Climate Impacts for the Southeastern U.S. and Dauphin Island, AL

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Introduction

Across the United States and throughout the world, climate change has become apparent with rising sea levels, increasing temperatures, more frequent, intense rain storms and decreasing snow and ice levels, which impact the timing and amounts of river flows. These changes and their impacts are projected to continue to grow in the future, though depending on the climate model used, the projected effects of climate change vary. The projections differ because of the uncertainty of future global emission levels of heat-trapping gases and the climate's reaction to those emissions. As a result of this uncertainty, climate models use different emission scenarios to predict the potential impacts of changes to climate.

Although climate change is occurring throughout the world and the United States, regions will experience a changing climate differently. For example, the Eastern U.S. is experiencing increased forest growth, while the western part of the country is seeing decreased forest growth. Likewise, the Southeast and Gulf Coast region have and will experience different climate impacts than other regions in the United States. Some current and projected climate changes for the Gulf Coast include:

- Rising sea levels;
- Ocean acidification that threatens coral and shellfish growth;
- More severe weather events;
- Heavy downpours;
- More frequent droughts;
- More intense and frequent heat waves; and
- Increasing demands on water supply.

In particular, the Gulf Coast is particularly vulnerable to sea level rise and coastal storms because of its long, low-lying coastline. Rising sea levels are threatening coastal communities, barrier islands, coastal marshes and wetlands, and will cause Gulf Coast shorelines to retreat. Because the Gulf Coast is sinking due to land subsidence, the region's relative sea level rise has been significantly higher than the global average rate over the last 50 years, and this trend is expected to continue into the future. The region is also experiencing land loss. For example, the Mississippi-Alabama Barrier-Island Chain has experienced accelerated rates of land loss since the mid-1800s.

Dauphin Island, Alabama

In particular, because of its location and geography, Dauphin Island, Alabama has already felt some of these impacts. Dauphin Island is a low-lying barrier island with an average elevation of only 7.2 feet, located 5 miles south of Mobile, Alabama. It is a narrow island, only a mile across at its widest point, and is approximately 15 miles long. According to the 2010 Census, the Town has 1,238 residents, who mostly live on the more stable eastern seven miles of the island.

Dauphin Island has been in a net erosional phase since the late 1950s, and in 2007, the island was 16% smaller than it was in 1958. Like the rest of the Gulf Coast region, Dauphin Island is particularly vulnerable to sea level rise. Sea level rise will make barrier islands more susceptible to coastal storms and related storm surges, including weaker, seasonal storms. These factors could have a strong impact on barrier islands by increasing erosion, permanently inundating some areas and leading to higher salinity levels in estuaries and freshwater aquifers. These climate stressors will likely impact the island's natural resources, as well as access to and transportation on Dauphin Island. These stressors could also have a potential economic impact on the island. Increases in population and the amount of development in many coastal areas are amplifying these effects.

Photo of Dauphin Island,
courtesy of Jimmy Emerson.

The Town of Dauphin Island (Town) was incorporated in 1988. A mayor and a five-member town council govern the Town, establish policy and provide governmental services for such things as public safety, land use and solid waste disposal. A planning commission assists the Mayor and Town Council in preparing, maintaining and implementing plans, regulations and ordinances for the orderly development of the Town. The Dauphin Island Water and Sewer Authority, which operates independently from the Town, provides water and sewer services. The Dauphin Island Park and Beach Board manages the island's public parks, beaches, campgrounds and other recreational facilities. Like the Water and Sewer Authority, the Park and Beach Board operates independently from the Town under the leadership of an executive director and board.

