

# ADAPTING TO COASTAL STORMS AND FLOODING

## Report on a 2014 Survey of Old Saybrook Residents

*George Perkins Marsh Institute/Clark University  
and The Nature Conservancy*



*Town of Old Saybrook*

## **ADAPTING TO COASTAL STORMS AND FLOODING**

REPORT ON A 2014 SURVEY OF OLD SAYBROOK RESIDENTS

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## EXECUTIVE SUMMARY

This report summarizes the findings of the survey *Adapting to Coastal Storms and Flooding* conducted in Old Saybrook, Connecticut, from June through August 2014. The survey evaluated the attitudes and preferences of Old Saybrook residents toward the risks of coastal storms and flooding, along with potential adaptation actions that could be taken to address these risks. The survey was conducted through a collaboration of Clark University and The Nature Conservancy in Connecticut, and funded by a research grant from the Northeast Sea Grant Consortium.

The survey was developed and pretested over more than two years in a collaborative process involving economists and natural scientists; meetings with town officials and stakeholder groups; and multiple focus groups comprised of community residents. This development and pretesting ensured that information in the survey was accurate and that the survey could be easily understood and answered by the public. The survey was mailed to a sample of 1,728 randomly selected Old Saybrook residents. Out of 1,489 deliverable surveys, 489 were returned for a response rate of 32.8%. This is a relatively high rate of return for a mail survey, and suggests the relevance of the topic to the public.

The survey included a wide range of attitudinal questions, along with referendum-style voting questions that enabled residents to vote for or against different types of hypothetical adaptation alternatives for the town. Unlike typical public opinion surveys, this approach enables quantification of the specific types of tradeoffs that residents would support, when considering alternative ways to protect their town. Results provide insight into the way that Old Saybrook residents understand the risks facing their town, and their preferences for how those risks should be addressed.

Principal findings of the survey include:

- Old Saybrook residents perceive coastal storms and flooding as a major problem, but have split opinions regarding the degree to which the town is well prepared for these reoccurring events. Most residents are not confident that the town is well prepared.
- Residents have strong opinions about many methods and outcomes of coastal adaptation, and these opinions differ. On average, residents are

more concerned with the protection of the town's natural resources, infrastructure and community services than with potential changes in taxes and fees, flood insurance rates, or development restrictions.

- When asked to vote for or against hypothetical but feasible adaptation plans for Old Saybrook, residents' votes show support for coastal adaptation, even if this requires new taxes and fees. These votes reveal relatively high values for the protection of natural assets such as beaches and wetlands, as well as value for the protection of private homes. However, a large number of homes must be protected to have the same value as protecting a single acre of beach or wetland—suggesting the relatively high value of natural and recreational services to Old Saybrook residents. For example, based on the pattern of observed votes, an adaptation plan would have to prevent the expected flooding of approximately 107 private homes (per Category 2 storm) to have the same value as preserving one acre of beach in perpetuity.
- Residents place slightly higher values on the protection of homes that are in lower-risk locations (i.e., homes that are projected to flood only in more intense storms), compared to similar homes in higher-risk locations.
- Old Saybrook residents are more likely to support—and pay for—hazard mitigation that involves soft or natural defenses, compared to similarly effective strategies that apply engineered or hard defenses.

Survey results suggest that taking action to adapt is important to Old Saybrook residents, and that residents are willing to pay for effective adaptation strategies. However, some effects of coastal adaptation are more important and highly valued than others. For example, although protection of waterfront homes from flooding may be very important to the residents living in those homes, it does not appear to be the top priority of the public at large. A coastal adaptation strategy prioritizing the broader protection of natural habitats and public resources will gain more support from the community than one emphasizing engineered defenses and the protection of private homes.

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Results further identify some apparent differences between the top priorities of average town residents and those of recent hazard mitigation plans. Findings such as these highlight potential differences between the values and perceptions of town residents and those of experts, and suggest the benefits of additional engagement with town residents on priorities for hazard mitigation.

