Ocean & Coastal Management 59 (2012) 77–82

Contents lists available at SciVerse ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Policy and management hazards along the Upper Texas coast

Garrett Dolan [a,*], Davin J. Wallace [b]

[a] Severe Storms Prediction, Education and Evacuation from Disasters Center, Rice University, Houston, TX 77251, USA
[b] Department of Earth Science, Rice University, Houston, TX 77251, USA

ARTICLE INFO

Article history:
Available online 4 January 2012

ABSTRACT

Coastlines are some of the most populated and rapidly expanding areas of the United States. Here, people seek employment, build residences and facilitate urban growth. However, most people do not fully realize all of the risks associated with living along a coast. Relative sea-level rise, erosion, and severe storms continuously alter the landscape. Anthropogenic interventions designed to slow these natural processes often foster decline at a greater rate. Building residences and other permanent structures further exacerbates the problem. Along the Upper Texas coast, public policy intended to protect and make life more viable is actually creating "moral hazards" and escalating the financial burdens on government. This article identifies several public policies at the local, state and federal levels of government that are working at cross purposes by allowing risky investment decisions that put people's livelihoods in jeopardy. The authors conclude that a different, more sustainable set of policy options is required and offer several recommendations for consideration.

© 2012 Elsevier Ltd. All rights reserved.

1. Introduction

Since the late 19th century, the Upper Texas coast has had a prosperous history of shipping and trade, with a relatively dense population (Sealy, 2011). Currently, population growth in Texas has been occurring at some of the highest rates in the nation. Between 2000 and 2010, the U.S. Census Bureau announced an increase of 20.6% (4,293,741) to 25,145,561 people (United States Census Bureau, 2011a). Along the Gulf of Mexico, the Upper Texas coast (Houston-Sugar Land-Baytown) is one of the fastest growing regions in the country (United States Census Bureau, 2011b), and coastal counties in general had the third highest percentage change in the United States between 2000 and 2009 (United States Census Bureau, 2011c). The significance of a dense coastal urban population regularly threatened by hurricanes cannot be overstated. The more people there are living in this area, the greater the potential for harm. Additionally, demographic characteristics such as poverty and the elderly, point to population groups that are especially vulnerable to hurricanes because of their compromised ability to react and move to safety. A recent analysis using the U.S. Census data showed that the total population living in hurricane evacuation zones along the Upper Texas coast has increased from 1.365 million in 2000 to 1.563 million in 2010; over the same time, the percentage of socially vulnerable[1] people has increased from 51% to 56% (Messen, 2011). Growth also brings with it an increased pressure on natural resources that threaten the sustainability of ecosystems which provide these economic benefits. Population pressures, in combination with the major natural processes reshaping the coast (i.e. subsidence, sediment supply and transport, global sea-level rise, and tropical cyclones) are projected to continue transforming the shoreline and raise the potential risk for catastrophic floods (Anderson, 2007). Hurricane Ike's destruction in 2008 (Berg, 2009) is a good example of the adverse consequences of natural events impacting the region's urban centers. In fact, according to the National Oceanic Atmospheric Administration's National Climatic Data Center, the Texas Gulf Coast is a leading contributor to the "BILLION Dollar Disaster List" (U.S. Department of Commerce, 2011). The challenge for policymakers is to understand if policies under their sphere of influence are increasing the potential for disasters to occur. If so, an opportunity is available to proactively mitigate the hazard in a more sustainable manner.

* Corresponding author. Rice University, Civil and Environmental Engineering, 6100 Main Street, P.O. Box 1892, MS-317, Houston, TX 77251-1892, USA. Tel.: +1 713 348 4257; fax: +1 713 348 5239.
E-mail address: gdolan@rice.edu (G. Dolan).

[1] Social vulnerability is an emerging concept in natural hazard management (Blaikle et al., 2004). It describes the attributes of a person or group in terms of their capacity to anticipate, manage and recover from the impacts of a natural hazard. The three socially vulnerable characteristics used in this paper include those living in poverty, those over the age of 65 and those that may not understand the English language and are categorized by race/ethnicity.