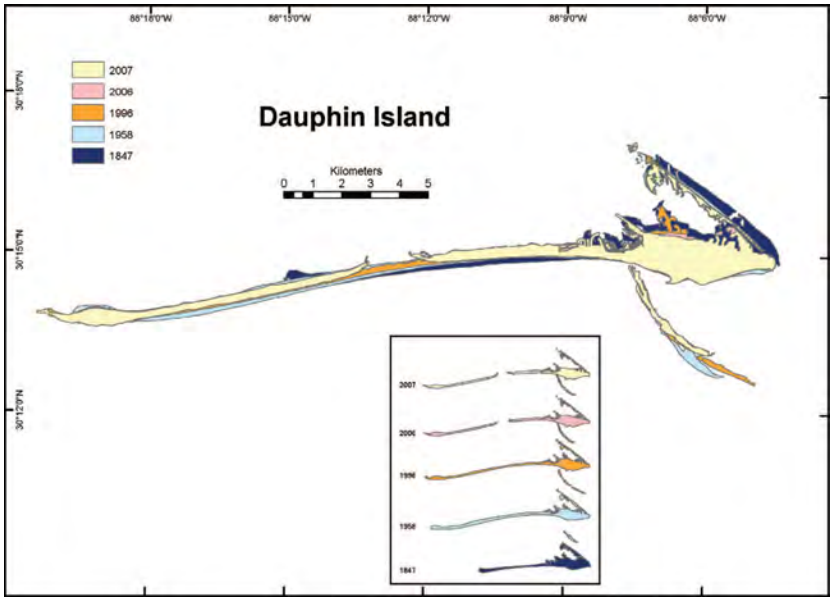
Given Dauphin Island's fragmented governance structure, it is essential that all three organizations evaluate the potential climate change impacts to the natural and human systems falling within their respective authorities and develop adaptation plans. While these assessments could be done independently, a coordinated approach saves time and money, provides opportunities for joint fact-finding, mutual learning and collaboration and ensures that all of the island's resources are included in the Town's adaptation efforts.

To assist with this fact-finding, the Mississippi-Alabama Sea Grant Consortium (MASGC) has begun working on a two-year climate resiliency study for Dauphin Island. In the first year of this study, the Mississippi-Alabama Sea Grant Legal Program (MASGLP) has prepared this report on the anticipated regional changes in climate variables and how these changes can impact Dauphin Island's natural and built resources. As part of a larger climate resiliency study, MASGLP will also facilitate a climate change vulnerability and risk assessment process, through which the Town will prioritize its planning areas and climate change adaptation efforts.

Land Loss and Sea Level Rise

Land Loss

A 2008 U.S. Geological Survey Study looked at the historical changes to the Mississippi-Alabama Barrier-Island Chain (MS-AL Barrier Islands) and found that since the mid-1800s, the island chain has sustained accelerated rates of land loss. Specifically, Dauphin Island has been eroding since 1958. From 1958-2007, the island decreased by 16%.



Morphological and Spatial Changes in Dauphin Island between 1847 and 2007, Morton 2008.

The study found that storm cycles and sand supply were combining with rising sea levels to cause land loss on the MS-AL Barrier Islands. While sea level rise can change landmasses over longer time periods like centuries and millennia, storms have more short-term effects over briefer time periods like years and decades. For example, Hurricane Katrina had a significant effect on the more recent land loss rate of Dauphin Island. From 1958-1996, the island's land loss rate averaged -6.1 hectare/year. However, due in part to how Hurricane Katrina redistributed sand on the island's West End, the land loss rate decreased to -2.2 hectare/year from 1996-2007.

Reduced amounts of sand supply also exacerbate land loss. Since the late 1800s, the MS-AL Barrier Islands have experienced a reduction to the volume of sand supply due to the dredging of navigation channels in the area. Since that time, sand has been trapped in the navigation channels and removed by dredging, making it unavailable for barrier-island nourishment. However, the 2008 U.S. Geological Survey Study concluded that Dauphin Island is probably the least affected of the MS-AL Barrier Islands by sand supply reduction because of sand stored in an ebb-tidal delta.

Specific factors have made the West End of Dauphin Island more susceptible to land loss than the East End, which is relatively stable due in part to riprap and groins around Fort Gaines and bulkheads constructed on the island's sound-side shores. In comparison, the West End is susceptible to storm overwash and erosion on the Gulf beaches. This area of the island is also vulnerable to barrier breaching and island segmentation that exposes more of the island's shores to erosive processes.

