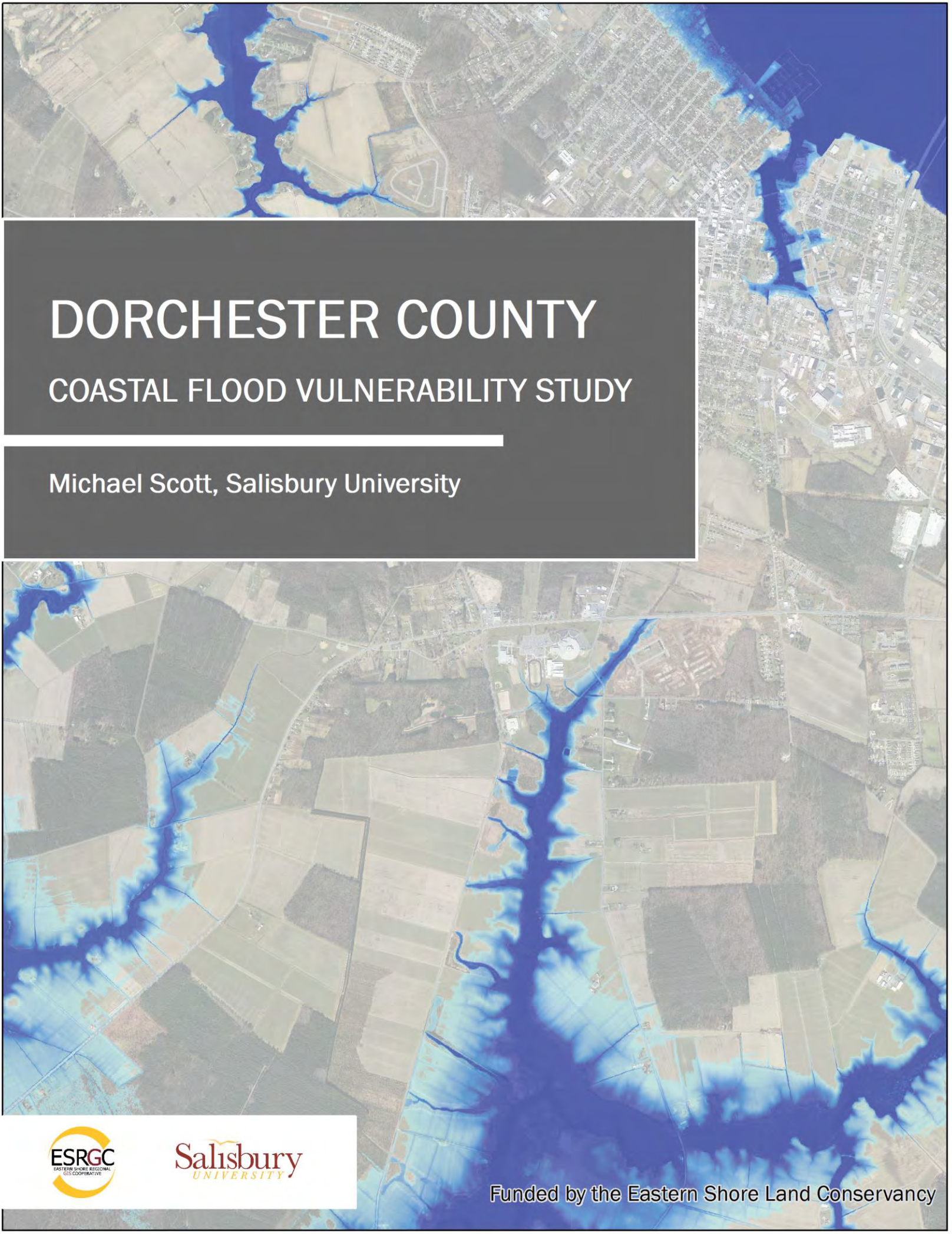

DORCHESTER COUNTY

COASTAL FLOOD VULNERABILITY STUDY

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ESRGC EASTERN SHORE REGIONAL GIS COOPERATIVE

Salisbury UNIVERSITY

Funded by the Eastern Shore Land Conservancy

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Executive Summary

Given the topography and historical development patterns of Maryland's Eastern Shore, the potential for damage from periodic flood events caused by coastal storms and extreme high tides is well-known. What is uncertain is the degree to which the vulnerability of Eastern Shore communities is increasing as sea levels change in the Chesapeake Bay and its tributaries. Therefore, the goal of the study was to model the potential damage to buildings and their contents from severe periodic coastal flooding events, both today and in the future using a value for predicted sea level change. The methods employed in this research are considered best practices, are accepted by FEMA and provide a consistent framework for assessing risk from floods. This information should help the residents, business owners, and government officials be aware of particularly vulnerable areas of the county and help make informed decisions about mitigation measures to reduce the potential impacts. Having said that, we recommend that the damage statistics in this report be viewed as merely an indicator of the potential degree of damage and not as a final and absolute number.

Results of the analysis predict that 2,713 buildings (worth $482.2 million in the structure and its contents combined) would feel the impacts of a 1%-chance flood in Dorchester County, with 631 of them experiencing more than 10% damage, for a total predicted damage of $11.2 million. Those moderately or severely damaged structures represent less than 25% of the total number of vulnerable buildings but they represent well over half of the potential damage in the county from the 1% chance flood. Working to make those structures less vulnerable to flooding should yield considerable financial benefits. The much more severe 0.2%-chance flood impacts 3,098 buildings in the county valued at $569.8 million with 1,195 damaged moderately with a total potential damage of $26.8 million. Given that about 93.4% of the potential damage from a 1% chance flood event comes from residential buildings, instigating mitigation actions that are targeted at Dorchester County homeowners might yield the best results.

In Dorchester County, the magnitude of predicted sea level rise for the remainder of this century is typical for the DelMarVa Peninsula. The US Army Corps of Engineers expects an estimated mean sea level increase in the county of 2.11 ft by 2050 and 5.78 ft by 2100. The sea level rise itself will impact a considerable number of buildings in 2050 – 790, worth $79.0 million in structure and contents. But by 2100, this balloons to 3,463 structures worth $659.4 million. The degree of potential damage from sea level rise inundation in 2100 is also concerning – only $66.4 million or $19,172 per building. Unfortunately a certain level of flood vulnerability seems to be built into Dorchester County, given its expanses of low-lying areas and wetlands.

However, when the 1% chance flood is combined with the predicted sea level rise, the vulnerability of the County's built environment is particularly highlighted. In 2050, the 1% chance flood is predicted to impact 3,619 buildings (a 75% increase over the same scenario today), worth $703.7 million (about 1.5x greater than present-day) and

potentially causing $77.3 million in flood damage (a 7x increase from 2015). The same flood in 2100 could impact 4,585 buildings (a 79% increase from 2050) worth $935.2 million in value (a 75% increase from 2050) and cost a potential $154.1 million in damage (about a 2x increase over the same estimate in 2050).

This coastal flood vulnerability analysis of Dorchester County yields several important conclusions. First, given that Dorchester County has several significant sources of flood threat and given that it contains more than 16,069 improved structures, the fact that 2,713 (16.9%) are already vulnerable to the 1%-chance flood is probably a result of historical land use patterns that are particularly water-oriented, the extreme lack of ground elevation in the southern half of the county, and the impact of sea level change since the 1660's. Second, given the potential for sea level rise in the coming decades, Dorchester County is uniquely vulnerable. By 2050, more than one-fifth of all of the structures in the county will feel the effects and by 2100, if the predictions hold, almost 30% of the county's buildings could be inundated by a 1% chance flood. Even with no flooding at all, mean sea level will bring water to the footprint of about 5% of all of the building stock in Dorchester County. Unfortunately, the impacts that other counties will experience in the future are happening now to the people of Dorchester. But all is not lost. One advantage of this situation is that there will be very little argument about the nature of the threat that Dorchester County faces. This will make consensus about potential mitigation measures much easier to achieve. There are many places around the world that have learned to live alongside a constant flood threat and thrived. It just means that the people of Dorchester County need to become vigilant about implementing in flood-proofing into every development and re-development project planned for the hazard zone. Doing so will enable them to avoid the worst of the negative impacts of flooding and preserve their way of life.

Introduction and Study Context

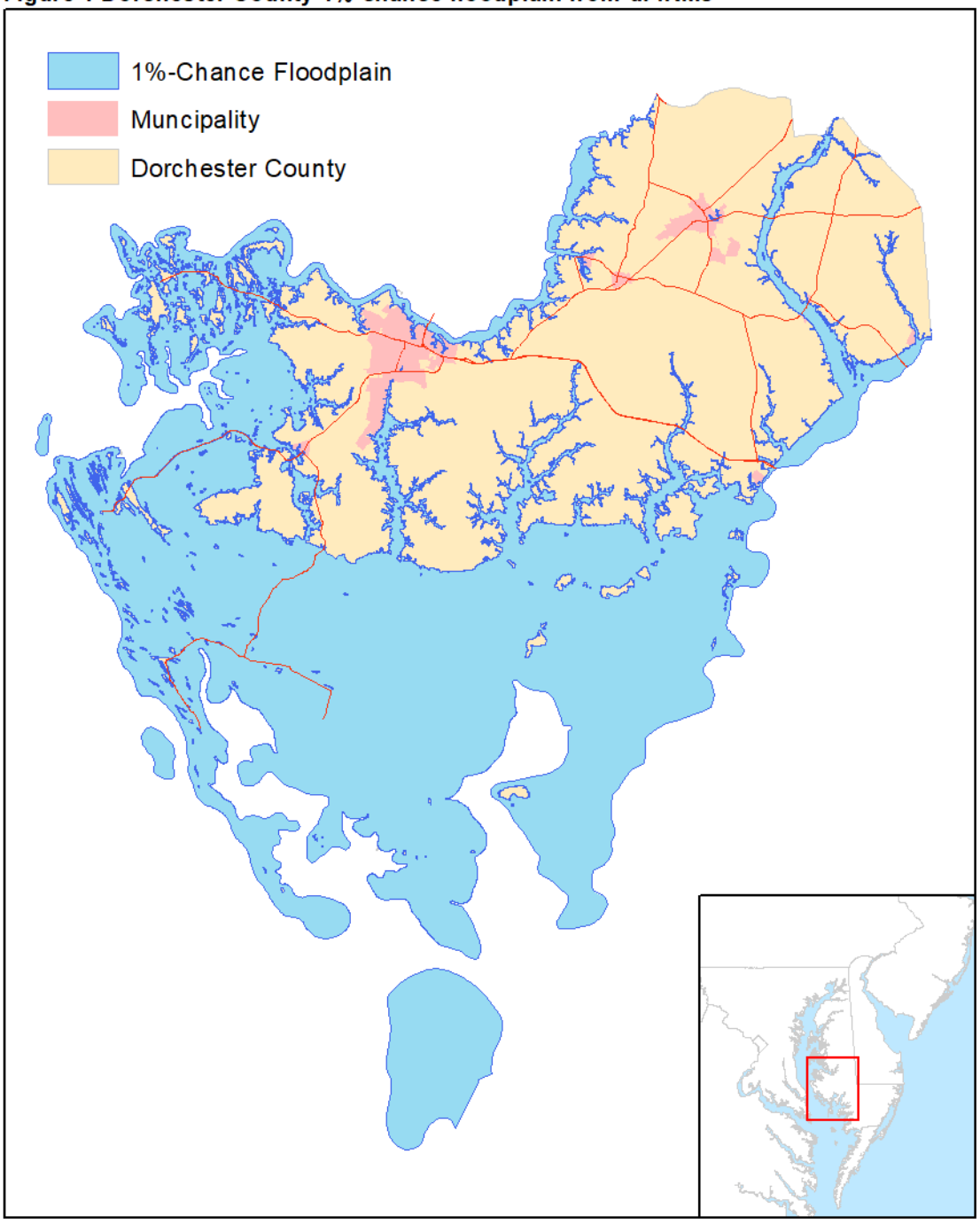
Flooding occurs when rivers, creeks, streams, ditches, or other water bodies receive more water that they can handle from rain, snowmelt, storm surge, or excessive high tides. The excess water flows over adjacent banks or beaches/marshes and into the adjacent floodplain. As many as 85 percent of the natural hazard disasters across the United States have been attributed to flooding.

This document presents the results of a coastal flood vulnerability study of Dorchester County, Maryland conducted by Dr. Michael Scott of Salisbury University at the request of the Eastern Shore Land Conservancy in Easton, Maryland. The goal of the study was to model the potential damage to buildings and their contents from severe periodic coastal flooding events, both today and in the future using a value for predicted sea level change. Specifically, using flood depth data calculated on behalf of the Maryland State Highway Administration, the flood scenarios of a 1% chance flood in 2015, a 0.2% chance flood in 2015, no periodic flooding in 2050, a 1% chance flood in 2050, no periodic flooding in 2100, and a 1% chance flood in 2100 were evaluated versus the location and value of buildings in Dorchester County. The results are an accounting of the potential damage from periodic flooding, exacerbated by future sea level change. This information should help the residents, business owners, and government officials be aware of particularly vulnerable areas of the count and help make informed decisions about mitigation measures to reduce the potential impacts.