0964-5691/$ – see front matter © 2012 Elsevier Ltd. All rights reserved.
doi:10.1016/j.ocecoaman.2011.12.021

2. Hazardous choices

Effectively managing coastal environments requires a delicate balance between addressing development desires while managing risk. Issues about where people live, ownership rights, accessibility and emergency management programs all need to be considered. Local, state and federal governments work to manage these issues but despite having their best intentions in mind, "moral hazards"[2] occur.

Moral hazards are concepts based on the premise that people will make decisions and take actions based on their own self-interest if the proper incentive is in place. Subsequently, people might overlook the adverse moral implications of their choices.

The etymology of moral hazards comes from two distinct historical pathways: insurance industry and economic decision making. Dembe and Boden (2000) believe the word originated in the 17th century to describe the tendency for insurance plans to encourage behavior that increases the risk of insured loss. In these scenarios there is a clear element of fraud or immoral behavior. However, economists in the 20th century conceptualized moral hazards as inefficiencies in the market system whereby risks are disassociated from gains. While economists' understanding of the term was subjective and slightly different from the insurance industry, they both share a common reference to the disassociation of risk from benefit.

Here, the authors use the term moral hazard to refer to situations where one party (i.e. individual or institution) exposes themselves to risk and does not fairly assume the full consequences and responsibilities of their actions. Consequently, they may accept extra risk knowing that if there is catastrophic failure a third party, often society, will shield them from their loss. In this paper, two stipulations are defined: 1.) in order for something to be a moral hazard there must be an immoral basis for acting. That is to say, there must be pre-purchase knowledge that one party is willingly perverting the insurance or bail out program's intended purpose for personal gain, and 2.) moral hazards can originate from societies, governments, cities, developers, and individuals. For example, the Federal Emergency Management Agency (FEMA) subsidizes the cost of flood insurance for homeowners living in hazardous areas. When private homeowners buy insurance, they are legitimately transferring some of the risk onto FEMA. However, conceived with the good intentions of protecting homeowners from potential disasters, the program has evolved into a system of incentives giving rise to ineffective and sometimes hazardous public policy. Below are four key categories.

3. Moral hazards of greatest concern along the Upper Texas coast

3.1. Policy paradoxes

3.1.1. Safe development paradox meets the local government paradox

Current public policy can create moral hazards through a development and government paradox scenario. Consider the following: tens of thousands of people build their homes on low-lying land only made available through raising a barrier island and erecting a seawall. This structure is a real engineering achievement constructed to protect residents from all but the largest hurricane impacts. People migrate into the area to take advantage of relatively low-cost land and build communities. Only a few can afford flood insurance but this is largely overlooked by the local government in favor of new property tax collection. Over time, the communities grow into cities, forcing expansion into exceedingly more hazardous areas due to a lack of appropriate restrictive policies, and thereby substantially increasing the geohazard potential. This is the situation Galveston Island (Fig. 1) found itself in when Hurricane Ike impacted the area in 2008, making it one of the most costly and deadliest storms ever (Blake et al., 2011). The example reflects the intersection of two policy paradoxes that combine to form a greater societal moral hazard. It starts with a safe development paradox where government tries to make a hazardous area safer by offering insurance but inevitably increases the potential for catastrophic property destruction and economic loss. Compounding the matter, the local government's paradox is that while their citizens bear the brunt of suffering and loss, they have neither paid sufficient attention to limiting their vulnerability nor have they the resources to adequately recover (Burby, 2006).