Hurricane Katrina and subsequent tropical storms severely impacted the low-lying beaches on the West End, and the flooding conditions and wave action exacerbated by these storms accelerated and worsened the effects of erosion throughout the island. The relatively undeveloped western end of the island has been particularly susceptible to the effects of erosion, with over 350 feet of beach destroyed to date. Hurricanes Ivan and Katrina also caused the island to lose over 300 homes.

Photo of Dauphin Island beach, courtesy of David King.

In August 2011, Dauphin Island completed a three-phase study that looked at ways to address chronic beach erosion on the island and preserve the barrier island and beaches for future generations. The study found that while the shoreline on the East End of the island was receding at a rate of 9.0 feet/year, the shoreline on the West End of Dauphin Island was receding at a faster rate of 12.7 feet/year.

Sea Level Rise

Although there were large swings in sea level throughout the last 20,000 years, sea levels reached a state of equilibrium with coastlines around 6,000 years ago, which allowed coastal landforms, including barrier islands, estuaries and coastal wetlands, to develop. For the last 2,000 years, sea levels have remained mostly constant, and the sea level history of the northern Gulf Coast and Florida has closely followed this trend. However, this trend began to change over the past 100 years, as global sea level rose around 8 inches during the 20th century. This rate is projected to increase throughout the 21st century.

What makes sea level rise?

Warmer global temperatures cause sea level to rise in two ways. First, water molecules expand when they are warmer, causing the warmer water to take up more space. Since temperatures are expected to continue to rise, water molecules are likely to continue to expand. Second, warmer temperatures cause ice sheets and glaciers to melt, which adds more water to the oceans and makes sea levels rise. Currently, Arctic ice is melting at unprecedented rates, creating a vicious cycle. Ice reflects sunlight, while the darker ocean water absorbs heat. As more ice melts, more of the dark ocean is uncovered and the exposed water absorbs heat. This leads to increased heat in the air, which results in more ice loss.

The National Weather Service reported that in August 2012 the ice sheet covering the North Pole had melted to the smallest size ever recorded, shattering the previous record from 2007. During the summer of 2007, the Arctic experienced almost ideal weather to melt ice with heat-trapping water vapor in the air, unusually sunny skies and warm winds. In comparison, this past summer had unremarkable weather for melting ice, providing strong evidence of the earth's long-term warming.

Why do some areas experience sea level rise differently?

Factors other than average global sea level rise will affect the rate of sea level rise in a particular location, including the location's proximity to melting ice sheets. An area's relative sea rise will also depend on whether the area is rising or sinking. While some areas along the U.S. coastline are rising, a process referred to as uplift, most areas are sinking, a process referred to as subsidence. In the U.S., this subsidence has ranged from as little as a few inches to more than 2 feet per century. Because the Gulf Coast is sinking, the region's relative sea level

rise has been significantly higher than the global average rate over the last 50 years, and this trend is expected to continue into the future.

What changes have already occurred?

Globally, sea levels have risen an average of about 1.7 mm/year over the past 100 years, but this rate has increased in the past 15 years to around 3.1 mm/year.

Table 1 shows how sea levels have risen in different parts of the Gulf Coast. From 1966-1997, Dauphin Island experienced a rise in sea level of 2.98 mm/year, which is comparable to Pensacola's sea-level rise (2.1 mm/year) and more than the rise in global sea level.