Dorchester County's Floodplain

The following map (Figure 1) depicts the 1% chance floodplains within Dorchester County, as designated by FEMA on the Flood Insurance Rate Maps or FIRMs. The 1% chance flood (formerly referred to as the 100-year flood) is a flood which has a 1 percent chance of being equaled or exceeded in any given year (MDE, *Maryland Floodplain Manager's Handbook*). Dorchester County can experience riverine flooding as a result of excessive rainfall in a matter of hours, such as from a severe thunderstorm. Additionally, some soils can become saturated over a longer period of time and reduce their absorption potential. Riverine flooding can affect any of the rivers and streams in the County but primarily affects the non-tidal or brackish portions of the streams that feed Chesapeake Bay. Tidal flooding in Dorchester County usually occurs as a result of tropical storms (including hurricanes) as well as the combination of high astronomical tides with a landward wind. Dorchester County has 48.3% of its land area is in the 1% chance floodplain.

Figure 1 Dorchester County 1% chance floodplain from dFIRMs



While Dorchester County is clearly vulnerable to both riverine and coastal/tidal flooding, only tidal flooding is considered in this vulnerability study. It is entirely possible that those areas in the county beyond the tidal flooding extent will experience a change in their flooding occurrence if the consensus predictions of global climate change come to pass. Current research suggests that extreme rainstorms (as well as extreme droughts) will become more common (National Climate Assessment, 2014).

Flood Measurement

There are two US Geological Survey gauging stations within the County. Four National Weather Service Advanced Hydrologic Prediction Service hydrographs are within the County as well as and two National Oceanographic and Atmospheric Administration tide gauges (Table 1). Measurements of stream discharge, river stage, and tide height are critical to the prediction of flood events. At the CAMM2 hydrograph, flood stage is considered 3.5 ft above average tide and this hydrograph does offer flood level prediction. At the NOAA tide gauge in Bishops Head, the average range of the tide is 1.76 ft. The maximum water level ever recorded was 4.50 ft above mean lower low (MLLW) on March 7, 2018 during a nor'easter. That equals 3.48 ft above MSL, or less than the 1% chance flood height. The tide gauge at Bishops Head has only been recording since 2005. At the NOAA tide gauge in Cambridge, the average range of the tide is 1.62 ft. The maximum water level ever recorded was 6.18 ft above mean lower low (MLLW) on September 19, 2003 during Hurricane Isabel. That equals 5.16 ft above MSL, or just about than the 1% chance flood height. The tide gauge at Cambridge has been recording since 1980.

Table 1. River gauges, hydrographs and tide gauges in Dorchester County

Agency	ID Number	Station Name	Real-Time or Daily
USGS	01490000	Chicamacomico River near Salem	Real-time
USGS	01488110	Nanticoke River at Sharptown	Real-time
NWS	CAMM2	Chesapeake Bay at Cambridge	Real-time
NWS	BISM2	Chesapeake Bay at Bishops Head	Real-time
NWS	CMCM2	Chicamacomico River at Salem	Real-time
NWS	SRPM2	Nanticoke River at Sharptown	Real-time
NOAA	8571421	Bishops Head	Real-time
NOAA	8571892	Cambridge	Real-time

Flood Levels

Using the Flood Insurance Studies (FIS) of Dorchester County, published by FEMA effective March 16, 2015, the following table (Table 2) reports the flood elevations for the key flooding sources.

Table 2. Flood elevations for coastal event (Units are NAVD 1988 feet)

Flooding Source and Location	10% Annual Chance	2% Annual Chance	1% Annual Chance	0.2% Annual Chance
CHESAPEAKE BAY				
At Rioll Cove	3.1	3.7	3.9	4.3
At Charity Point	3.1	3.6	3.8	4.7
At Nancy's Point	3.2	3.7	3.8	4.6
CHOPTANK RIVER				
At Castle Haven Point	3.4	3.9	4.1	4.7
At Cambridge	3.5	4.1	4.3	5.0
LITTLE CHOPTANK RIVER				
At Casson Point	3.2	3.7	3.9	4.4
At Smith Cove	3.3	3.8	4.0	4.6
HONGA RIVER				
At Crab Point	3.2	3.8	4.0	4.8
FISHING BAY				
At Elliot's Island	3.9	4.6	4.8	5.3
HOOPER STRAIT				
At Hopkins Cove	3.4	3.9	4.2	4.7
NANTICOKE RIVER				
At Mulberry Point	4.0	4.8	5.0	5.8
At Upper Greens Cove	4.3	5.3	5.6	6.4

Hazards from Floods

Flooding causes $6 billion in average annual losses in the United States annually and account for an average of 140 casualties annually (USGS, "Flood Hazards – A National Threat," 2006). While most people's vision of the threat from flooding may include being swept away or buildings being structurally impacted, there are actually a number of hazards associated with flooding that occur both during and after an event.

During the Flood

While a flood event is underway, citizens will be faced with a number of threats. The hydraulic power of water is significant and walking through as little as 6 inches of moving water is dangerous because of the possibility of losing stable footing. Driving through flood water is the cause of many flood deaths each year. As little as one foot of water can float many cars and two feet of rushing water can carry away most vehicles including SUVs. That fact, combined with an inability for drivers to judge the depth of flood water, as well as the potential for flood waters to rise quickly without warning, making driving through flood water a very unwise action.

In addition to being swept away, flood water itself is to be avoided. Because of leaking industrial containers, household chemicals, and gas stations, it is not healthy to even touch the flood water without protective equipment and clothing. Downed power lines, flooded electric breaker panels, and other sources of electricity are a significant threat during a flood. One should also be prepared for the outbreak of fire. Electric sparks

often cause fire to erupt and because of the inability of firefighting personnel to respond, a fire can quickly burn out of control.

After the Flood

Cleaning up after a flood can also expose citizens to a number of threats. For example, electrical circuits or electrical equipment could pose a danger, particularly if the ground is wet. Buildings that have been exposed to floodwater may exhibit structural instability of walkways, stairs, floors, and possibly roofs. Flood waters often dislodge and carry hazardous material containers such as tanks, pipes, and drums. They may be leaking or simply very heavy and unstable. The combination of chemical contamination and the likely release of untreated sewage (necessary when the sewage treatment plant is overwhelmed with flood-swelled effluent) mean that drinking water supplies can be unusable. Fire continues to be a very real threat after a flood. First-responders could be occupied with more pressing emergencies and traditional fire suppression equipment may be inoperable, but there may be mobility problems that keep fire-fighting equipment from reaching an outbreak. Finally, there is the mental toll of being involved in a disaster. Continued long hours of work, combined with emotional and physical exhaustion and losses from damaged homes and temporary job layoffs, can create a highly stressful situation for citizens. People exposed to these stressful conditions have an increased risk of injury and emotional crisis, and are more vulnerable to stress-induced illnesses and disease.

Impact to Buildings

Fortunately, the number of people killed or injured during floods each year is relatively small. The built environment within the floodplain, however, is likely to bear the brunt of a flood's impact. Whether the water is moving or standing, the exposure of buildings to flood water could cause a great deal of damage. If the water is moving, the differing hydraulic pressure inside the building vs. outside can cause the walls and foundation to buckle and fail. If the water is standing for any length of time, even materials above the flood height will become saturated with flood water as the flood water is absorbed (known as wicking). Certainly, most of the contents of flooded buildings that were located at or below the flood height will need to be discarded. This includes carpet, furniture, electronic equipment, and other household or commercial items. In most cases it is not simply the fact that the objects have become wet but since the flood water brings with it sediment and chemicals, it makes it nearly impossible to recover all but the most precious/heirloom items.

Flood Vulnerability Assessment

The goal of mitigation is to increase the flood resistance of a community, so that the residents and businesses will become less susceptible to future exposures to flooding, thereby resulting in fewer losses. A key component to reducing future losses is to first have a clear understanding of the current threats, the current probability that those threats would occur, and the potential for loss from those threats. The Vulnerability Assessment is a crucial first step in the process as it is an organized and coordinated process of assessing potential hazards, their risk of occurring, and the possible impact of an event.

Study Method

The Vulnerability Assessment was conducted using the method developed for HAZUS-MH, FEMA's loss estimation software, to assess the County's built environment to vulnerability to flooding. HAZUS-MH is a Geographic Information System (GIS)-based software tool that applies engineering and scientific risk calculations that have been developed by hazard and information technology experts to provide credible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards, including floods, hurricane winds and earthquakes. The methodology supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

The primary input to any vulnerability assessment is a "depth of flood" grid. This flood depth grid was created using an elevation grid derived from LiDAR measurements. By incorporating the polygons of the 1% chance floodplain from the FIRMs, the coastal flood elevations from the Flood Insurance Study as well as the current elevation grid, HAZUS-MH was able to create a flood depth grid with a reasonable precision for the 1% (Figure 2) and 0.2%-chance (Figure 3) coastal flood scenarios with Dorchester County's current mean sea level. In addition, areas predicted to be inundated by a higher mean sea level in 2050 (Figure 4) and 2100 (Figure 5) were also modeled. Finally, the depth of flood for the 1%-chance event was mapped using the 2050 (Figure 6) and 2100 (Figure 7) predicted sea levels. For the full detail of how these depth grids were created, please see "GIS Data Products to Support Climate Change Adaptation Planning: Dorchester County, Maryland" at http://www.esrgc.org/mapServices/.

Figure 2 Predicted flood depths for Dorchester County 1% chance floodplain at MSL in 2015

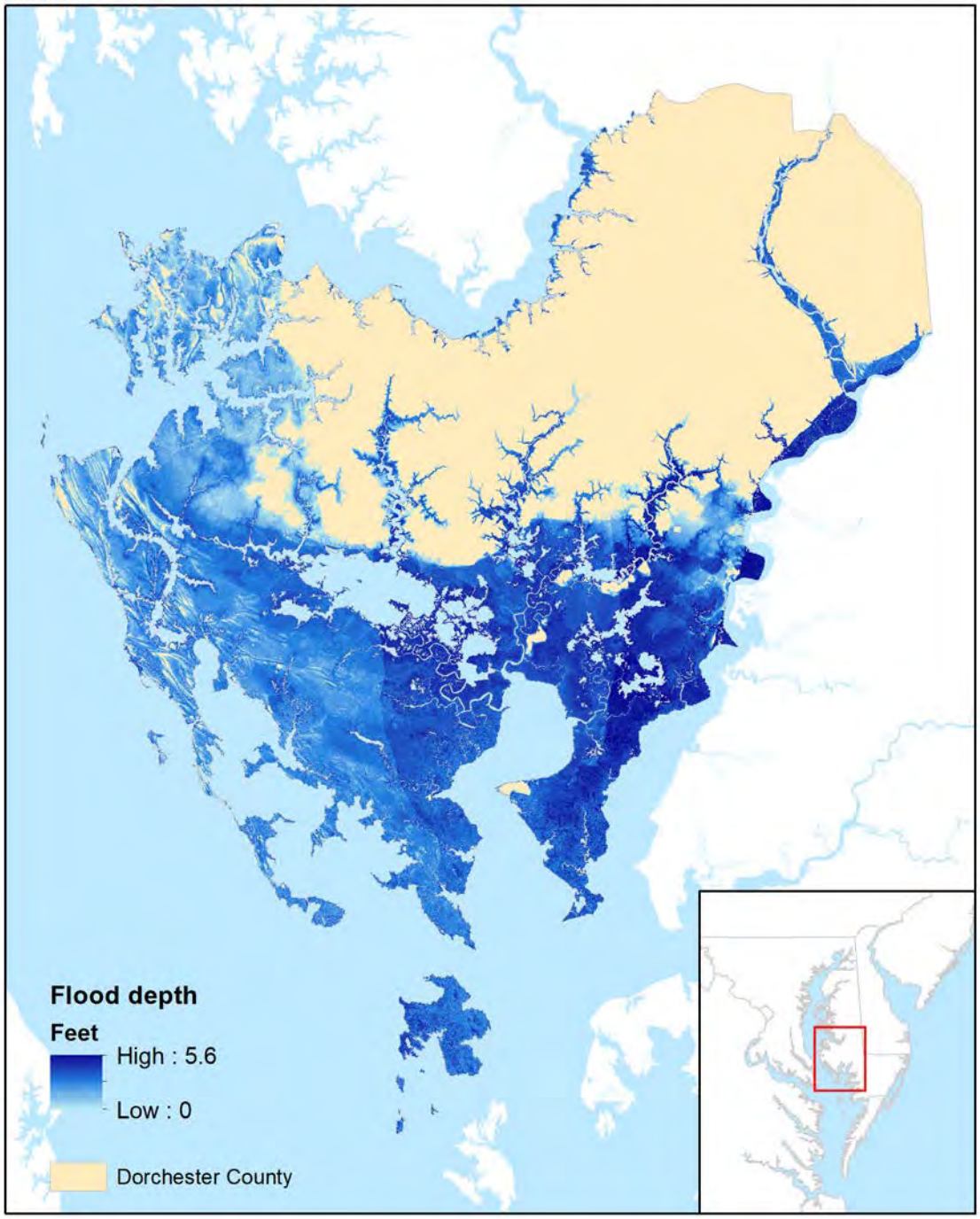


Figure 3 Predicted flood depths for Dorchester County 0.2% chance floodplain at MSL in 2015