Along the Upper Texas coast, the construction of more levees is being considered to help protect the area from future hurricane storm surges. If the region follows a development path like that of New Orleans (Grunwald and Glasser, 2005), it is easy to see how new societal moral hazards could arise. If, however, there was a concerted effort to prevent future hazards, several public policy options should be considered which include:

- prohibiting or minimizing investments of fixed assets in flood prone areas (Blackburn and Denney, 2010)
- encouraging policy that minimizes the expenditure of public money to evacuate and house those most vulnerable (i.e. low income, disabled) if they have been previously warned of the hazard
- minimizing the development of any government facilities (i.e. prisons) that would require additional public sector expenditures to evacuate inhabitants and rebuild damaged structures
- implementing non-structural mitigation measures that reflect community based adaptation measures such as "social learning" (Eriksen, 2011)
- making living in the area conditional on the purchase of flood insurance, even for those who own a building outright (Blackburn and Denney, 2010)
- increasing the standard for hazard mitigation planning requirements that applicants must achieve if they want to be eligible to receive FEMA hazard mitigation money.

3.2. Applicable acts

3.2.1. Texas Open Beaches Act

Passed in 1959, one of the main goals of the Texas Open Beaches Act (TOBA) is to define public versus private land along coastal shoreline environments. Beaches in Texas are for public use, and historically have been used for transportation, commerce, and recreation (In the Supreme Court of Texas, No. 09-0387). TOBA effectively guarantees the public's access to State of Texas owned beaches seaward of the vegetation line. The Act states "…that the public, individually and collectively, shall have the free and unrestricted right of ingress and egress to and from the state-owned beaches bordering on the seaward shore of the Gulf of Mexico, or if the public has acquired a right of use or easement to or over an area by prescription, dedication, or has retained a right by virtue of continuous right in the public, the public shall have the free and unrestricted right of ingress and egress to the larger area extending from the line of mean low tide to the line of vegetation bordering on the Gulf of Mexico…" (Sec. 61.011., Subchapter B. Access to Beaches). Citizens have a legal right to access beaches, but they should be managed within social and ecological boundaries (Gunter et al., 1987). Landward of the vegetation line, private

[2] In this paper the term "moral hazard" is used interchangeably with policy and management hazards.

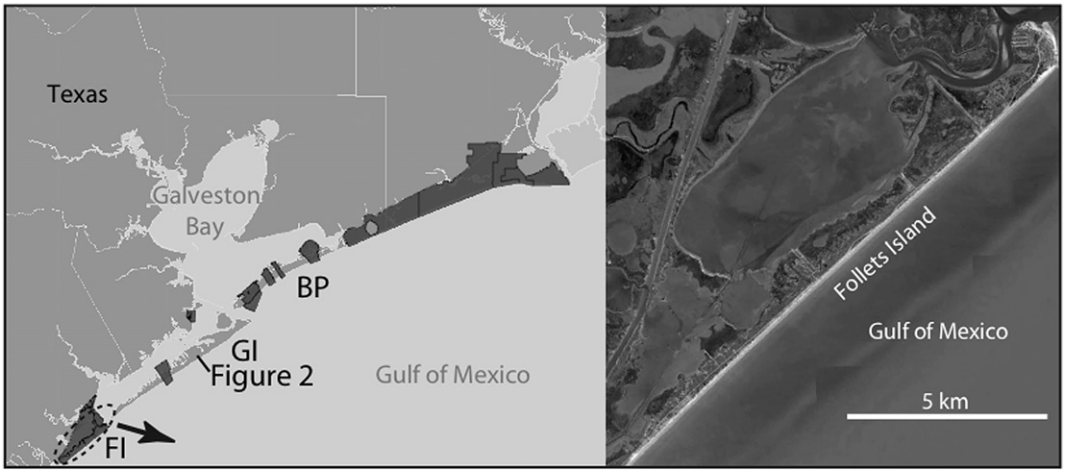

Fig. 1. Map defining the CoBRA boundaries along the Upper Texas coast (modified from U.S. Fish and Wildlife Service- http://www.fws.gov/CBRA/Maps/Locator/TX.pdf), denoting where federal assistance is banned in darker areas (left panel). Follets Island, shown with dashed oval in left panel, (base map modified from SIO, NOAA, U.S. Navy, NGA, GEBCO-Google Earth), just southwest of Galveston Island, exists almost fully within the CoBRA zone. Here, development is sparse (right panel), and clearly suggests that homeowners understand that there is some risk associated with living along the coast. Therefore, expanding the CoBRA zones to areas with a high geohazard potential clearly can curtail unsustainable development. FI = Follets Island; GI = Galveston Island; BP = Bolivar Peninsula.

property owners have the right to buy, sell, and develop the land according to their wishes.