TABLE 1- LONG-TERM TIDE-GUAGE DATA FOR ALL NORTHERN GULF OF MEXICO STATIONS WITH MORE THAN 40 YEARS OF RECORD- NOAA (2010A)- DONOGHUE, 2011

STATION LOCATION	MEAN SEA-LEVEL RISE (mm/yr)	+/-	EARLIEST RECORD
KEY WEST, FL	2.24	0.16	1913
NAPLES, FL	2.02	0.60	1965
FORT MEYERS, FL	2.40	0.65	1965
ST. PETERSBURG, FL	2.36	0.29	1947
CEDAR KEY, FL	1.80	0.19	1914
PENSACOLA, FL	2.10	0.26	1923
DAUPHIN ISLAND, AL	**2.98**	**0.87**	**1966**
GRAND ISLE, LA	9.24	0.59	1947
SABINE PASS, TX	5.66	1.07	1958
GALVESTON PIER, TX	6.39	0.28	1908
FREEPORT, TX	4.35	1.12	1954
ROCKPORT, TX	5.16	0.67	1948
PORT MANSFIELD, TX	1.93	0.97	1963
PORT ISABEL, TX	3.64	0.44	1944
PADRE ISLAND, TX	3.84	0.75	1958

What are the Projected Changes?

Although sea levels are expected to continue to rise, models differ as to the extent of the rise. While climate models often differ due to different emission scenarios, the uncertainty in how ice sheets affect sea level rise also influences sea level projections. Ice sheets, also known as continental glaciers, are glacier ice that cover

terrain and are larger than 20,000 square miles. While scientists understand how melting glaciers and the thermal expansion of water will affect sea level, they do not fully understand how ice sheets will contribute to sea level rise. Because of this uncertainty, the Intergovernmental Panel on Climate Change's (IPCC) did not account for changes in sea level due to ice sheet dynamics and projected that by the end of the century the world's oceans would rise anywhere from 8 inches to 2 feet.

Unlike the IPCC, more recent studies have tried to quantify how melting ice sheets will contribute to rising sea levels, and these recent studies have suggested that the IPCC's projections for sea level rise were too conservative. These more recent studies exceed the IPCC's predictions, with average estimates of a 3 to 4 foot sea level rise this century under higher emissions scenarios. Most recently, the 2013 Draft Report on Global Climate Change Impacts in the United States found that sea levels would rise an additional 1 to 4 feet during this current century, depending on the emission scenario. Although few studies have looked at what the maximum amount of sea level rise could be, there is evidence suggesting that a sea level rise greater than 6.5 feet by the end of this century would be almost impossible.

What are the potential future effects of rising sea levels?

With an average elevation of only 7.2 feet, Dauphin Island is highly susceptible to rising sea levels, which are expected to result in coastal inundation and retreating shorelines. Wetlands are also expected to erode, with some ecosystems and areas becoming permanently lost. As discussed above, there are various projections as to the extent of sea level rise that the island may face. However, because of the small size and relatively low elevation of the island, a slight vertical increase in sea level can force the shoreline to move significantly inland, particularly in the low-lying areas of the island already threatened by erosion and shoreline retreat. Sea level rise will therefore serve as a threat to property in these parts of the island.

Photo of waves crashing on Dauphin Island, courtesy of Quiksilver1850 Photos.

Sea level rise may affect the mainland highway that provides access to Dauphin Island, as well as other infrastructure on the island. For example, Dauphin Island's wastewater treatment plant is currently only about 2 feet from the water, making it very vulnerable to sea level rise. As shorelines erode and the island loses both dunes and the vegetation on the dunes, the island will become more susceptible to storms. Higher sea levels will also increase the possibility of saltwater intrusion in the region's porous aquifers, threatening the Town's drinking water supply.

Storms

In the last 100 or so years, the number of hurricanes based in the Atlantic Ocean has increased. Since 1970 the Southeast has experienced an increased number of Category 4 and 5 hurricanes, and this increase is thought to have been caused by both changes in climate and natural variability. Although projections differ as to how storms will be affected by climate change, many believe the region will face stronger hurricanes since hurricanes gain strength over warmer water. Some projections also suggest that while the number of tropical storms will decrease globally, there will be an increase in stronger Category 4 and 5 storms. Stronger hurricanes could further stress infrastructure, ecosystems and threaten human safety.

