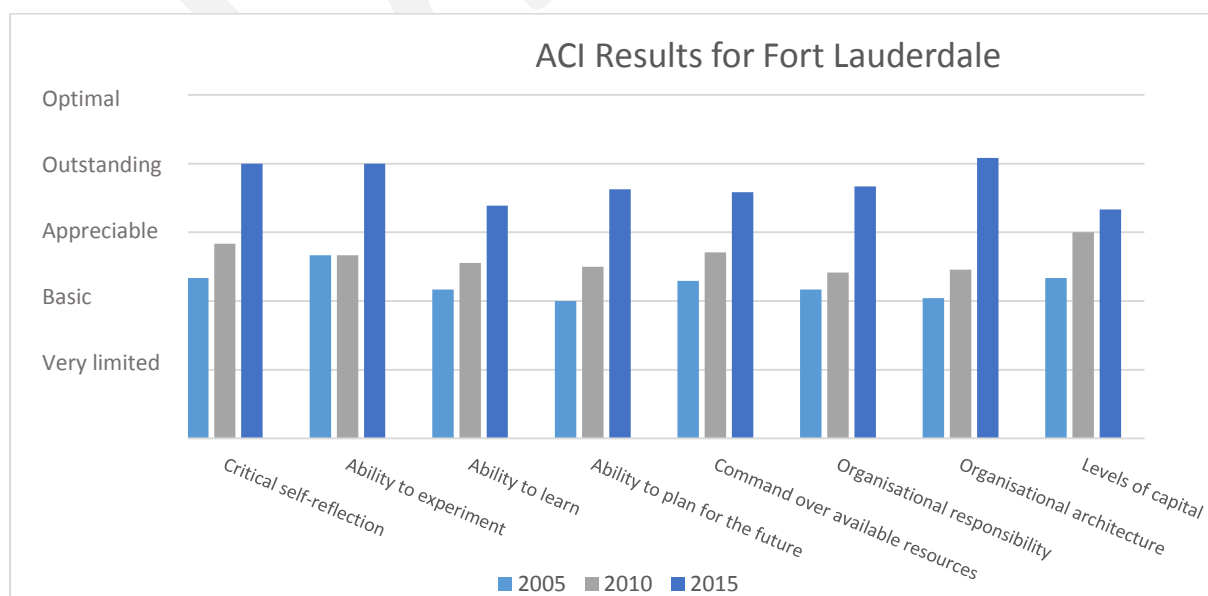
This desire has resulted in the ongoing reassessment of organisational goals and structure and the realignment of resources towards long term adaptation efforts as well as the development of capacity across city divisions, results which are demonstrated by the high ACI levels currently present in Fort Lauderdale as a whole. While the availability of resources was highlighted as a significant barrier to success, the development and subsequent implementation of city-wide planning documents represent the necessary foundation for Fort Lauderdale to become an adaptation leader in the region and beyond.

‘Of course we are always looking for grant opportunities, we have our eyes open but its more about what we already do and doing it through that lens of climate change resiliency, understanding sea level rise, understanding data that are now available and then how do our engineers use that, how do our planners use that. It’s connecting the dots and making those strategic alignment across all of operations and then across all of the City’

Respondent from the Office of the City Manager, Fort Lauderdale, personal communication, March 2015

Table 6. Adaptive Capacity Sub-Components for Fort Lauderdale

	2005	2010	2015
Critical self-reflection	2.33	2.83	4.00
Ability to experiment	2.67	2.67	4.00
Ability to learn	2.17	2.56	3.39
Ability to plan for the future	2.00	2.50	3.63
Command over available resources	2.29	2.71	3.58
Organisational responsibility	2.17	2.42	3.67
Organisational architecture	2.04	2.46	4.08
Levels of capital	2.33	3.00	3.33



County Level ACI Index

The results for Broward County show a similar trend to that of Fort Lauderdale with a progression across all of the sub-components (Table 7). With the exception of critical self-reflection, all sub-components returned a result of greater than ‘appreciable’ on the 5-point index scale. However, the greatest rate of change in adaptive capacity sub-components occurred between 2005 and 2010. Efforts to make climate-induced impact management a dedicated function of County government agencies began formally in 2007 with the integration of sea level rise into hydrological modelling due to the constrained nature of water supplies by the salt water front of the Biscayne Aquifer. The establishment of the Southeast Florida Regional Climate Compact in 2008, an initiative in which individuals within Broward County government were highly influential, was a catalyst for greater planning efforts at the regional scale.