Fundamental to understanding the TOBA, and origin of moral hazards relating to it, is the notion of the vegetation line. This boundary reflects the location where natural vegetation grows on beaches and dunes along shorelines. As such, the vegetation line migrates landward and/or seaward due to a variety of natural processes. Historical erosion rates are publicly available from the Texas Bureau of Economic Geology, and demonstrate this boundary migrates over timescales relevant to coastal communities. Therefore, this boundary is considered a dynamic rolling easement.

Often, homes and developments are built with little to no buffer (Fig. 2) for this moving boundary, as homeowners and developers can legally build right at the vegetation line. However, if a private building is overtaken by the beach, the owner is to remove the property at his or her expense. Until complete removal occurs, destroyed houses present a significant safety hazard for beachgoers exercising their right to access the beach. Development occurs in this manner because the State of Texas has no defined setback rules, despite the fact that "…the Texas General Land Office is leading the fight against coastal erosion" (Texas General Land Office, 2011). This lack of planning has created a significant governmental moral hazard. A setback rule forcing developers and homeowners to build some distance behind the vegetation line would alleviate much of the risk. Consequently, this policy void associated with the TOBA leads to a cascading effect of ever increasing hazardous situations, and risk and hazards are transferred from the government to individuals.

If the homeowner takes out a mortgage through a federally regulated or insured lender and the home is located in an area prone to severe storms, they are required to purchase flood insurance. The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP). Unfortunately, the program is financially troubled because the amount of disaster payouts has exceeded revenue collection by an estimated $18-$19 billion (Conrad, 2010). This governmental moral hazard further grows in scale if the homeowner has flood insurance. Assuming a hurricane comes ashore and in addition to eroding the beach and making the home closer to the ocean, it destroys the home's roof. The federal government will now be financially liable to repair the roof even though the home is becoming more vulnerable to future hazards. An additional consequence of risky development in a hazardous area concerns emergency response personnel. Imagine a hurricane comes ashore, inundating the land through storm surge. It is common knowledge that some homeowners do not and/or cannot heed storm warnings and evacuate. Thus, stranded in a dangerous situation, they expect to receive help. Local, state and federal disaster agencies are then asked to put their lives at-risk to save others from a governmental moral hazard of their own making.

Here, we have a situation where a moral hazard involving government escalates the risk profile and adversely affects the