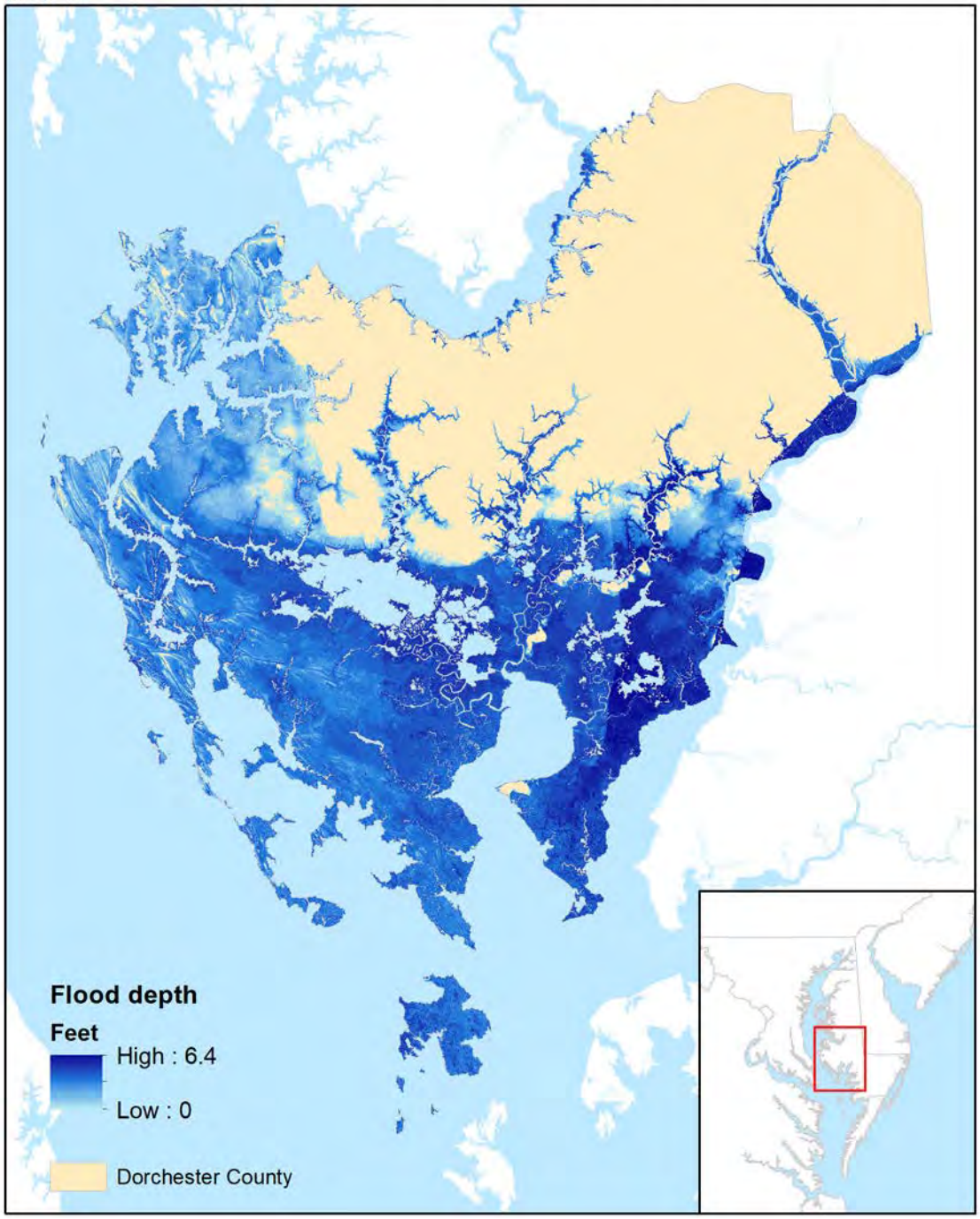


Figure 4 Predicted depth of MSL inundation in Dorchester County in 2050

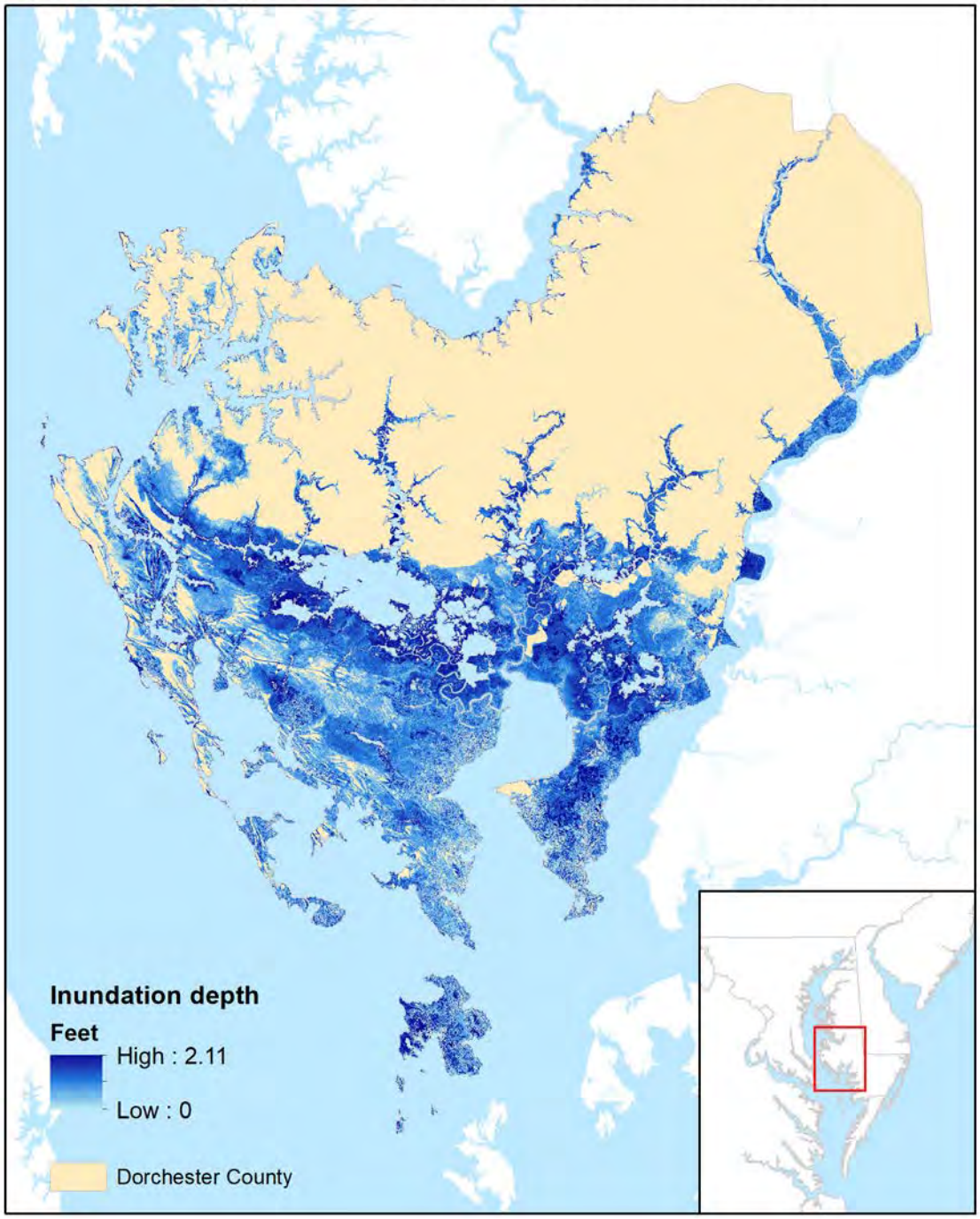


Figure 5 Predicted depth of MSL inundation in Dorchester County in 2100

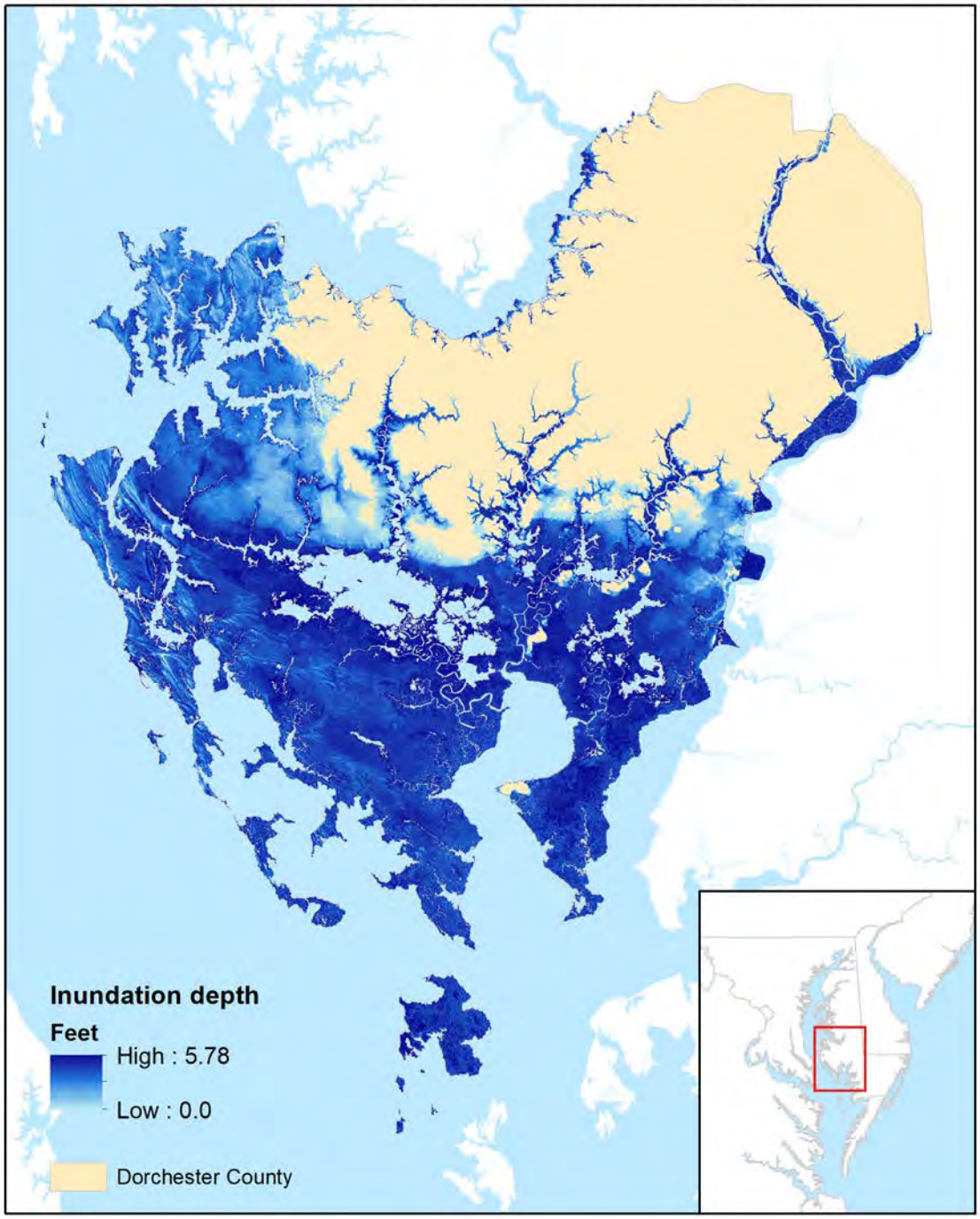


Figure 6 Predicted flood depths for Dorchester County 1% chance floodplain at MSL in 2050