Another factor that had a large impact on the adaptive capacity of Broward County was the reorganisation of division and departmental structure that occurred in 2009 as a result of the 2008 economic downturn. This allowed several divisions to be rehoused under the Environmental Protection and Growth Management Department including Emergency Management. This action increased the connectivity and integration of wider community resilience planning efforts as well as encouraged information sharing and learning between the divisions through cross training programme development. These actions had a large impact of perceived and actual levels of adaptive capacity within Broward County as a whole, as is reflected in the 2010 ACI results.

‘In this agency it would now be more likely that we would have people who are involved in planning and policy. For example, before the reorganisation Emergency Management used to be independent and before that it was part of the fire department. So when you take agencies and you put them somewhere else you change the paradigm. When you switch from boots on the ground to planning, then you change their focus so I think there was a paradigm shift with the changing of the director there that made them more accessible and supportive of what other divisions were doing’.

Respondent from the Environmental Protection and Growth Management Department, personal communication, March 2015

While quantity of resources at the County scale is appreciable when compared to city budgets, the increased expectations related to planning that now exist in terms of the cities represents a potential pitfall for the County considering the demands on current budgets. The influence of state mentality towards climate change may also create barriers when planning efforts shift towards the implementation of such plans which may affect the assessment of adaptive capacity at future time periods. There is also concern at the County level that the planning horizons of critical infrastructure managers such as public utility agencies and telecommunications companies may not be sufficient

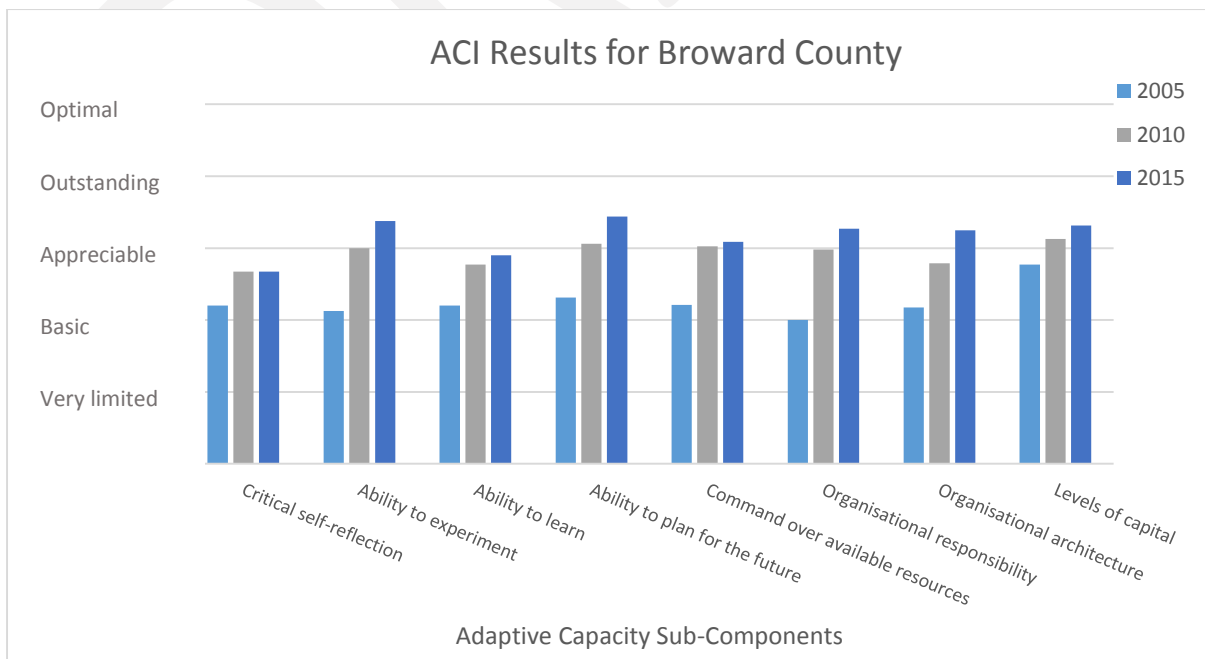
since ‘a lot of the utility folks tend to only operate on 10 year time-frames and they are really not concerned about what that system looks like in 30 years’ (personal communication, 2015). While the County government agencies may be responsive to absorbing responsibility for planning efforts, the success of those efforts are reliant on other organisations, both public and private, across a range of sectors.