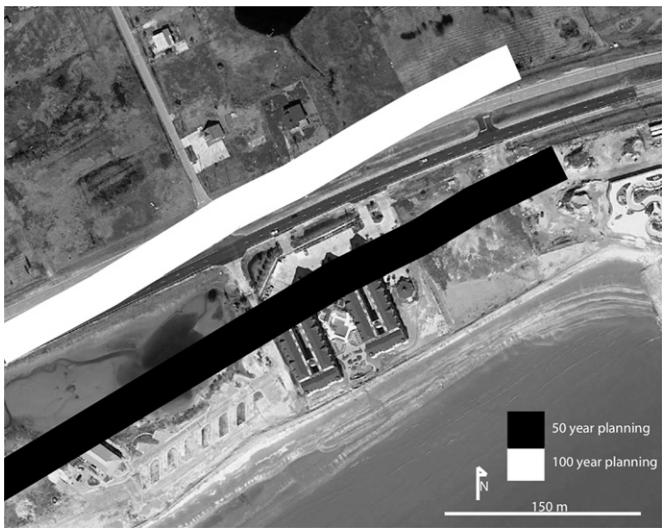

Fig. 2. Map (modified from SIO, NOAA, U.S. Navy, NGA, GEBCO-Google Earth) showing an example proposed 50 year and 100 year planning scenario near the west end of the seawall. The black and white lines are the setback suggestions using the average erosion rate for the area (1.7 m/yr-Texas Bureau of Economic Geology) multiplied by 50 and 100 years, respectively. We suggest designating land seaward of either scenario within the CoBRA zone. These scenarios would involve building behind FM 3005, which would be the case for most of the Island. Note that a large development is within very close proximity of the current vegetation line. This same scenario is representative for most of the Upper Texas coast.

livelihoods of others. The State of Texas creates legislation that tries to steward beaches in an environmentally acceptable way while defining property rights. Most likely under pressure from the local community, the government codifies rules that allow people to build permanent structures on migrating land like barrier islands. Scientific data are available that could be used to plan for a safer setback distance so the property is more sustainable, but they are not required to be used. Underscoring all of this is a moral hazard relating to individuals, as ultimately it is their desire to live in geologically hazardous areas which drives governmental intervention.

3.2.2. Coastal Barrier Resources Act

One of the most powerful and influential ways of deterring development along barrier islands has been achieved through the Coastal Barrier Resources Act (CoBRA- http://www.fws.gov/habitatconservation/PL_97_348.pdf). This act aims to "…minimize the loss of human life, wasteful expenditure of Federal revenues, and the damage to fish, wildlife, and other natural resources associated with the coastal barriers along the Atlantic and Gulf coasts by restricting future Federal expenditures and financial assistance which have the effect of encouraging development of coastal barriers…" (Coastal Barrier Resources Act). This Act has curtailed development along the Texas coastal barrier islands within the designated CoBRA zones (Federal funding and assistance restricted) but it appears to have had little effect on land outside of the CoBRA boundary (Federal funding and assistance available). However, the geohazards are virtually the same within or outside of the CoBRA boundaries. It is clear that homeowners and developers could reasonably understand that there is some risk associated with development along coastal areas, as development ceases right at the CoBRA boundary (Fig. 1). The fact that they are able to get federal insurance and funding directly adjacent to CoBRA boundaries is therefore another significant governmental moral hazard.

As previously mentioned, the Texas Open Beaches Act is one of the most direct and powerful examples of government restricting development along beaches (Jacob and Showalter, 2007). However, this act coupled with an increasing pressure to develop coastal land has caused a major dilemma regarding the lack of a setback rule. Furthermore, CoBRA provides a viable solution for alleviating much of the moral hazard associated with steady coastal erosion. In most places along the Upper Texas coast, the shoreline is eroding at long-term average rates of between 1 and 2 m per year (Texas Bureau of Economic Geology). This is the long-term, time-averaged rate of change, and is consistent with the rolling easement boundary line shift. Therefore, public policy changes should incorporate:

- building at least 50–200 m behind the vegetation lines, thereby providing at least 50–100 yrs of sustainable development (50–100 yrs times 1–2 m/yr = 50–200 m, respectively) (Fig. 2)
- expansion of the CoBRA zones to areas within 200 m of all barrier island vegetation lines
- a hurricane or tropical storm moving the vegetation line hundreds of meters in a single event (i.e. possible episodic retreat of the vegetation line).

3.3. Fragmented governance

Fragmented governance also gives rise to moral hazards through tempering county governing power. In Texas, there is considerable disconnect for regulatory enforcement and land use planning control between municipalities and counties, (i.e. cities and surrounding unincorporated areas). This divergence may result in development sprawling outside of the city limits to areas within a county in which development practices are much less limited or defined (Jacob and Showalter, 2007).