Storms can erode large quantities of sand from the area's beaches. From the spring through fall, wave energy is low, allowing some sand from offshore sandbars to be added to the shoreline. During storms, wave energy increases, and these waves can remove sand from the beach and deposit the sand offshore. When wave and wind action return to normal, this sand may be redeposited on the area's beaches. However, strong storms have the potential to remove a significant amount of sand from the beach very quickly. Therefore, if the area is expected to face stronger storms in the future, these storms could have a large effect on the amount of sand eroded from Dauphin Island's and the region's beaches.

Damage to beachfront homes on Dauphin Island, AL. September 11, 2005, courtesy of Lieut. Commander Mark Moran, NOAA Corps, NMAO/AOC.

Less intense seasonal storms could also adversely affect Dauphin Island. Coastal storms and associated surge flooding, combined with sea level rise, may increase erosion and inundate some areas, causing low areas on the island to be permanently lost. The loss of land and marshes will reduce Dauphin Island's storm resiliency. The island will also face the cumulative impact of heavier storms in the fall, when sea levels are already at their highest. Dauphin Island has already become less resilient due to repetitive storms, allowing weaker storms to have a larger impact on the island. With these weaker, seasonal storms, areas of the island are expected to become flooded, and rising sea levels, land subsidence and erosion could magnify this flooding.

Coastal storms can also lead to increased salinity in estuaries and freshwater aquifers. This shift in salinity can kill native species and allow invasive species to take over an area. In addition, the salt spray from storms can weaken or kill trees on the island, which can lead to erosion. Further, the loss of trees will mean that the island will lose the protection of the trees against storm winds. Previous storms have also caused the loss of vegetated dunes on the island, which makes the island more susceptible to future storms.

Photo of Dauphin Island Bird Sanctuary, courtesy of Cara Zuri Eggers.

Other potential storm impacts include the loss of shoreline, the rollover of sand into Mississippi Sound and a loss of elevation. Storms can also inundate docks, and the overtopping of bulkheads during storms could lead to additional erosion. Further, the island could be susceptible to further breaches as water rolls over or actually cuts through the island. While storms can erode sand from the area's beaches, storms surge and winds can also push sand onto property and the island's roads. For example, Hurricane Isaac caused the roads on the West End of Dauphin Island to be blocked by sand, which limited access to that part of the island.

Because Town employees will evacuate the island along with the Town's other residents before a dangerous storm, there are also limited resources on the island during and after a storm. Storms could also lead to a loss of infrastructure on the island, including the loss of sewers and roads, which would make these services unavailable to residents for periods of time.

Temperature

What Changes Have Already Occurred?

Globally, temperatures have increased during the last 50 years. In the Southeast, the average annual temperature has increased around 2° F since 1970, with the region experiencing the largest increase in the summer. In addition, most of the Southeast has experienced a decline of 4 to 7 freezing days a year since the mid-1970s. There have also been more days above 95° F and nights above 75° F.

What are the Projected Changes?

Globally, temperatures are expected to rise, though the extent of the increase varies among the various climate scenarios. In the Southeast, rates for projected temperature increases are more than twice the rate that has already occurred in the Southeast since 1975. Overall, on average temperatures in the region are expected to increase between 2° F and 6° F. The Southeast is expected to experience the greatest temperature increases during the summer. The region will continue to experience an increase in the number of days over 95° F and a decrease in the number of freezing events. Further, the Southeast is projected to experience the country's highest increase in heat index, which is a measure of comfort that combines relative humidity and temperature.

What are the Possible Effects of the Projected Changes?

Higher temperatures are expected to adversely affect the natural environment in various ways. Specifically, higher temperatures will lead to increased rates of evaporation and plant water loss that will in turn alter the amount of water available for groundwater recharge into aquifers. In coastal areas, this may also lead to saltwater intrusion in shallow aquifers because there will be less freshwater available to flow into and recharge the aquifers. Temperature increases will also stress agricultural crops and may lead to degraded water quality in coastal waterbodies. Warmer waters are susceptible to algal blooms and the growth of bacteria that affect shellfish, both of which could be harmful to human health. Warming is also expected to influence the range of species, including allowing invasive species to enter an area. Further, higher temperatures will heighten the risk of forest fires.