‘The difficulty that we will have is when you show the modelling and say well this is what the impacts look like in 2055 and that gives us 45 years for the investment but it’s not as if its business as usual until that point you are eroding in the meantime and so how are we going to incrementally organise those resources in order to be responsive as you are having to transition’.

Respondent from the Environmental Protection and Growth Management Department, personal communication, March 2015

Table 7. Adaptive Capacity Sub-Components for Broward County

	2005	2010	2015
Critical self-reflection	2.20	2.68	2.68
Ability to experiment	2.13	3.00	3.38
Ability to learn	2.20	2.77	2.90
Ability to plan for the future	2.31	3.06	3.44
Command over available resources	2.21	3.03	3.09
Organisational responsibility	2.00	2.98	3.27
Organisational architecture	2.18	2.79	3.25
Levels of capital	2.77	3.13	3.31



Sectoral ACI Indices

The analysis of ACI results by sector demonstrates the potential for the results to be influenced by National and Federal Agencies whose ability to access and command resources is greater than at the local level. This is particularly noticeable across the land-use/planning/management sector, the environment sector and the energy and water sector. Organisations such as the U.S Army Corps of Engineers, the Office of Everglades Restoration Initiatives and the South-Florida Water Management District reinforce this point across each sector respectfully. In contrast the results for the transport sector were confined to more local organisations and so did not receive the same influential boost. Overall, results across sectors demonstrate a high level of adaptive capacity in Broward County.

One of the two non-governmental sectors, the environmental/civil society, demonstrated a similar pattern to many of the governmental sectors with a sustained level of increased across the ACI sub-components for the three time periods. While results between the 2005 and the 2010 time periods show little change, there is a marked change for 2015. This corresponds with an increasing influence of the non-governmental sector in the policy making arena through involvement in the Southeast Regional Climate Compact. As that influence has increased, so has the ability to learn and to plan for the future. Levels of capital remain high across all time periods due to the maintenance of core social support for NGOs even in times of economic downturn.

The economy/private sector in Florida was shown to be more susceptible to shifts in the economy due to supply and demand for services although the organisations that participated in this research showed little change between ACI sub-components for the three time periods. This was mainly due to two key factors. Firstly, private organisations must maintain a high level of flexibility and responsiveness as a baseline in order to survive in the business landscape therefore large changes across some sub-components would be unexpected. Private sector organisations must also answer to shareholders and respond to profit margins suggesting that circumstances may dictate rapid changes to structure beyond the control of individuals within the organisation. Secondly, in general, private sector organisations are more adept at looking critically at themselves and analysing their organisational functions in order to survive in a competitive landscape. Organisational assessments have become commonplace in the fight for market share and the competitive edge. This would typically result in a lower overall ACI results than other sectors due to the fact that the organisation under examination already has a baseline to compare performance to. This situation is much less common in governmental organisation and one that may lead to potentially inflated results in some sectors.

Table 8. ACI Results by Sector

	Land Use/Planning/ Management	Environment	Emergency and Risk Management	Transport	Energy and Water	Economy	Social Structure	Health
Government (local, regional, state and federal agencies)			Insufficient data			Insufficient data	Insufficient data	
Civil society							Insufficient data	Insufficient data
Private sector								

Key: 1. Critical self-reflection, 2. Ability to experiment, 3. Ability to learn, 4. Ability to plan for the future, 5. Command over available resources, 6. Organisational responsibility 7. Organisational architecture, 8. Levels of capital ¹

¹ Sufficient data for a robust analysis was not collected across some sectors of the analysis as is reflected in Table 8. In most cases this was because only one respondent in that sector was available for interview during the study lifespan.