This disconnect in authority is perhaps most evident by the fact that Texas has the highest degree of municipal (city) autonomy in the nation, but is ranked near the bottom for county discretionary authority (Richardson et al., 2003; Jacob and Showalter, 2007). Along the Upper Texas coast, this could result in a moral hazard if homeowners and developers begin expanding further south toward low-lying coastal areas with a very high geohazard potential. To make both municipalities and counties equally autonomous:

- a Home-Rule Amendment[3] should be petitioned.

This would enable Texas counties to obtain more regulatory power, in order to restrict risky development outside of strict city limits. However, a few counties have attempted with little success to petition the state legislature to do just this (Jacob and Showalter, 2007).

Another consequence of fragmented government is a moral hazard involving the city of Galveston. The city grants development along the west-end of Galveston Island, a location with considerable geohazard risk because it is far from the protection of any seawall and higher elevations associated with the east end. Tax revenue is generated from the west end of the island, but the city relies on federal funding for most recovery expenditures associated with hurricane impacts, coastal erosion, and vegetation line shifts. In the end, it is the federal and/or state government who bares the financial burden for damage or loss of homes.

3.4. Disaster risk levels

The miscommunication of disaster risk levels in coastal areas comprises a significant moral hazard. Relative to flooding, public policy often requires the provision of information about the risks associated with living in flood prone areas. However, the information provided is often conveyed in such a way that constitutes a governmental and societal moral hazard. Take for example, the term 100-yr flood. Most people understand this to mean a large flood that will only occur once every 100 years. This however, is a "misinterpretation of terminology that leads to a misconception of what 'a 100-year flood' really is" (United States Geological Survey, 2011). Properly stated, a "100-yr flood" means that a flood has a 1% probability of occurring in any one year. Furthermore, it is possible the "100-yr" flood could occur in two or three consecutive years. Confusion is often associated with this term for two reasons: it refers to depth of water and not time frame; and, it is a statistical calculation and not an absolute recurrence interval. To make matters easier to understand we recommend adding a word "depth" to the term – 100-yr flood depth.

Floods are classified by the frequency of occurrence (over a given period of time) and their possible depth. Contextually relevant methods for informing people about risk levels from flooding needs to be developed and communicated in an easily understandable format. For example, table one represents the probabilities of a flood occurring over different periods of time. If someone is considering the purchase of a home with a mortgage, they should be informed about the level of risk they will be incurring during the relevant period of time. Floods and hurricanes

[3] A Home-Rule Amendment would grant either a city or county power through the state constitution without needing any statutory authorization (56 Am. Jur. 2d Municipal Corporations and Other Subdivisions § 108 (2006).

Table 1
Table showing the probability of flood occurrence (measured by water depth) through time. (http://acequia.ccrfcd.org/pdf_arch1/floodzoneinfo/Whatis100yr.pdf, originally from FEMA) Note, this table does not include the potential flooding caused by hurricane storm surge.

Length of mortgage time (years)	Measured by depth of water			
	10-yr flood	25-yr flood	50-yr flood	100-yr flood
1	10%	4%	2%	1%
10	65%	34%	18%	10%
20	88%	56%	33%	18%
30	96%	71%	45%	26%
50	99%	87%	64%	39%

annually occur along the Upper Texas coast with probabilities of ~4%[4] (http://waterwatch.usgs.gov/new/index.php) and ~6%[4] (NOAA, 2011), respectively, for more than the last century. Depending on the amount of precipitation delivered by individual hurricane events, there can be additional interactions with river floods and hurricane impacts in coastal regions. To synthesize these data, flood occurrences can be converted to a probability percentage of occurrences versus mortgage lengths (Table 1). For example, a "100 year flood" has a 26% probability of flooding during a 30 year mortgage. The probability of these hazards generally gets lower the further away from the coast and/or floodplain one gets. This must be communicated better during property or home purchase. Therefore, we recommend:

- communication of hazard risks through the use of probabilities of hazards from the historic record
- adding a word "depth" to the term – 100-yr flood depth.