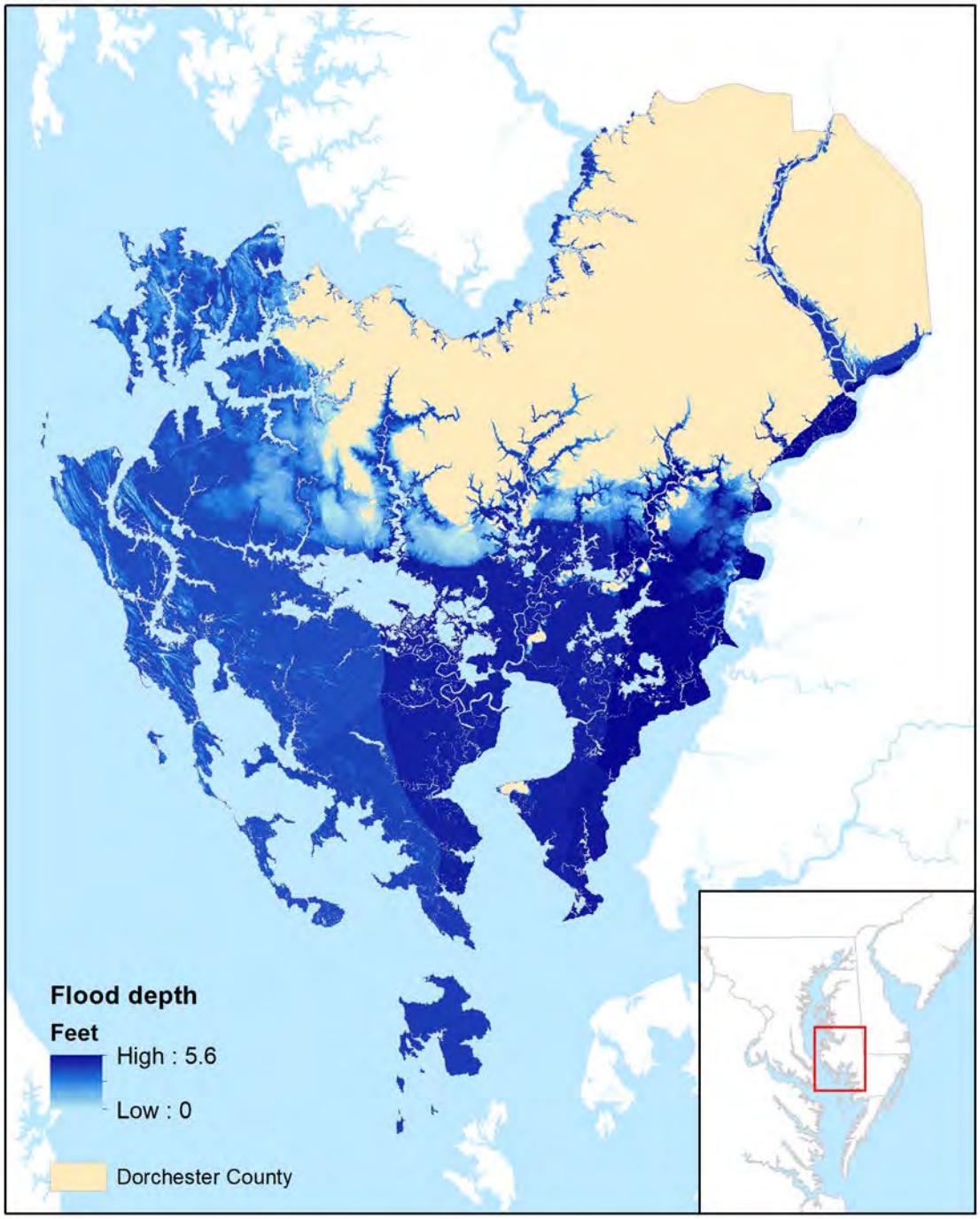
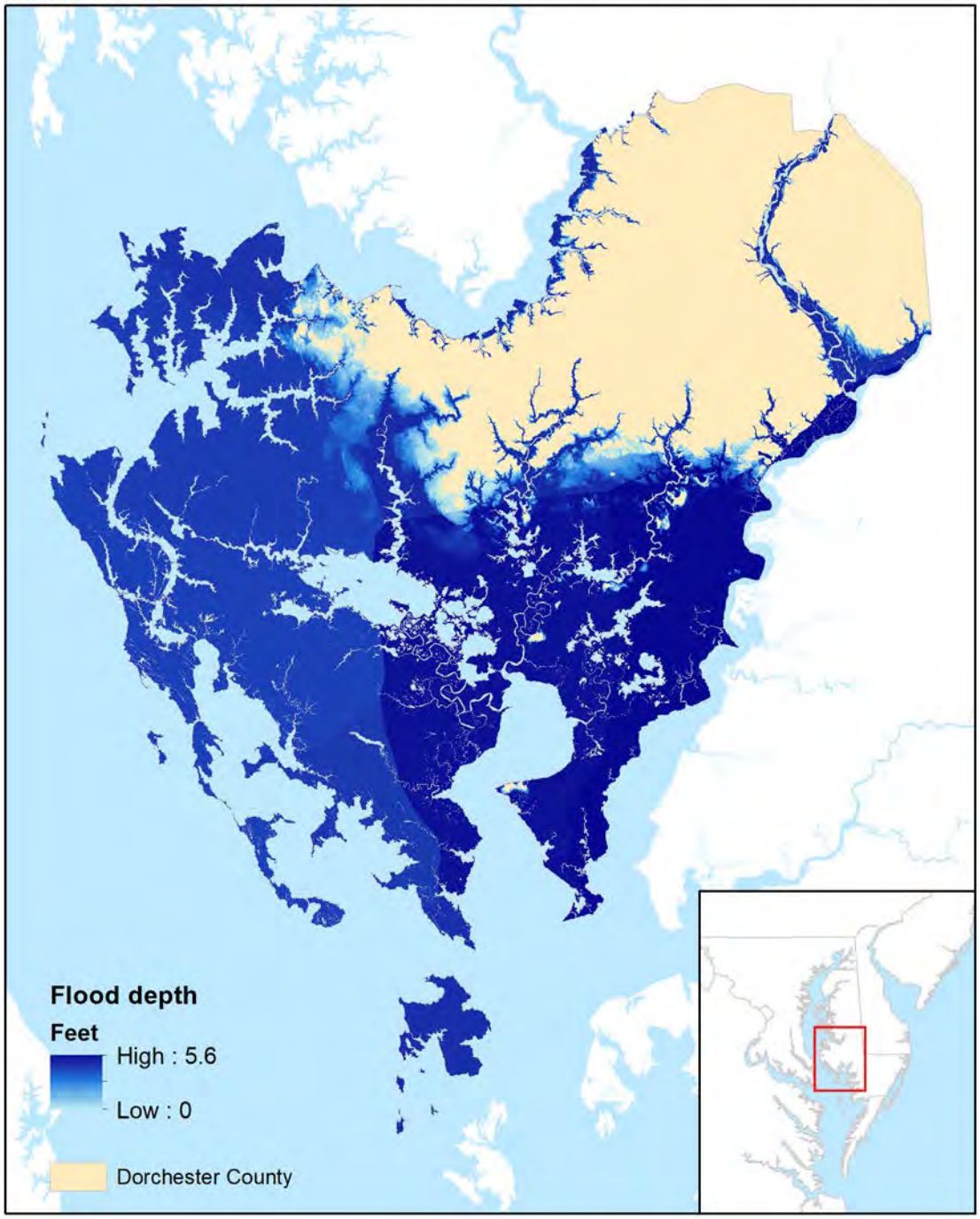


Figure 7 Predicted flood depths for Dorchester County 1% chance floodplain at MSL in 2100



Using these flood depth grids, those buildings that are vulnerable to flood water, and the degree to which they are vulnerable, were determined. Fortunately, Dorchester County maintains a set of "addressable" building footprint polygons, separate from any outbuildings. Next, the average depth of flood water for each modeling scenario was calculated for each building by converting the depth grids to depth points and intersecting the building footprints and the depth points. Dorchester County's 2015 tax parcels were then digitally overlaid, thus assigning attributes such as total assessed value of the improvements, the land use of the parcel (residential, commercial, etc), and the structure style (1 story, 2 story, apartments, etc) to the building footprint. Because the foundation heights are unknown, an assumption of a 24" foundation was made. Using that assumed foundation height, the flood depth above the first finished floor was calculated. The total value of the building and its contents was found, using industry-standard estimates of the contents value based on the use of the building (i.e. residential contents are 50% of the building value, while commercial contents are 100% of the building value). Finally, using the depth-damage curves provided by FEMA via the HAZUS-MH software, the potential damage percentage, and therefore the potential damage to both the building and its contents in 2015 dollars, for each building for each flood scenario was estimated.

It is important to note when viewing the following results that the numbers generated carry with them a degree of uncertainty. Nearly every component (the ground elevations, the flood heights, the foundation heights, the assessed value, etc.) has confidence constraints of various magnitudes. The HAZUS-MH model itself is a simplified version of the complex engineering models used to create the flood insurance rate maps. Having said that, considerable research has been conducted to review HAZUS-MH analysis results after an event and have found that the software does a reasonably good job of both predicting the depth of flood as well as the insured losses. But was with any simulation analysis, we recommend that these damage statistics be viewed as merely an indicator of the potential degree of damage and not as a final and absolute number.

Flood Results for Present-Day (2015)

The results of the analysis indicate that there are 2,713 buildings predicted to be impacted by a 1% chance flood in Dorchester County (Table 3). A majority of them (1,468) would only experience minor nuisance flooding in this scenario; Nearly a quarter of them (631 or 23.3%) would experience greater than 10% damage. Thus, the overall predicted damage percentage from this flood level is 2.3% of the total value of the structures and contents ($11.2 million of damage from $482.2 million in value). When standardized per building, those buildings that are predicted to incur incidental damage are also the most valuable (an average of $234,130 per building vs $74,869 per building that are damaged 10% or greater). This is not surprising given that many of these more expensive structures are found in Cambridge and the other more densely populated areas – areas that by their nature are well-known to be susceptible to occasional

flooding. It is also worth noting that a significant mitigation opportunity exists. There are 126 buildings predicted to be damaged between 20 and 60% in the 1% chance event that represent less than 5% of the total number of vulnerable buildings. However, they represent over 12% of the potential damage. Working to make those structures less vulnerable to flooding should yield worthwhile financial benefits. Unfortunately, nearly all the half of the potential damage comes from 505 buildings damaged between 10 and 20%. That is a large number of property owners to reach in a short time period.

The spatial distribution of the structures vulnerable to the 1%-chance flood event follows a predictable pattern (Figure 8). Large concentrations of vulnerable buildings are found in the Neck District (between the Choptank River, the Little Choptank River, and the Chesapeake Bay), the Church Creek area, Taylor's Island, Hooper's Island, and the southern peninsula headed for Crocheron. One can see the road network in the south of the county highlighted as that is where the development has taken place. Other areas impacted, but less so, are along the Little Blackwater River, the Nanticoke River, the Chicamacomico River, and Marshyhope Creek.

Table 3. Potential damage to structures/contents from a 1% chance flood event in 2015 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	1,468	54.1%	$343,703,305	$234,130	$88,313	$60	0.8%
1 - 10%	614	22.6%	$91,281,677	$148,667	$4,217,805	$6,869	37.6%
10 - 20%	505	18.6%	$41,625,330	$82,426	$5,512,769	$10,916	49.1%
20 - 30%	112	4.1%	$5,167,598	$46,139	$1,227,945	$10,964	10.9%
30 - 40%	8	0.3%	$337,354	$42,169	$119,230	$14,904	1.1%
40 – 50%	4	0.1%	$87,450	$21,862	$39,863	$9,966	0.4%
50% or more	2	0.1%	$24,450	$12,225	$12,872	$6,436	0.1%
Total	2,713	100.0%	$482,226,894	$177,747	$11,218,796	$4,135	100.0%

Note: All dollar values are from 2015 tax assessments.

The very severe 0.2% chance flood event represents a current worst-case scenario for Dorchester County (Table 4). In such an event, 3.098 buildings would be impacted with 1,184 impacted moderately (10 – 50%) and 9 impacted severely (50% or greater). The total value of the structures and their contents that are vulnerable to flooding expands to $569.8 million and the potential damage is calculated to be $26.8 million, or more than double that of the 1% chance event. The number of buildings that are minimally effected (1,147) drops by more than 17% as a percentage of the total vulnerable buildings (54.1% in 1%-chance scenario vs. 37.0% in the 0.2%-chance). This indicates that in such a severe flood, the water is not reaching many more structures than previously

impacted, only 385. Unfortunately, the potential damage that could be sustained to those buildings subjected to the flood will be higher.

Figure 8 Spatial distribution of vulnerable structures in Dorchester County 1% chance flood at MSL in 2015 (n=2,713)

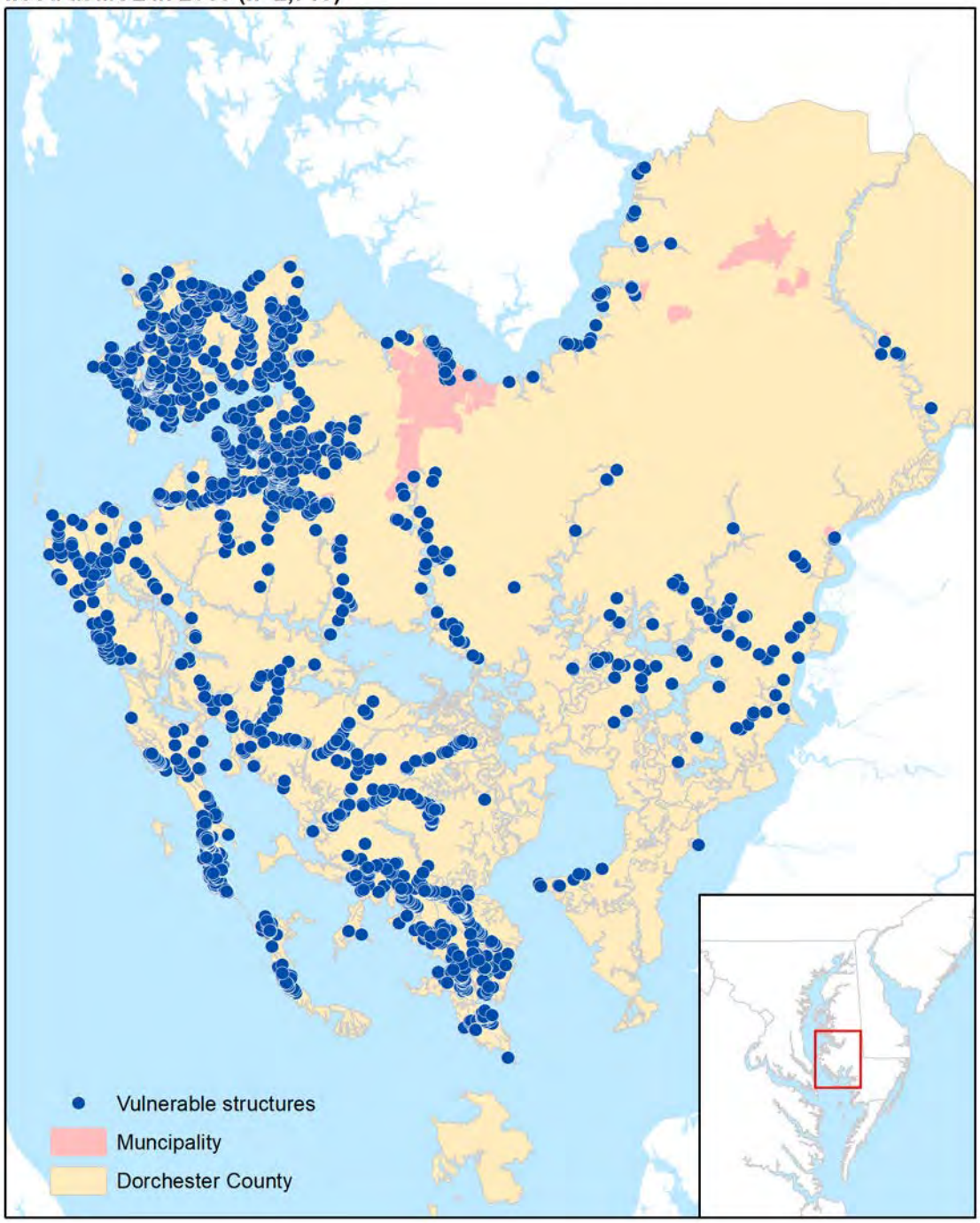


Table 4. Potential damage to structures/contents from a 0.2% chance flood event in 2015 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	1,147	37.0%	$289,544,515	$252,436	$102,732	$90	0.4%
1 - 10%	756	24.4%	$159,791,863	$211,365	$8,269,028	$10,938	30.8%
10 - 20%	853	27.5%	$98,618,509	$115,614	$13,234,030	$15,515	49.3%
20 - 30%	299	9.7%	$20,200,873	$67,561	$4,596,321	$15,372	17.1%
30 - 40%	24	0.8%	$1,072,912	$44,705	$365,372	$15,265	1.4%
40 – 50%	10	0.3%	$292,502	$29,250	$132,447	$13,245	0.5%
50% or more	9	0.3%	$259,200	$28,800	$141,277	$15,697	0.5%
Total	3,098	100.0%	$569,780,374	$183,919	$26,841,208	$8,664	100.0%

Note: All dollar values are from 2015 tax assessments.