In some specific sectors, the refusal of some respondents was as a direct result of media coverage surrounding the term ‘climate change’ and Governor Rick Scott in March 2015 when the data for this study were being collected. This resulted in several key interviews being cancelled at short notice.

DRAFT

Key Findings and Discussion Points

Two events have been shown to have had a major effect on adaptive capacity in the Broward County region over the last decade: i) the 2008 economic downturn and ii) the establishment of the Southeast Regional Climate Compact in 2009. Both events have had positive and negative impacts of the environmental risk management landscape from 2005 to 2015, affecting governmental agencies and private sector organisations differently.

The overarching amount of resources, and the ability to allocate those resources, were significantly reduced by the economic downturn especially in the smaller cities in the study area. According to several respondents, this forced organisations with responsibility for environmental risk management in the Southeast Florida region to develop closer relationships and develop enhanced learning mechanisms in order to maintain a level of effective management. As such, the overall measure of adaptive capacity was not negatively affected as might have been expected but instead in some cases, due to shifts in organisational interactions, networks and information sharing practices, levels of were maintained or even shown to have increased during the 2005-2010 time period. This state was further enhanced by the establishment of the Compact in 2008-09 which focused regional efforts around specific threats and actions as well as created an impetus for investment.

While bearing this in mind, it is however clear that differences between county level and some city viewpoints have become more marked over time with differences in adaptive capacity becoming more increased, with Fort Lauderdale being the exception. Bridging the gap between higher order organisations and local capacities is a common and recurring challenge associated with adapting to climate change and environmental risk management. Both Hollywood and Dania Beach have realigning their own governance goals in the face of change, turning inward towards the prioritisation of shorter term, locally visible projects rather than embarking on longer term planning exercises aimed at understanding and coping with '*highly variable and highly uncertain*' impacts of climate change (personal communication, 2015). These short term rapid development goals have primarily been brought about by economic and political pressure as the region seeks to recover and generate growth following the 2008 economic downturn, however, the fear for some respondents is that this divergence in practices has encouraged a reliance of local, small city level on higher order organisations and agencies, a dependence which could actually reduce the capacity levels at that scale. One example regularly used to provide context was that of land use planning.

There is currently a reliance on Broward County and the South Florida Regional Planning Council officials to lead land-use planning efforts in the region. This is understandable from expertise, scale and resource perspectives. This reliance not only includes data generation and planning efforts but also the vital linkage of information and knowledge dissemination from the County to all cities and organisations involved in the environmental risk management arena. For instance, the County has developed enviable expertise in hydrological modelling and vulnerability mapping and, in partnership with federal agencies such as the USGS, is in the position to develop an understanding of many of the risks the region faces, especially in terms of water resources. However, this expertise is not replicated in the smaller cities in Broward and ultimately, many planning decisions taken by the County may be misconstrued by city staff due to a lack of knowledge and understanding, compounded by unsuccessful or inaccurate communication.

The County has land use authority over the cities. In other words if we change our land use plan then we have to get it approved by the County and they can deny land use changes. What they have done recently has been more beneficial but previously they were very punitive about how they judicially dealt with those land use changes. Most cities want to urbanise and they want redevelop and the County wouldn't really allow that. But what the County has done recently is that they have changed their policy so the plan is more generalised. It has been a bone of contention, there hasn't been good coordination between the cities and County on land use for a while.

Respondent from Dania Beach, personal communication, March 2015

While the consequences of this reliance may not be that keenly felt at present due to the fact that the main focus of the region is on planning, the real impact of a reduction of adaptive capacity at more local levels will be noticeable as the shift from a planning mind-set to the implementation phase occurs at multiple scales. This reinforces the need for enhanced information exchange and communication between actors. These findings indicate that County support for adaptation is either finding it more difficult to reach smaller city actors, or that policy is not having as much impact at this level than the county. This suggests that there are important gains to be made at the local orientation through increased support especially in Hollywood and Dania Beach, while simultaneously working with State level actors to maintain or in some cases create a supportive institutional architecture.