Photo of Dauphin Island Audubon Bird Sanctuary, courtesy of Champagne for Monkeys Photos.

Warming can also have numerous impacts on the built and human environments. Increased temperatures can have negative effects on infrastructure, such as causing pavement and railways to buckle. Humans will also feel the effects of increased temperatures. As stated above, changes to groundwater recharge and saltwater intrusion could stress water resources. Warmer summers could also lead to greater energy demands and higher power bills. Heat-related deaths are also expected to increase, due to more frequent heat waves. Hotter temperatures can also lead to poor air quality, which may cause more respiratory problems. Because the Southeast is expected to experience the U.S.'s greatest increase in heat index, the quality of life in the region could also decrease.

Precipitation

What Changes Have Already Occurred?

The Southeast has also seen changes to the amount of rainfall in the region. Since 1901, the amount of precipitation in the region has increased by 30% during the fall months. During this same time period though, the extent of drought in the region increased by 9%. In the spring and summer, the region has experienced more moderate to severe droughts, with an increase of 12-14% since the mid-1970s. The fact that overall precipitation has increased while the number of droughts has also increased is due to the fact that rain occurred in more intense storms, with longer periods of dryness between precipitation events.

What are the Projected Changes?

The projections for precipitation patterns in the region are less certain than the region's temperature projections. During the winter and spring, Gulf Coast states are projected to have less rainfall. The U.S. Environmental Protection Agency (EPA) states that although precipitation is projected to decrease in Florida, climate models are unclear as to whether precipitation will increase or decrease in the rest of the Southeast region. However, models do suggest that rain will be in heavier downpours, with longer periods of dryness between storms and an increased number of droughts that are longer and more intense.

What are the Possible Effects of the Projected Changes?

First, the region will have to adapt to longer, more intense and more frequent droughts. Decreased precipitation could also make areas more susceptible to fires that could damage both property and ecosystems. However, because precipitation is expected to come in heavier downpours, the region is also expected to experience increased flooding.

Photo of flooded road on Dauphin Island, courtesy of Jay Williams.

Flooding can have many negative impacts, including interfering with roads and other transportation infrastructure and damaging property and natural resources. Strong storms that suddenly increase water flow and related run-off can also impede an ecosystem's ability to process pollutants by reducing the time the ecosystem has to filter pollutants and by washing away pollutant-removing plants and microbes.

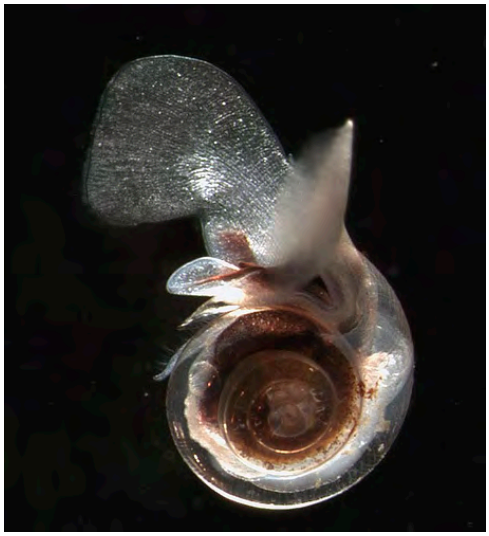
These stressors will likely also impact stormwater systems. Where communities use combined stormwater overflows, greater rainfall and sudden storm events can lead to sewer overflows that jeopardize water quality and human safety. These events can present risks to human health and could trigger boil water notices and beach closures in coastal areas. For example, on September 5, 2012, there was a sanitary sewer overflow into Salt Creek on Dauphin Island of around 2,360 gallons. The overflow was due to heavy rainfall and a partially blocked sewer main. As a result, the Mobile County Health Department advised residents to thoroughly wash their hands and clothing if they came into contact with untreated sewage. The health department also advised residents to fully wash and cook seafood harvested in the affected areas.