When the potential damage was also examined with respect to land use, it was found that no matter the scenario, the vast majority all of buildings vulnerable to flooding in Dorchester County were residential, ranging from 92.8% in the 1% chance scenario (Table 5) to 93.0% in the 0.2% chance scenario (Table 6). The second largest category was agricultural buildings, 1.9% in both the 1% chance scenario and the 0.2% chance scenario. In the 1% chance scenario, the majority of the damage (93.4%) comes from residential buildings, which is to be expected given the number of residential buildings affected. However, given that (relatively) few industrial buildings are predicted to be impacted (21 or 0.8%), it is concerning that they account for 2.8% of the predicted damage. But still, the vast majority of mitigation actions need to be targeted at Dorchester County homeowners as that will yield the best results.

Table 5. Potential damage to structures/contents from a 1% chance flood event in 2015 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	2,518	92.8%	$445,000,845	$10,480,245	2.4%	93.4%
Commercial	50	1.8%	$14,275,613	$265,008	1.9%	2.3%
Government	42	1.5%	$13,446,811	$13,102	0.1%	0.1%
Industry	21	0.8%	$5,565,754	$313,749	5.6%	2.8%
Religious	30	1.1%	$3,598,650	$144,113	4.0%	1.3%
Agricultural	52	1.9%	$339,220	$2,579	0.8%	0.0%
Total	2,713	100.0%	$482,226,894	$11,218,796	2.3%	100.0%

Note: All dollar values are from 2015 tax assessments.

Table 6. Potential damage to structures/contents from a 0.2% chance flood event in 2015 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	2,880	93.0%	$523,423,336	$24,272,748	4.6%	90.4%
Commercial	57	1.8%	$21,371,215	$994,891	4.7%	3.7%
Government	45	1.5%	$14,305,814	$686,814	4.8%	2.6%
Industry	21	0.7%	$5,565,754	$640,450	11.5%	2.4%
Religious	36	1.2%	$4,422,827	$238,653	5.4%	0.9%
Agricultural	59	1.9%	$691,428	$7,652	1.1%	0.0%
Total	3,098	100.0%	$569,780,374	$26,841,208	4.7%	100.0%

Note: All dollar values are from 2015 tax assessments.

One final way to break down the countywide vulnerability results is to examine them by property value. The following tables explore the vulnerability of the buildings based on the values of the structure and its contents (Tables 7 & 8). Each flooding scenario presents remarkably consistent results and thus there are some overall conclusions that can be made. First, in both flood scenarios, the least valuable properties suffer the most damage, relative to their value. Given that the owners of these properties are historically the least likely to have flood insurance, this situation could be debilitating for those property owners. Second, nearly 2/3 of the total damage from the 1% chance event is generated by relatively inexpensive properties (both a structure and contents value between $50,000 and $300,000). This is a concern as not only does it represent nearly 1,600 separate properties but these homeowners (nearly all are residential) are unlikely to have the resources necessary to make significant changes themselves. Finally, with the increase in flood depths in the 0.2% chance scenario, the damage percentages begin to spread out among the range of property values. This suggests that the 0.2%-chance flood is severe enough to damage many different areas and are felt by working-class, middle-class, and upper-class neighborhoods alike.

Table 7. Potential damage to structures/contents from a 1% chance flood event in 2015 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	648	23.9%	$11,887,727	$1,095,883	9.2%	9.8%
$50 - $100	520	19.2%	$38,664,175	$2,446,942	6.3%	21.8%
$100 - $200	691	25.5%	$100,812,975	$3,261,330	3.2%	29.1%
$200 - $300	388	14.3%	$93,828,765	$1,477,059	1.6%	13.2%
$300 - $400	220	8.1%	$74,936,192	$781,806	1.0%	7.0%
$400 - $500	100	3.7%	$44,216,950	$407,149	0.9%	3.6%
$500 - $1,000	130	4.8%	$86,160,610	$637,539	0.7%	5.7%
$1,000 - $2,000	11	0.4%	$14,347,500	$270,504	1.9%	2.4%
$2,000 - $3,000	1	0.0%	$2,832,200	$0	0.0%	0.0%
More than $3,000	4	0.1%	$14,539,800	$840,584	5.8%	7.5%
Total	2,713	100.0%	$482,226,894	$11,218,796	2.3%	100.0%

Note: All dollar values are from 2015 tax assessments

Table 8. Potential damage to structures/contents from a 0.2% chance flood event in 2015 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	711	23.0%	$13,211,357	$1,669,277	12.6%	6.2%
$50 - $100	581	18.8%	$43,275,025	$4,331,658	10.0%	16.1%
$100 - $200	783	25.3%	$114,119,075	$7,660,639	6.7%	28.5%
$200 - $300	470	15.2%	$113,914,840	$4,905,126	1.6%	18.3%
$300 - $400	258	8.3%	$88,158,342	$2,574,715	2.9%	9.6%
$400 - $500	117	3.8%	$51,740,725	$1,549,323	3.0%	5.8%
$500 - $1,000	156	5.0%	$104,201,160	$2,059,465	2.0%	7.7%
$1,000 - $2,000	15	0.5%	$19,515,450	$1,114,205	5.7%	4.1%
$2,000 - $3,000	3	0.1%	$7,104,600	$0	0.0%	0.0%
More than $3,000	4	0.1%	$14,539,800	$976,799	6.7%	3.6%
Total	3,098	100.0%	$569,780,374	$26,841,208	4.7%	100.0%

Note: All dollar values are from 2015 tax assessments

Sea level Rise Inundation in 2050 and 2100

Unfortunately, we know that the water levels in the Chesapeake Bay that feed this periodic tidal flooding are not static – they are quite dynamic. Scientists at the USGS estimate that mean sea level in the Bay was about 2 feet lower when Captain John Smith first mapped it in 1608 (Larsen, 1998; https://pubs.usgs.gov/fs/fs102-98/). The Mid-Atlantic region is predicted to be one of the most affected by sea level change going forward because of the presence of the combination of eustatic sea level rise, thermal expansion of sea water as the earth warms, the slowdown of the North Atlantic gyre, and the subsidence of the land surface from the glacial isostatic rebound. The current sea level trend, measured from 1937 to 2015 at the Solomons Island tide gauge is 3.74 mm/year or 1.23 ft in 100 years.

However, scientists do not think that a linear trend will continue. The rate is expected to increase. The models used in this flood mitigation plan follow the same method used by the Maryland State Highway Administration to document the potential flood vulnerability of the road infrastructure from periodic flooding in 2050 and 2100. For that method, the "high" estimates of sea level change from the US Army Corps of Engineers was chosen as the appropriate planning scenario. For Dorchester County, this means the USACE expects an estimated mean sea level increase of 2.11 ft by 2050 and 5.78 ft by 2100 (Figures 4 & 5).

Using these amounts of change in mean sea level, additional analysis of the vulnerability of the built environment from the inundation expected from mean sea level (but no flooding) in 2050 and 2100. However, it should be noted that these damage estimates are not particularly appropriate for non-periodic flooding. They are included here primarily for comparison's sake. If the buildings predicted to be inundated constantly by a rise in mean sea level were not elevated beyond the reach of the water, the damage done to them would be a great deal more severe.

As the 2050 mean sea level inundation results show (Table 9), Dorchester County is uniquely vulnerable on Maryland's Eastern Shore. There are 790 buildings are predicted to experience water in the footprint of their structure. Thankfully, nearly all (98.4%) are not damaged to any quantifiable degree. These are building footprints intersecting with less than 6" of water. The remaining thirteen properties in the county that may be impacted by sea level inundation are worth about $2.1 million. The spatial distribution of the properties shows the majority in the southern portion of the county below the Blackwater River: Toddville, Crapo, Wingate, Bishops Head, and Crocheron are examples. There are small clusters of buildings in Tilghman's Island, Church Creek, and Brooks Creek (Figure 9). By 2100, the situation will have changed dramatically – the number of buildings at risk from inundation increased 4.4x, from 790 in 2050 to 3,463 in 2100 (Table 10). Those 3,463 buildings represent $659.4 million in structure and content value. Again, the prediction of damage in the scenario is very uncertain as the processes that cause inundation damage are quite different than periodic flood damage. However, an overall damage rate of 10.1% is very concerning and is more than 6x the

rate that we expect from a 1% chance flood event in 2015. With regard to the spatial distribution of the structures predicted to be inundated in 2100 (Figure 10), it is difficult to discern any specific pattern besides the widespread impacts across all of peninsular Dorchester County.

Table 9. Potential damage to structures/contents from mean sea level inundation in 2050 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	777	98.4%	$76,950,218	$99,035	$848	$1	0.4%
1 - 10%	9	1.1%	$282,862	$31,429	$14,455	$1,606	6.4%
10 - 20%	4	0.1%	$1,806,125	$451,531	$211,074	$52,768	93.2%
20 - 30%	0	0.0%	$0	$0	$0	$0	0.0%
30 - 40%	0	0.0%	$0	$0	$0	$0	0.0%
40 – 50%	0	0.0%	$0	$0	$0	$0	0.0%
50% or more	0	0.0%	$0	$0	$0	$0	0.0%
Total	790	100.0%	$79,039,205	$100,050	$226,377	$337	100.0%

Note: All dollar values are from 2015 tax assessments

Table 10. Potential damage to structures/contents from mean sea level inundation in 2100 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	598	17.3%	$162,108,798	$271,085	$69,588	$116	0.1%
1 - 10%	566	16.3%	$137,635,936	$243,173	$7,746,354	$13,686	11.7%
10 - 20%	1,392	40.2%	$262,212,848	$188,371	$34,358,077	$24,683	51.8%
20 - 30%	783	22.6%	$92,753,727	$118,459	$22,252,730	$28,420	33.5%
30 - 40%	62	1.8%	$2,150,214	$34,681	$726,440	$11,717	1.1%
40 – 50%	30	0.1%	$1,521,150	$50,705	$681,435	$22,714	1.0%
50% or more	32	0.1%	$995,325	$31,104	$556,845	$17,401	0.8%
Total	3,463	100.0%	$659,377,999	$190,407	$66,391,470	$19,172	100.0%

Note: All dollar values are from 2015 tax assessments

Figure 9 Spatial distribution of vulnerable structures in Dorchester County, no flood at MSL in 2050 (n=790)