During the discussions had with respondents it became clear that many excellent adaptive practices are already being undertaken in Southeast Florida in general and Broward County in particular. Yet, these practices are not always systematically recognised and the adoption of such practices is not uniform across the region. This perhaps highlights a key challenge for sub-county actors caught between the desire to innovate and adapt and the very real need to attract external support to i) embark on large-scale infrastructure improvements that are more aligned with regional risks, ii) take action to increase staffing levels to improve adaptive capacity as planning efforts shift towards implementation,

iii) maintain public support in the face of financial constraints and changing environmental conditions in order to justify investment on a political level.

The interviews raised several key areas that represent opportunities and constraints and provide possible recommendations for action at a variety of scales. These include:

1. Multi-directional learning and public engagement

Fort Lauderdale has a very engaged citizenry and an extensive data collection process is currently in place through their resident satisfaction surveys programme as well as strong linkages with home owner associations. Hollywood is maintains connectivity to the wider public through their Green Team of volunteers which provides public input in a formal advisory role. Both cities have created mechanisms which provide at least some scope for knowledge transfer between government organisations and stakeholders and residents as well as for increased accountability and transparency. In contrast the County and higher order agencies have a more reduced interaction with the general public due a combination of organisational mandate, available skill sets, organisational will and need.

‘Dissemination is one of our biggest challenges, to figure out what information is useful for the public and then how to distil it into information that the public is both interested in understanding and that either act on or can understand how they can interface with that information. We are trying. It’s general efforts of community engagement that we struggle with’

Respondent from a Federal Government Agency, personal communication, March 2015

The varying levels of engagement and public involvement provides an avenue for criticism in terms of procedural justice and limits the potential for more public ownership of, and investment in, adaptation efforts. A greater understanding of public viewpoints and values provides leverage and defensibility of adaptation actions while ensuring less need for ‘command and control’ policies.

2. Information exchange and coordination

Building further on the multi-directional learning concept, respondents highlighted the need for good information management systems to provide mechanisms for information generation and exchange both with the public and with other organisations. Communication was identified by multiple respondents as the key to success for adaptation in the region and yet lack of communication and strained communication between County and city organisations was repeatedly mentioned as a barrier that has affected efforts to date. As the difference between adaptive capacity sub-components continues to grow the potential for greater communication issues to become a reality is a challenge that needs addressing at all levels. While events such as the Annual Leadership Summits organised by

the Compact will aid this exchange, there is a very real need for an extensive communication strategy between risk management actors at all scales.

3. Responsibility devolution and resources

With responsibilities for long term planning currently being assumed by the County, there is a very real possibility that a shift in responsibilities will occur in the future as the planning phase morphs into a more implementation driven agenda. This shift is expected to take place in the form of responsibility devolution, however, there is a very real set of questions that surround the devolution of both power of decision making and available resources. For instance, the need to modify, update (climate-proof) and replace aging critical infrastructure is recognised across the County by all respondents.

‘We know we are going to have to rebuild structures and rebuild canals but don’t do it for tomorrow, do it for 20, 30, 40 years out so what is the answer for that, what do you need to have. We currently invest about \$50 million a year on just rehabbing old existing infrastructure we have so if you are going to spend \$50 million can you improve it not just replace, can you improve it for the people who live here or for an increased population or for their environmental outcome’

Respondent from the South Florida Water Management District, personal communication, March 2015

It is also recognised that, to a large extent, cities will have to be responsible for the upgrades needed across many diverse systems such as transport, housing, utilities and coastal defences. The concern is that the increased cost of upgrading systems to specific climate risk scenarios will also have to be absorbed by the cities at a time when budgets are already stretched beyond capacity. This devolution of responsibility without resource is a difficult one to negotiate, especially with the multi-tiered governance system in the USA, and often results in the disenfranchisement of smaller cities who lag behind larger one in terms of adaptive capacity and access to resources. It also leads to cities having to way up a series of trade-offs between long term, high cost improvements to infrastructure and shorter term, politically acceptable decisions that may not have the same influence or risk reduction effects.