Potential Effects

Natural Resources and Ecosystems

Climate change impacts will negatively affect the natural resources of Dauphin Island. Higher temperatures can lead to the introduction of nonnative invasive species, as well as increase the risk of wildfires. Increases in temperature will also alter groundwater recharge, which can lead to saltwater intrusion in shallow aquifers. Rising sea levels and saltwater storm surge can also lead to increased salinity levels in estuaries and freshwater aquifers.

Although it is a global issue, ocean acidification could impact the region and Dauphin Island. Ocean acidification is the change to the carbon chemistry of the ocean due to increased amounts of carbon dioxide in the atmosphere. Ocean waters absorb the carbon dioxide, which acidifies the water by reducing the water's pH. Globally, the pH of the world's oceans has been reduced by 0.1, which is an increase of acidity of around 30%. Projections expect pH to be reduced by another 0.3 over the next 100 years if global carbon emissions are not significantly reduced. Scientists believe that this change would be at a minimum 10 times faster than any other change over the last 50 million years. Certain factors will affect the amount of ocean acidification that a region experiences, including the amount of nutrients and hypoxia in the area.



Ocean acidification causes there to be less carbonate in the water, and carbonate is important to coral reef and shell formation. As a result, ocean acidification is a significant threat to both coral reefs and shellfish populations. Since coral reefs provide habitat for a multitude of species, as well as coastal protection, food and income for people, the loss of coral reefs due to ocean acidification could have adverse impacts on an area. Likewise, shellfish represents a large portion of the nation's seafood revenue, including a large amount of revenue in the Gulf. Due to ocean acidification, the region could also lose the ecosystem services of shellfish reefs.

Photo of shell affected by ocean acidification, courtesy of NOAA's National Ocean Service Photos.

Increased salinity levels could also threaten the marine resources of Dauphin Island, such as by threatening oyster beds that cannot tolerate large changes in salinity. A shift in salinity could also kill native species and allow invasive species to take over an area. For example, Dauphin Island experienced a shift in tree species after Hurricane Frederick in 1979 with the introduction of popcorn trees.

Pine tree in the bird sanctuary on Dauphin Island, courtesy of Macomb Paynes.

In addition, climate impacts such as salt spray from storms can also weaken or kill trees on the island, which can lead to erosion and a loss of protection from strong winds. Climate stressors like storms and fires also occur over short time frames, making it hard for local plants to adapt. Trees that are weakened will become more susceptible to disease and pests, and the loss of trees can cause erosion that can weaken the soil and destroy the island's canopy, which serves as wildlife habitat. This loss of habitat could serve as an additional threat to the island's bird watching and other tourist activities.

Climate impacts can also lead to a loss of habitat for other species on the island. The island's wildlife habitat could face a constant state of disruption as the shape of the island changes and dunes shift inland. Sea level rise will also threaten important coastal wetland ecosystems, which serve as both wildlife habitat and protection for inland areas from the effects of storms.

Transportation and Access

Sea level rise and flooding will affect transportation systems and access to and around Dauphin Island. For example, storms make the causeway to the island impassable, and rocks that are used to protect the highway often end up in the road, blocking passage until the rocks can be removed. The Town also faces issues with evacuation and re-entry of the island before and after a storm, including having limited access to the causeway. As a result of these access issues, more and more people have been choosing to stay on the island during storms. This could have disastrous consequences for those who stay if a storm intensifies after it is not feasible to leave the island. Because re-entry to the island can be delayed after storms, utility and emergency workers can also have difficulty getting back onto the island, which makes it difficult for the Town to get up and running after a storm.

With sea level rise and increased flooding, Dauphin Island may also face access problems with its docks, as well as the ramps and roads to those docks. When the causeway and bridge to the island are inaccessible due to flooding, the ferry to Dauphin Island has been used as backup access to the island. However, if sea level rise and increased flooding inundate the ferry docks, this mode of transportation may be impaired in the future as well.