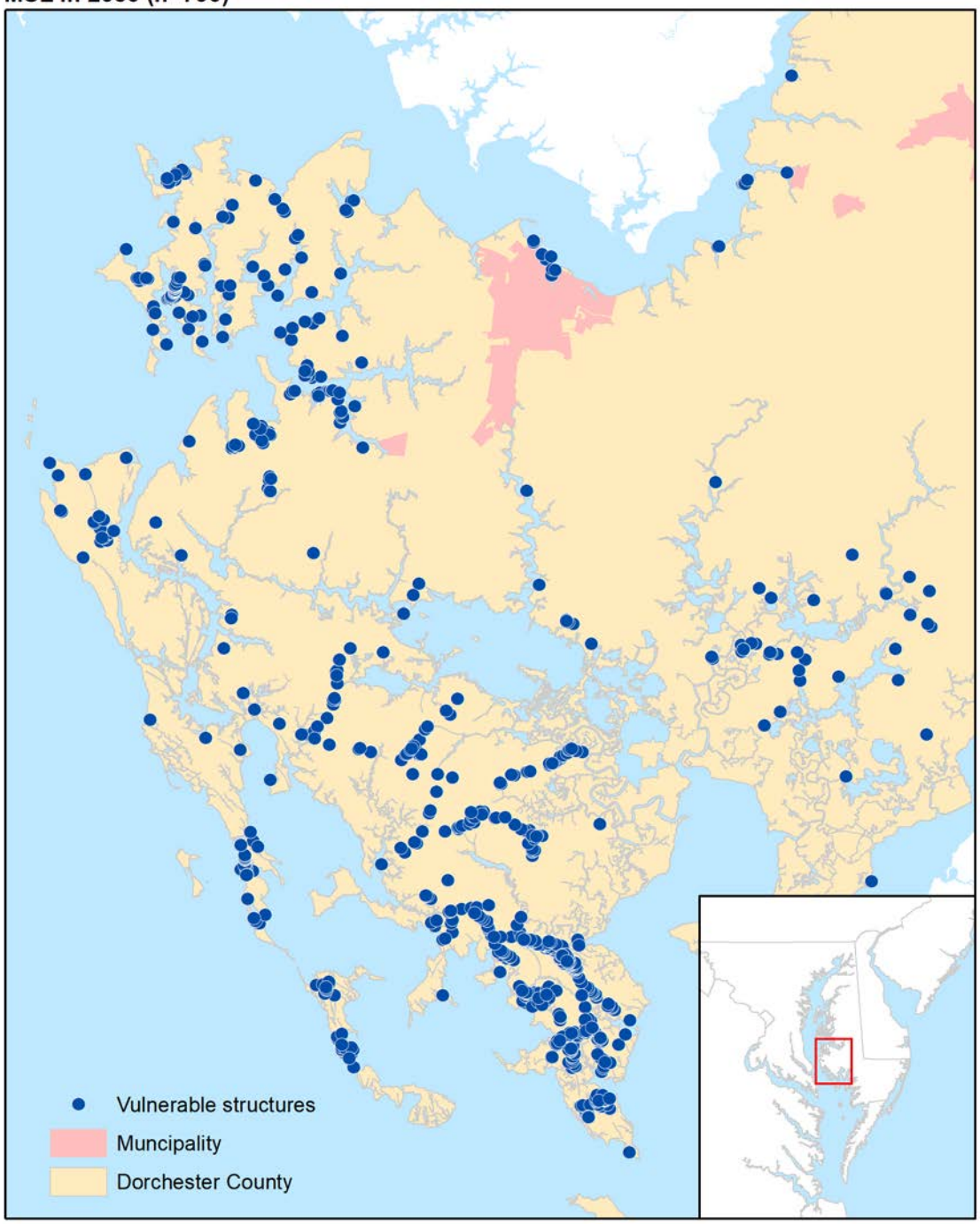
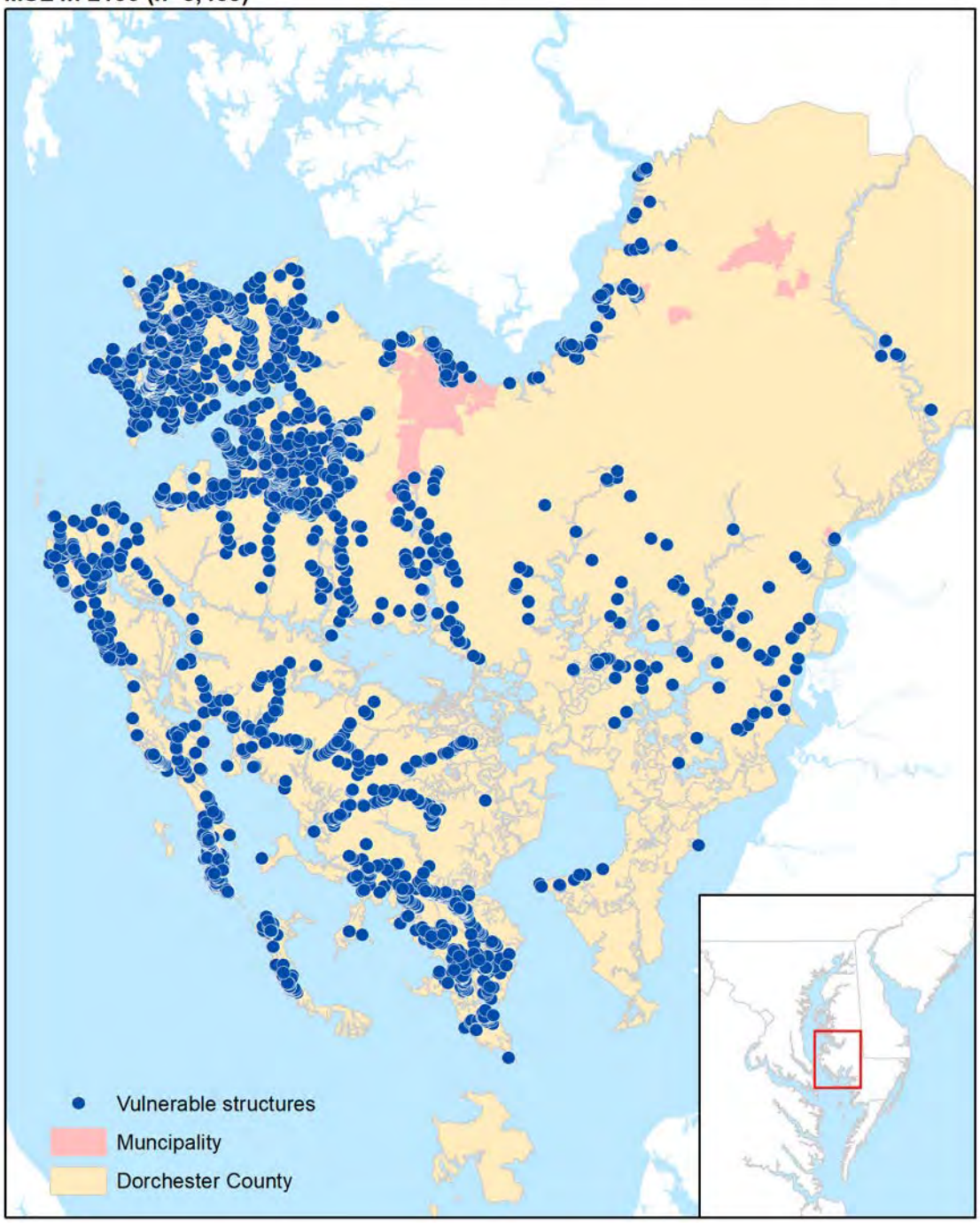


Figure 10 Spatial distribution of vulnerable structures in Dorchester County, no flood at MSL in 2100 (n=3,463)



With regard to inundation with respect to land use, the impact from sea level change in 2050 will be overwhelmingly (89.9%) residential (Table 11). However, nearly all of the potential damage comes from industrial buildings. In Dorchester County, these buildings are mostly infrastructure related (like power transfer stations). By 2100 however, it becomes clear that sea level change in Dorchester County will be disproportionately felt by residents, with 93.0% of all of structures being inundated as residential, and that sector suffering 91.4% of the potential damage (Table 12).

Table 11. Potential damage to structures/contents from mean sea level inundation in 2050 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	710	89.9%	$66,757,657	$20,394	0.0%	9.0%
Commercial	23	2.9%	$4,926,333	$0	0.0%	91.0%
Government	12	1.5%	$2,689,606	$0	0.0%	0.0%
Industry	12	1.5%	$3,483,502	$205,980	5.9%	0.0%
Religious	13	1.6%	$1,130,475	$0	0.0%	0.0%
Agricultural	20	2.5%	$51,632	$0	0.0%	0.0%
Total	790	100.0%	$79,039,205	$226,377	0.3%	100.0%

Note: All dollar values are from 2015 tax assessments.

Table 12. Potential damage to structures/contents from mean sea level inundation in 2100 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	3,220	93.0%	$606,237,280	$60,677,982	10.0%	91.4%
Commercial	67	1.9%	$26,475,090	$2,006,300	7.8%	3.0%
Government	47	1.4%	$14,519,814	$2,002,474	13.8%	3.0%
Industry	22	0.6%	$6,265,129	$1,073,869	17.1%	1.6%
Religious	42	1.2%	$5,137,204	$606,244	11.8%	0.9%
Agricultural	65	1.9%	$743,482	$24,601	3.3%	0.0%
Total	3,463	100.0%	$659,377,999	$66,391,470	10.0%	100.0%

Note: All dollar values are from 2015 tax assessments.

When examining the vulnerability of Dorchester County's structure by the property value, the results in 2050 show plurality of properties in the less than $50,000 range (Table 13). This result is particularly concerning – the owners of these properties will likely not have the financial resources to mitigate against the threat. In fact, it is possible that the modest values of the properties may be a result of the flood potential that is only going to worsen with sea level change. In 2100 however (Table 14), the results are distributed across the value spectrum with a peak in the modest $100,000 to $200,000 range. It is difficult to imagine that the owners of these properties will be able to make the changes necessary to warn off the impact of 5.78 ft of sea level rise.

Table 13. Potential damage to structures/contents from mean sea level inundation in 2050 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	378	47.8%	$7,162,882	$12,552	1.7%	5.5%
$50 - $100	186	23.5%	$13,381,000	$7,814	0.1%	3.5%
$100 - $200	140	17.7%	$19,331,725	$11,858	0.1%	5.2%
$200 - $300	46	5.8%	$10,600,350	$24,177	0.2%	10.7%
$300 - $400	17	2.2%	$5,680,608	$0	0.0%	0.0%
$400 - $500	7	15.4%	$3,118,300	$0	0.0%	0.0%
$500 - $1,000	10	1.3%	$6,825,240	$0	0.0%	0.0%
$1,000 - $2,000	4	0.5%	$5,596,300	$169,975	3.0%	75.1%
$2,000 - $3,000	0	0.0%	$0	$0	0.0%	0.0%
More than $3,000	2	0.3%	$7,342,800	$0	0.0%	0.0%
Total	790	100.0%	$79,039,205	$226,377	0.3%	100.0%

Note: All dollar values are from 2015 tax assessments

Table 14. Potential damage to structures/contents from mean sea level inundation in 2100 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	758	21.9%	$13,996,634	$2,427,464	17.3%	3.7%
$50 - $100	632	18.2%	$47,085,900	$7,215,907	15.3%	10.9%
$100 - $200	894	25.8%	$130,504,950	$16,887,529	12.9%	25.4%
$200 - $300	536	15.5%	$130,081,005	$13,542,359	10.4%	20.4%
$300 - $400	295	8.5%	$101,046,200	$9,146,396	9.1%	13.8%
$400 - $500	135	3.9%	$60,069,475	$4,994,714	8.3%	7.5%
$500 - $1,000	185	5.3%	$124,497,585	$8,596,136	6.9%	12.9%
$1,000 - $2,000	19	0.5%	$25,458,150	$1,878,626	7.4%	2.8%
$2,000 - $3,000	5	0.1%	$12,098,300	$553,598	4.6%	0.8%
More than $3,000	4	0.1%	$14,539,800	$1,148,740	7.9%	1.7%
Total	3,463	100.0%	$659,377,999	$66,391,470	10.0%	100.0%

Note: All dollar values are from 2015 tax assessments

In the event that the USACE's predictions come to pass, the 2.11 ft rise in MSL will significantly impact the flood vulnerability of Dorchester County (Table 15). In the 1%-chance flood scenario, the number of buildings impacted will increase by 75% (from 2,713 to 3,619). Additionally, the number of buildings with greater than minimal damage (greater than 10%) quadrupled, rising from 631 to 2,558 and from a value of $47.2 million to nearly $417.5 million. In 2050, 51 structures are predicted to be severely damaged (greater than 50%), up from just 2. The total amount of building and contents value vulnerable to flooding will not quite double from $482.2 million to $703.7 billion and the amount of potential damage will increase 7x from $11.2 million to $77.6 million. The spatial distribution of these vulnerable structures show that there are very few structures in the west or southern quadrants of the county that are not affected.

Of course, the prediction for the year 2100 (5.78 ft increase in MSL) must be considered highly uncertain. However, as of this writing, there is a growing consensus in the scientific community that the SLC estimates are more than likely too conservative, rather than too aggressive. Until that consensus solidifies, the current USACE estimate is still reasonable for planning purposes. Obviously, sea level being 5.78 ft higher in Dorchester County 82 years from now will significantly impact much of the vulnerable coastal development (Table 16). The number of vulnerable buildings will increase by 169% (from 2,713 in 2015 to 4,585 in 2100), with most (84%) of those buildings damaged 10% or more. The number predicted to be severely damaged will go from 2 in 2015 to 51 in 2050 to 149 in 2100. While the amount of building and contents value vulnerable to flooding will more than double, from $482.2 million to $935.2 billion, the

amount of potential damage will explode more than 13.8x from $11.2 million to $154.1 million. The spatial distribution shows flood waters reaching a large number of properties south of US 50 and expanding into communities on the tributaries of the Choptank River that were previously spared damaging flood waters. Paradoxically, the number of buildings and the total amount of value of vulnerable property does not increase an outrageous amount in the sea level change scenarios – because so many properties in Dorchester County are already at risk of flooding. Where the impact is mostly felt is in the potential damage amount, due to the increases the depth of flooding for those structures that are already vulnerable now (Figure 12).