4. Conclusion

The Upper Texas coast is experiencing unprecedented population growth causing an increased demand to place permanent structures on dynamic coastal lands. Public policy and laws intended to guide development and protect people are creating perverse incentives that undermine the very ecosystems life depends on. To correct these distortions and prevent disruptive policies from emerging, moral hazards must be addressed in a direct manner. For the Upper Texas coast, this specifically includes:

- minimizing new development in low-lying, flood prone areas, regardless of the proposed income, facilities, and infrastructure to be built (Blackburn and Denney, 2010). This could be incorporated through adoption of the existing geohazards map (found at: www.beg.utexas.edu/coastal/GalvHazidx.php) for Galveston Island (Anderson and Wallace, 2011), and therefore would rely on non-structural mitigation (Eriksen, 2011)
- requiring flood insurance for all coastal developments (Blackburn and Denney, 2010)
- a setback rule of at least 50–200 m behind the vegetation lines, and designating this area as a CoBRA zone. This would provide a cushion for both steady coastal erosion due to relative sea-level rise and hurricane impacts for several decades
- a Home-Rule Amendment, giving the counties more power to curtail risky coastal development outside of city limits
- straight-forward communication of flood and hurricane occurrence using annual event probabilities based on historic data.

Fortunately, moral hazards involving societies, governments, cities, developers, and individuals are the results of human choice – choice to use coastal resources, choice to accept risk, and choice to rely on government to compensate investors for their risky behaviors, to name a few. A new principle driven framework should be developed to reexamine the policies and practices that create moral hazards. Principles embodied in sustainable development such as intergenerational equity, precautionary principle and polluter pays would be useful guideposts for consideration (Rio Declaration on Environment and Development, 1992).

[4] These were calculated through an examination of two USGS stream gauges along the Upper Texas coast (http://waterwatch.usgs.gov/new/index.php). The Trinity River at Liberty, TX (USGS site 08067000) has flooded 4 times since 1922, meaning the average flood probability in any given year during this time interval is ~4.5%. For the Brazos River near Rosharon, TX (USGS site 08116650), four floods have been recorded since 1914, meaning the flood probability is ~4.1%. Aside from flood risks, residents directly along low-lying areas also need to understand and plan for the risks associated with hurricane impacts. Since 1900, seven category 3 and higher hurricanes have impacted along 125 km of the Upper Texas coast (6.3% annual landfall probability) (NOAA, 2011).

Acknowledgments

We would like to thanks Jim Blackburn, J.D. and John Anderson, Ph.D. for comments and edits for this paper.