Finally, increased temperatures could stress the roads to and on Dauphin Island. Extreme heat for long periods of time can soften asphalt, leading to damage on roadways. Further, storms can cause roadways to be covered by sand, impeding the use of these roads around the island.

Photo of sand covering roads on the West End of Dauphin Island after Hurricane Isaac, courtesy of Catherine Janasie.

Economic Effects

Many climate change impacts could have an adverse economic effect on the island. The degradation of ecosystems that help protect the island from storms may lead to more property loss on the island when storm events occur. Storms have also led to a loss of residential and rental property on the island. For instance, due to Hurricanes Ivan and Katrina, the Town lost over 300 homes. Because storms have the potential to destroy houses, the Town will likely lose property tax revenue in the future, as the homes cannot be rebuilt if the property remains under water. In addition, due to a loss of rental properties, fewer people may visit the island, which results in lower sales tax, gas tax and lodging tax revenue. Fewer tourists will also adversely affect the Town's businesses and restaurants.

Hurricanes and more common winter storms have led to homes becoming uninhabitable when water and sewer lines are broken or turned off. Since the electric company will turn off power if a house is under water, properties that become permanently flooded will also permanently lose power. Storms can lead to a loss of infrastructure on the island, including the loss of sewers and roads, and the Town faces the cost of repairing this infrastructure after storms. For example, this past fall, Hurricane Isaac pushed sand onto the island, blocking roads on the West End. The Town had to expend both time and resources to clear the roads and make this part of the island accessible to the Town's residents.

The Town and property owners on the island could also face increased insurance costs or the prospect of self-insuring their property due to storms. With the release of new Alabama Flood Insurance Rate Maps (FIRMs), the town may face increased requirements for building codes and elevation standards. These insurance issues and building requirements may cause people to move from Dauphin Island, further reducing the island's economic activity.

Climate effects could also affect people's decisions to live on or visit the island. By 2100 the Southeast is expected to face a large increase to its heat index, and this could lead to a decreased quality of life on the island. Stressed water resources could also contribute to this decreased quality of life.

Photo of Summer Tanager on Dauphin Island, courtesy of Mike's Birds Photos.

Climate impacts could also impose a constant state of disruption on the island's wildlife habitat. This disruption will affect vegetation on the island, imposing a cost on the Town, Park and Beach Board or property owners to replant damaged vegetation. Tree loss could also reduce property values, and property owners will have to pay to remove dead trees. Dead or weakened trees can also pose a public safety problem, as they can fall on property or people. Invasive species entering the area can have a negative economic impact as well. The Town will have to expend resources to eradicate the introduction of invasive species on the island. Changes to wildlife habitat and invasive species can also affect tourist revenue, as the island relies on revenue created from its bird-watching habitat.

Finally, climate impacts could threaten the economic health of the entire region. With erosion causing the beaches to recede along the western portion of Dauphin Island, a significant amount of Alabama's coastal marshes have been destroyed, which in turn could present a substantial threat to the state's seafood industry. Ocean acidification could also threaten the region's shellfish industry.

Because most of the Gulf Coast is low-lying, its transportation infrastructure is susceptible to sea level rise. This area sees a great deal of commercial transportation with large ports, freight gateways and U.S. operations of the oil and gas industry. Further, about 2/3 of the nation's oil imports travel through the region. Sea level rise could affect this transportation network that is valued in the hundreds of billions of dollars. Finally, the energy facilities located on the Gulf Coast are considered to be very vulnerable to rising sea levels, and the area could face having to repair or raise damaged equipment or build new inland facilities.

Conclusion

The Southeast Region of the U.S. and Dauphin Island have already experienced impacts from changes to climate, and these changes and impacts are expected to continue into the future. As discussed above, these impacts could have potentially large effects on the island. Because of this, the Town currently has the opportunity to proactively plan for these future impacts and make the island more climate resilient. As a next step, the Town can prioritize its planning areas to help focus its climate change adaptation efforts.

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