Table 15. Potential damage to structures/contents from a 1% chance flood event in 2050 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	573	15.8%	$160,586,917	$280,256	$73,409	$128	0.4%
1 - 10%	488	13.5%	$125,683,152	$257,547	$7,139,543	$14,630	25.2%
10 - 20%	1,510	41.7%	$293,193,795	$194,168	$38,495,164	$25,493	52.1%
20 - 30%	846	23.4%	$113,908,381	$134,643	$27,682,731	$32,722	19.2%
30 - 40%	125	3.5%	$6,790,800	$54,326	$2,135,043	$17,080	2.8%
40 – 50%	26	0.7%	$1,679,279	$64,588	$731,902	$28,150	0.0%
50% or more	51	1.4%	$1,881,675	$36,896	$1,104,748	$21,662	0.2%
Total	3,619	100.0%	$703,723,999	$194,453	$77,362,541	$21,377	100.0%

Note: All dollar values are from 2015 tax assessments

Figure 11 Spatial distribution of vulnerable structures in Dorchester County, 1% chance at MSL in 2050 (n=3,619)

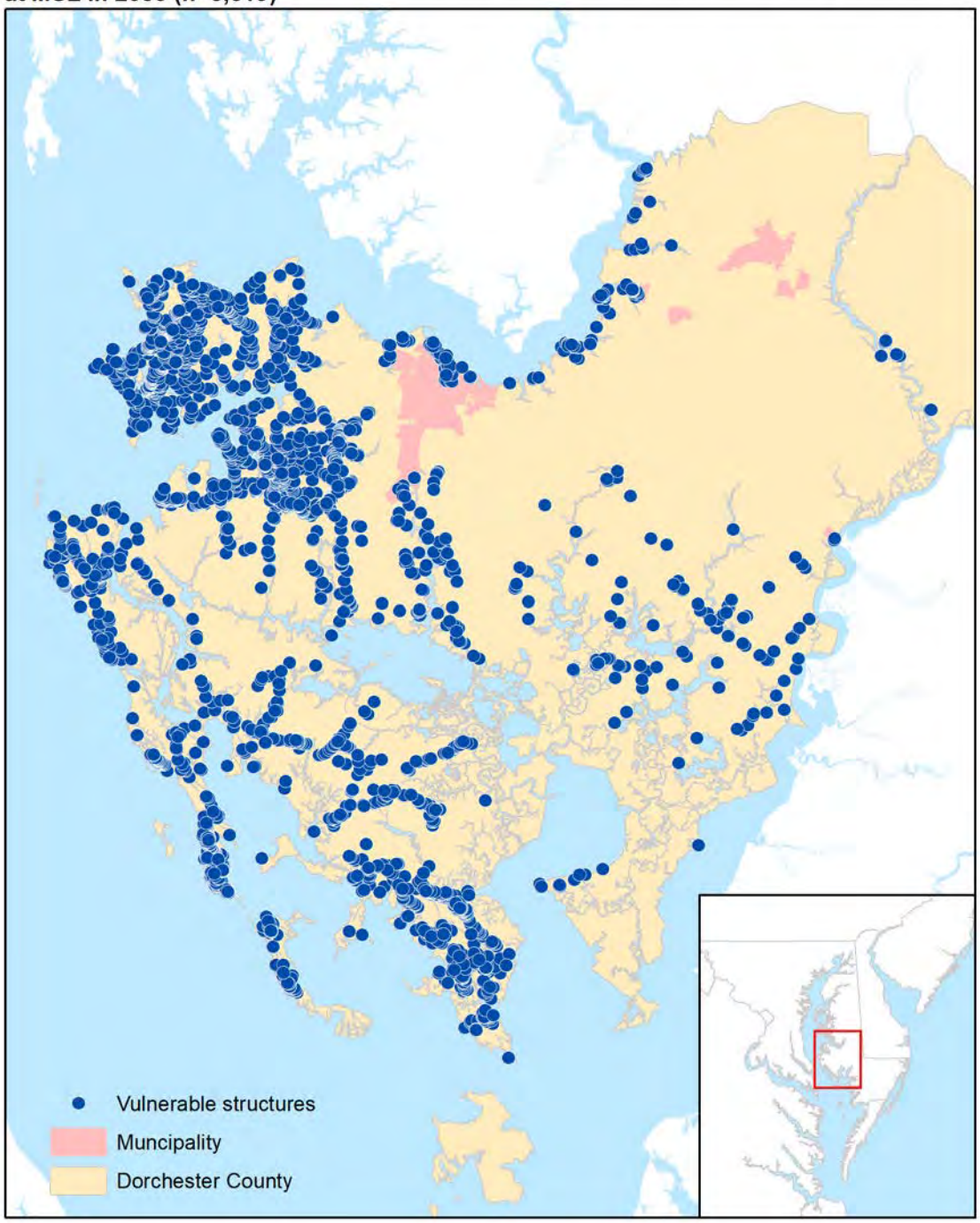


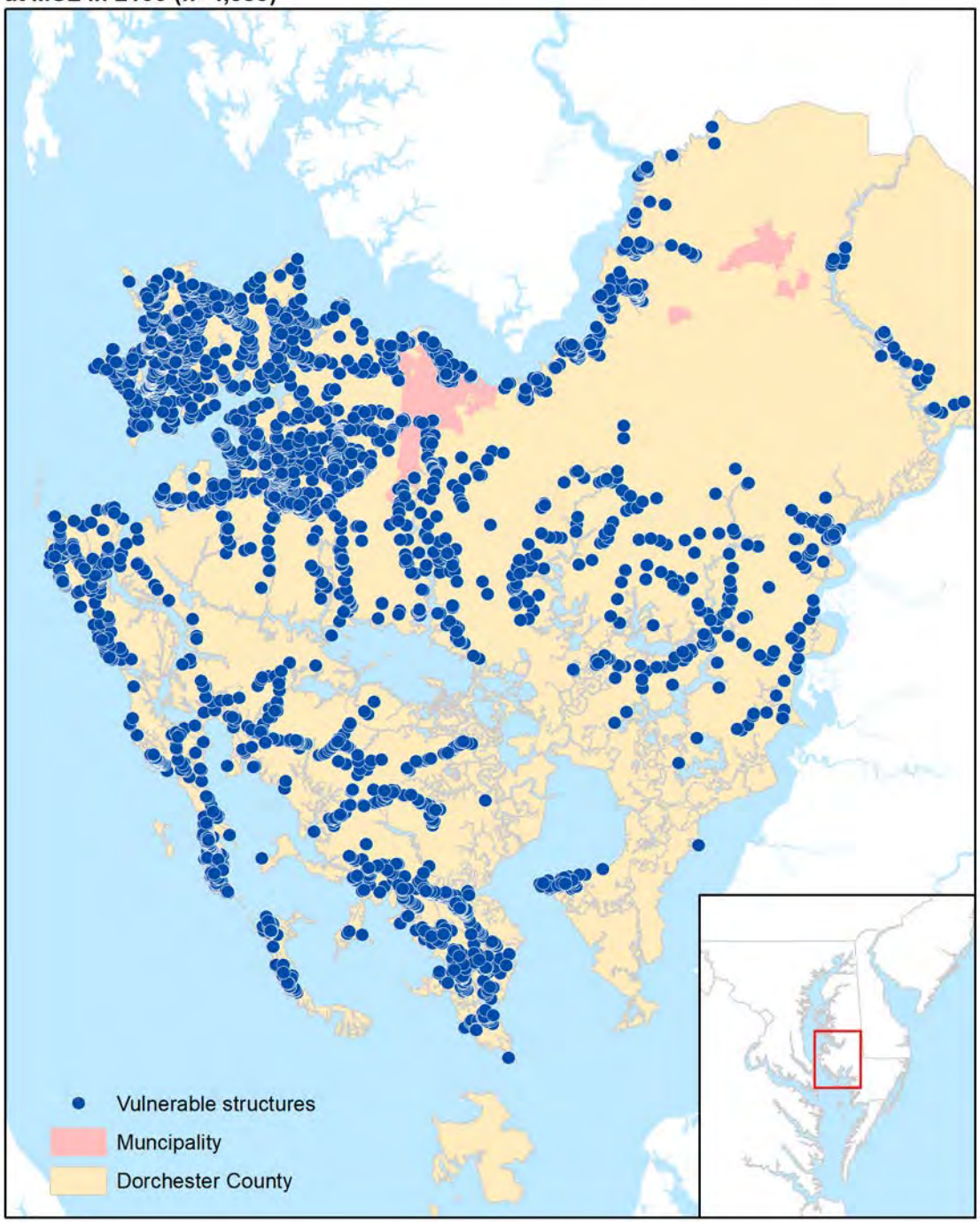
Table 16. Potential damage to structures/contents from a 1% chance flood event in 2100 by degree of damage category

Degree of Damage	Building Count	% of Total Count	Value of Structure and Contents	Value per Building	Total Potential Damage	Damage per Building	% of Total Damage
Less than 1%	527	11.5%	$162,038,692	$307,474	$23,460	$45	0.0%
1 - 10%	199	4.3%	$31,554,916	$158,567	$1,605,589	$8,068	1.0%
10 - 20%	1,942	42.4%	$448,343,743	$230,867	$68,126,359	$35,081	44.2%
20 - 30%	1,524	33.2%	$253,753,390	$166,505	$69,126,390	$45,359	44.9%
30 - 40%	238	5.2%	$29,615,372	$124,434	$9,538,449	$40,078	6.2%
40 – 50%	6	0.1%	$542,954	$90,492	$229,420	$38,237	0.1%
50% or more	149	3.2%	$9,325,050	$62,584	$5,423,927	$36,402	3.5%
Total	4,585	100.0%	$935,174,117	$203,964	$154,073,594	$33,604	100.0%

Note: All dollar values are from 2015 tax assessments

As for the spatial distribution of the flood threat in the two sea level change scenarios, it is a reasonable generalization to say that one can simply expect existing flood prone areas to flood more often, can expect deeper flood water when it does flood, and that areas adjacent to currently threatened areas are most likely to be newly-inundated. Maps of the 1% chance flood in 2050 and 2100 on along Water Street in Cambridge have been included as an example of what most areas in Dorchester County could expect (Figures 8 & 9). In the comparison of 2015 and 2050, the predicted 1% chance flood includes more buildings as vulnerable that are adjacent to the current flood area. But primarily, the 1% flood in 2050 will be more severe than today, thus yielding many more buildings in higher predicted damage categories. By contrast, the comparison of 2015 and 2100 shows not only a significantly more severe 1% chance flood, but a significant expansion of the vulnerable zone. This pattern is very similar across the peninsulas and necks of Dorchester County. The data from this analysis will be delivered to County officials so that they can map any area of the county this way, but Cambridge's patterns are very typical of what many areas of the county can expect.

Figure 12 Spatial distribution of vulnerable structures in Dorchester County, 1% chance at MSL in 2100 (n=4,585)



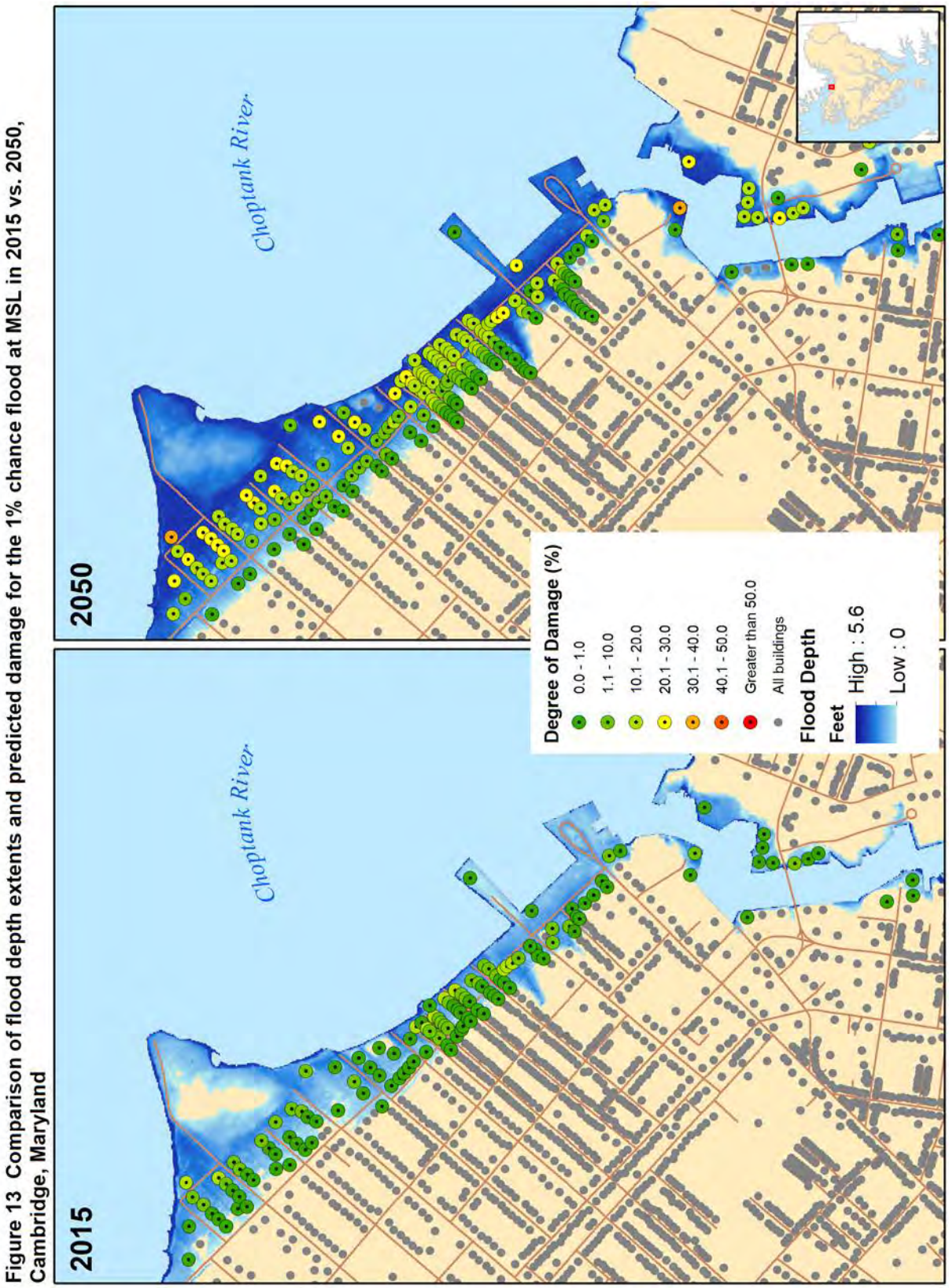


Figure 13 Comparison of flood depth extents and predicted damage for the 1% chance flood at MSL in 2015 vs. 2050, Cambridge, Maryland