References

Anderson, J., Wallace, D., 2011. Science Behind the Plan. In: Hight, C., Anderson, J., Robinson, M., Biolsi, S. (Eds.), Atlas of Sustainable Strategies for Galveston Island. Rice University, pp. 7–23.
Anderson, J.B., 2007. The Formation and Future of the Upper Texas Coast. Texas A&M University Press.
Berg, R., 2009. Tropical Cyclone Report, Hurricane Ike. http://www.nhc.noaa.gov/pdf/TCR-AL092008_Ike_3May10.pdf (accessed 1.11.11).
Blackburn, J.B., Denney, K., 2010. Presentation at Severe Storm Prediction, Education and Evacuation from Disasters Conference, Ike: a focus on reality and future steps. http://sspeed.rice.edu/sspeed/Archived_slides_0913.html September 13, in Houston, Texas (accessed 1.11.11).
Blaikle, P., Cannon, T., Davis, I., Wisner, B., 2004. At Risk: natural hazards, people's vulnerability and disasters. New York, Routledge.
Blake, E.S., Landsea, C.W., Gibney, E.J., 2011. The Deadliest, Costliest, and Most Intense United States Tropical Cyclones from 1851 to 2010 (and Other Frequently Requested Hurricane Facts). NOAA Technical Memorandum NWS NHC-6, National Oceanic and Atmospheric Administration. http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf (accessed 1.11.11).
Burby, R.J., 2006. Hurricane Katrina and the paradoxes of government disaster policy: bringing about wise governmental decisions for hazardous areas. The ANNALS of the American Academy of Political and Social Science 604, 171–191.
Conrad, D.R., April 21 2010. Senior Water Resources Specialist, National Wildlife Federation Regarding Legislative Proposals to Reform the National Flood Insurance Program, Subcommittee on Housing and Community Opportunity. House Committee on Financial Services, U.S. House of Representatives. http://www.house.gov/apps/list/hearing/financialsvcs_dem/conrad_4-21-10.pdf (accessed 1.11.11).
Dembe, A.E., Boden, L.I., 2000. Moral hazard: a question of morality? New Solutions 10, 257–279.
Eriksen, S., Aldunce, P., Bahinipati, C.S., Martins, R.D., Molefe, J.I., Nhemachena, C., O'Brien, K., Olorunfemi, F., Park, J., Sygna, L., Ulsrud, K., 2011. When not every response to climate change is a good one: identifying principles for sustainable adaptation. Climate and Development 3, 7–20.
Gunter, V.J., Ditton, R.B., Olson, S.G., 1987. An assessment of beach access and management issues on Galveston Island. Coastal Management 15, 247–260.
Grunwald, M., Glasser, S., October 9 2005. The Slow Drowning of New Orleans. Washington Post. http://www.washingtonpost.com/wp-dyn/content/article/2005/10/08/AR2005100801458.html (accessed 1.11.11).
Jacob, J.S., Showalter, S., 2007. The Resilient Coast: policy frameworks for adapting the built environment to climate change and growth in coastal areas of the U.S. Gulf of Mexico. http://www.urban-nature.org/publications/documents/TheBuiltEnvironment08-sm_000.pdf (accessed 1.11.11).
Messen, D., 2011. Socioeconomic Modeling Program Manager. Houston-Galveston Area Council. Phone Interview. November 28.
National Oceanic and Atmospheric Administration, 2011. Historical Hurricane Tracks. http://csc-s-maps-q.csc.noaa.gov/hurricanes (accessed 1.11.11).
Richardson Jr., J.J., Gough, M.Z., Puentes, R., 2003. Is Home Rule the Answer? Clarifying the Impact of Dillon's Rule on Growth Management. http://www.brookings.edu/es/urban/publications/dillonsrule.pdf (accessed 1.11.11).
Rio Declaration on Environment and Development, 1992. Report of the United Nations Conference on Environment and Development. http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm (accessed 1.11.11).

Sealy, E.C., 2011. Handbook of Texas Online: Galveston wharves. Texas State Historical Association. http://www.tshaonline.org/handbook/online/articles/etg01 (accessed 1.11.11).

Texas General Land Office, 2011. Caring for the Coast: coastal erosion. http://www.glo.texas.gov/what-we-do/caring-for-the-coast/coastal-erosion/index.html (accessed 1.11.11).

United States Census Bureau, 2011a. State & County QuickFacts. http://quickfacts.census.gov/qfd/states/48000.html (accessed 1.11.11).

United States Census Bureau, 2011b. 50 Largest Metropolitan Statistical Areas in 2009 - Components of Population Change: 2000-2009. http://www.census.gov/compendia/statab/2011/tables/11s0021.pdf (accessed 1.11.11).

United States Census Bureau, 2011c. States with Coastal Counties - Population, Housing Units, Establishments, and Employees by Coastal Region and State: 2000 to 2009. http://www.census.gov/compendia/statab/2011/tables/11s0025.pdf (accessed 1.11.11).

U. S. Department of Commerce, 2011. National Oceanic and Atmosphere Administration, National Climatic Data Center. Billion Dollar Weather Disasters 1980-2010. http://lwf.ncdc.noaa.gov/img/reports/billion/billion2010.pdf (accessed 1.11.11).

United States Geological Survey, 2011. Floods: recurrence intervals and 100-year floods. http://ga.water.usgs.gov/edu/100yearflood.html (accessed 1.11.11).