The Compact has been identified as a potential avenue for joint federal funding applications that could be used at both the regional and the local level however no specific strategies for such as initiative were highlighted by any respondent during the interview process. The development of such a strategy or series of strategies presents a great opportunity for the region as a mechanism to ease the impacts of responsibility devolution without resources conundrum that often impacts adaptation efforts in smaller scale cities.

4. Formal and informal networks

The importance of the shadow space was regularly highlighted by respondents with many stating the adaptation efforts and levels of adaptive capacity would have stagnated in the region if it were not for

individual relationships and informal avenues of collaboration in the face of institutional and political barriers. Two main reasons were given in explanation of how these important relationships had been formed. Firstly, many individuals have remained in positions of technical authority and influence in the County and city arenas even when they have moved jobs therefore allowing a continuity of network to be maintained. Several individuals have moved from County to city, from city to city in southeast Florida, from city to Federal agency based in the Florida but retained similar functions in their new positions providing opportunities to continue to engage with the same colleagues and professional networks as before thereby reinforcing existing ties and providing a productive shadow space in which to operate. Secondly, the strategic employment of certain individuals in key positions has allowed created an overriding culture of action-mindedness despite the very real presence of barriers at the State and National levels.

The best example of the importance of the shadow space can be found in the development and success of the Compact which was driven by individual action and not by formal legislative efforts. This does however create the possibility of a multi-tiered system where personalities are the basis for interaction and not organisational or policy mandates. The fear within smaller cities is that individuals will prioritise those relationships above the region's needs and be drawn to working within a 'safe' network as opposed to higher risk areas. Although no direct evidence was found to support this fear during the time of this study, the closed nature of the shadow space was mentioned as a potential source of conflict by some respondents.

Challenges and Limitations of the Broward Study

One of the major limitations of this study is the lack of sectoral spread. This was due in part to the unforeseen circumstances of media coverage regarding climate change and the State Governor resulting in the cancelation of a number of interviews especially with State level agencies representing both emergency management and the economic sector. The use of the Environmental Protection and Growth Management Department of Broward County as a communication broker in order to maximise interview numbers through the leverage of existing relationships may have also limited the community available for contact and inadvertently biased the sample although every action possible to avoid this bias was employed by County staff and the Metropole Project team alike.

A second challenge is the possibility that respondents provided an inflated sense of the ability of their organisation and of the region to adapt to change. There is potentially a large culturally influence to this challenge with organisations not wanting to lose face in a more formal interview setting and also wanting to represent current efforts in the most positive light. The need or want to be self-critical may

also have presented a challenge for some respondents who were being asked to participate as representatives of specific organisations rather than provide their personal opinions.

Conclusions

The ACI analysis of organisations involved in environmental risk management in Broward County, and its surrounding key influencers at higher scales, indicates some areas where positive movement can be enhanced so that gains that have been demonstrated over the last decade take advantage of incorporating the lessons from such as adaptive capacity assessment. From this basis many of the options for enhanced adaptive capacity that are concerned with learning, information, responsibility devolution and networks can be approached.

Summarising the analysis of the ACI five key recommendations can be made:

1. Increased connectivity between, and understanding of, local efforts and activities driven by sector and local specific concerns and County risk management and planning and development architecture
2. Increased transparency of decision making processes at higher scales to enhance local knowledge levels and understanding
3. Development of an integrated grant application strategy across the region, e.g. through the Compact, to compete for Federal resources to support critical infrastructure upgrades at the more local level with increased local scale oversight
4. Increased advocacy for experimentation and adjustments to help support those in the region who are beginning to implement adaptive practices
5. Review existing management priorities, organisational structures and governance with a view to identifying efficient pathways for mainstreaming adaptation into the policy and legal framework, with specific advocacy efforts at the State level wherever possible, including a focus upon the balance of capacity and responsibility between State/County and more local or sector specific actors.

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