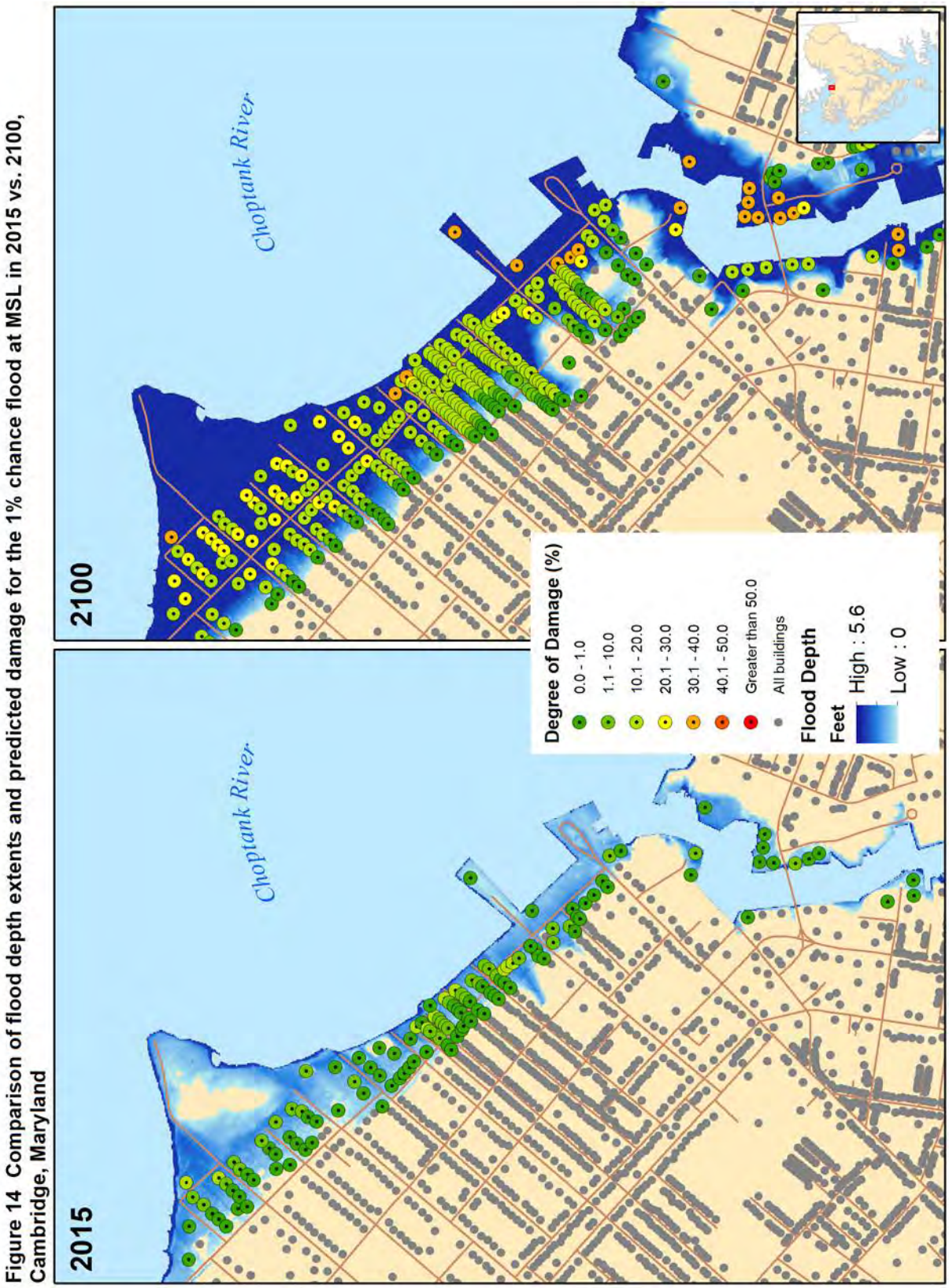


Figure 14 Comparison of flood depth extents and predicted damage for the 1% chance flood at MSL in 2015 vs. 2100, Cambridge, Maryland

The patterns of damage from flooding in the future when considering the use of the property are extremely similar to the results in 2015 (Table 17 and 18). The percentage distribution between the occupancy types is virtually identical between 2015 and 2050. Other than a slight rise in the percentage of commercial properties, the other key takeaway is that over 90% of the flood damage in 2050 will be residential. By 2100, there continues to be a very slight growth in the number and percentage of commercial properties affected, increasing from a total value in $78.2 million from $14.3 million in 2015.

Table 17. Potential damage to structures/contents from a 1% chance flood event in 2050 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	3.363	92.9%	$634,149,901	$70,873,166	11.2%	91.6%
Commercial	72	2.0%	$32,252,790	$2,377,438	7.4%	3.1%
Government	48	1.3%	$17,377,814	$2,311,425	13.3%	3.0%
Industry	24	0.7%	$13,770,754	$1,041,676	7.6%	1.3%
Religious	45	1.2%	$5,429,254	$722,859	13.3%	0.9%
Agricultural	67	1.9%	$743,486	$35,978	4.8%	0.0%
Total	3,619	100.0%	$703,723,999	$77,362,541	11.0%	100.0%

Note: All dollar values are from 2015 tax assessments.

Table 18. Potential damage to structures/contents from a 1% chance flood event in 2100 by general occupancy type

General Occupancy Type	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Residential	4,256	92.8%	$779,335,022	$135,834,711	17.4%	88.3%
Commercial	107	2.3%	$78,216,016	$9,696,250	12.4%	6.3%
Government	64	1.4%	$53,777,624	$4,149,129	4.4%	2.7%
Industry	24	0.5%	$13,770,754	$2,451,749	7.7%	1.6%
Religious	56	1.2%	$9,150,454	$1,768,874	19.3%	1.1%
Agricultural	78	1.7%	$924,248	$172,880	18.7%	0.1%
Total	4,585	100.0%	$935,174,117	$154,073,594	16.4%	100.0%

Note: All dollar values are from 2015 tax assessments.

In general, the distribution of vulnerability by property value does not change considerably once sea level change is added in 2050 (Table 19). There is a small percentage shift to the more valuable properties in this scenario. For example, 4.8% of

all of the properties valued between $500,000 and $1 million are impacted by the 1% chance flood in 2015 but that percentage grows to 5.5% in 2050. This lack of significant change is not unexpected. Dorchester County does not have any significant enclaves of very wealthy property owners, nor is there spatial clustering of more impoverished areas, except perhaps some entrenched neighborhoods in Cambridge. The other reason there is no significant change to the distribution of properties values affected is that there is not a large expansion of vulnerable properties. Most of these properties are affected in both scenarios, but the damage is much greater in the sea level change scenarios. By 2100, this pattern is much the same (Table 20). It is also important to note that these are 2015 property values. If the rate of inflation for the next 85 years is the same as the last 85 ($1 in 1930 is worth $13.96 in 2015, according to the Consumer Price Index), the total property value at risk from flooding would be over $13 billion.

Table 19. Potential damage to structures/contents from a 1% chance flood event in 2050 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	780	21.6%	$14,443,494	$2,677,930	18.5%	0.5%
$50 - $100	660	18.2%	$49,288,575	$8,052,016	16.3%	3.3%
$100 - $200	940	26.0%	$136,919,075	$19,181,614	14.0%	17.3%
$200 - $300	564	15.6%	$136,960,980	$15,857,520	11.6%	17.0%
$300 - $400	306	8.4%	$104,741,300	$10,961,226	10.5%	17.3%
$400 - $500	139	3.8%	$61,773,375	$5,898,279	9.5%	13.8%
$500 - $1,000	198	5.5%	$133,136,800	$10,148,785	7.6%	22.9%
$1,000 - $2,000	20	0.6%	$26,657,150	$2,198,067	8.2%	7.9%
$2,000 - $3,000	6	0.2%	$14,956,300	$694,257	4.6%	0.0%
More than $3,000	6	0.2%	$24,846,650	$1,692,846	6.8%	0.0%
Total	3,619	100.0%	$703,723,999	$77,362,541	11.0%	100.0%

Note: All dollar values are from 2015 tax assessments

Table 20. Potential damage to structures/contents from a 1% chance flood event in 2100 by property value

Property Value (000s)	Building Count	% of Total	Value of Structure and Contents	Total Damage	% of Value	% of Total
Less than $50	938	20.5%	$17,697,768	$3,744,873	21.2%	2.4%
$50 - $100	854	18.6%	$64,163,950	$12,397,369	19.3%	8.0%
$100 - $200	1,280	27.9%	$186,264,250	$35,145,518	18.9%	22.8%
$200 - $300	704	15.4%	$171,010,800	$31,752,390	18.6%	20.6%
$300 - $400	372	8.1%	$127,633,900	$21,789,928	17.1%	14.1%
$400 - $500	169	3.7%	$75,048,450	$11,564,457	15.4%	7.5%
$500 - $1,000	224	4.9%	$150,050,300	$23,886,573	15.9%	15.5%
$1,000 - $2,000	23	0.5%	$30,165,050	$5,126,339	17.0%	3.3%
$2,000 - $3,000	8	0.2%	$19,200,100	$2,849,207	14.8%	1.8%
More than $3,000	13	0.3%	$93,940,449	$4,816,839	5.1%	3.1%
Total	4,585	100.0%	$935,174,117	$154,073,594	16.4%	100.0%

Note: All dollar values are from 2015 tax assessments

Study Caveats

It should not go without mentioning that the prediction of the flood threat with a future sea level change has more than the normal level of uncertainty. Not only are the estimates of sea level change not a foregone conclusion, but the nature of the flood threat itself is likely to change. For example, in a world with oceans that are 2 (or 5) feet higher, the controlling forces (subtropical high pressure systems, ocean upwelling, thermal heat transfer, etc.) of tropical storms are likely to be different. Thus, the periodicity of certain magnitudes of storm events could change. Similarly, this analysis uses statistical/stochastic models, not a dynamic simulations. Therefore, it does not take into account either individual storm parameters or geographic parameters such as land cover or the shape of the near-shore bottom, both of which will impact the flood predication and both are likely to change in a rising sea level scenario.

With regard to vulnerability estimates, there are also a number of important caveats to remember. First, this analysis assumes that all of the built infrastructure would be exactly as one found it in 2015. That is almost certainly not going to be the case, both with new structures being built and older structures being made more flood-resistant as the waters rise. Second, as mentioned above, the potential damage is being evaluated as if property values will not change by 2050 or 2100 – also not the case. Finally, this vulnerability analysis deliberately examined only damage to structural/contents because the relationship between building damage and depth of water is best understood. There are still many other sources of potential vulnerability: infrastructure damage/loss (both to rebuild and its impact on restarting the economy after a disaster), loss of productivity with businesses closed, debris removal, other consumer losses (cars, boats, sheds/garages), and of course, the potential loss of life.

Conclusions

Several conclusions can be made regarding the question of coastal flooding vulnerability in Dorchester County. First, given that Dorchester County has several significant sources of flood threat and given that it contains more than 16,069 improved structures, the fact that 2,713 (16.9%) are already vulnerable to the 1%-chance flood is probably a result of historical land use patterns that are particularly water-oriented, the extreme lack of ground elevation in the southern half of the county, and the impact of sea level change since the 1660's. Second, given the potential for sea level rise in the coming decades, Dorchester County is uniquely vulnerable. By 2050, more than one-fifth of all of the structures in the county will feel the effects and by 2100, if the predictions hold, almost 30% of the county's buildings could be inundated by a 1% chance flood. Even with no flooding at all, mean sea level will bring water to the footprint of about 5% of all of the building stock in Dorchester County. Unfortunately, the impacts that other county's will experience in the future are happening now to the people of Dorchester. But all is not lost. One advantage of this situation is that there will be very little argument about the nature of the threat that Dorchester County faces. This will make consensus

about potential mitigation measures much easier to achieve. There are many places around the world that have learned to live alongside a constant flood threat and thrived. It just means that the people of Dorchester County need to become vigilant about implementing in flood-proofing into every development and re-development project planned for the hazard zone. Doing so will enable them to avoid the worst of the negative impacts of flooding and preserve their way of life.