## SECTION 1

### Introduction

Hazards related to a variable and changing climate are a challenge facing coastal communities in Connecticut and elsewhere. Strategies to address these challenges involve tradeoffs between development, ecosystem health, costs and community needs. Hazard mitigation requires tradeoffs. Many different actions are possible, yet available funds are rarely sufficient to protect all sites and resources. Some strategies may also affect the rights of coastal property owners. Thus, difficult choices must be made.

According to the Town of Old Saybrook & Borough of Fenwick Natural Hazards Mitigation Plan Update, 2014, Old Saybrook includes approximately 15.2 square miles of land area and over 23 linear miles of shoreline along Long Island Sound and the Connecticut River. The Town has a total population of 10,367, a large portion of which resides in areas subject to flood risk or other coastal hazards. The town “is susceptible to high winds and storms affecting Long Island Sound due to its geographic location,” with much of the town at relatively low elevation. According to data in Coastal Resilience (<http://coastalresilience.org/>), approximate 24% of the town’s tidal shoreline has some form of hard armoring. Every storm is unique, with damage depending on storm intensity, timing, path, wind direction/speed and many other factors. Topography and elevation also provide protection to some areas of the town. Nonetheless, the impacts of Hurricane Sandy in 2012, together with coastal storm scenarios for the town, suggest that a considerable portion of Old Saybrook’s homes, infrastructure and natural capital (e.g., beaches, wetlands) is exposed.

When designing hazard mitigation plans and strategies, coastal communities frequently rely on extensive input from community officials,

experts and stakeholder groups. The values and preferences of community residents are also important; these are the individuals who both experience losses and pay the taxes and fees necessary to support many types of hazard mitigation actions.

The survey *Adapting to Coastal Storms and Flooding*, implemented from June through August 2014, evaluated the attitudes and preferences of Old Saybrook's residents toward the risk of coastal storms and flooding and potential adaptation actions that could be taken to address these risks. One of the goals of the survey was to identify the types of hazard mitigation actions that would provide the greatest value to—and would be most supported by—town residents. A related goal was to quantify the types of hazard mitigation tradeoffs that would be most acceptable to them.

The survey was conducted through a collaboration of Clark University and The Nature Conservancy in Connecticut, and was supported by a grant from the Northeast Sea Grant Consortium. The survey was designed using economic choice experiment methods. These methods quantify the economic benefits of different types of policy actions and predict public support for them. The survey included attitudinal questions, along with referendum-style voting questions that enabled residents to vote for or against different types of hypothetical but feasible adaptation alternatives for the town.

The survey results provide insight into the way that Old Saybrook residents understand the risks facing their town, their preferences for how those risks should be addressed, and their willingness to pay additional taxes/fees for different types of adaptation programs. They suggest that Old Saybrook residents perceive a growing sense of urgency regarding coastal hazard mitigation and are willing to support actions to reduce the associated risks. Residents are particularly concerned with—and willing to pay for—programs that (a) protect public natural resources such as beaches and coastal marshes and (b) reduce the extent of coastal hard armoring. Contrasting these results to the priorities in the 2014 Natural Hazards Mitigation Plan Update suggests that there is at least some difference between the top priorities of the plan (focusing, for example, on repetitive loss private property owners) and the current priorities of

average town residents (for whom effects on privately held homes are important, but not a top priority). Findings such as these highlight potential differences between the values and perceptions of town residents and those of experts, and suggest the benefits of additional engagement with residents on priorities for hazard mitigation.

## SECTION 2

### Survey Design

Survey development engaged a diverse set of Old Saybrook residents and public officials over two years of design and pretesting. The process included meetings with town planners, engineers and stakeholder groups; multiple focus groups<sup>1</sup> with community residents; and extensive pretesting. This survey development ensured that information in the survey was accurate and that the survey could be easily understood and answered by the public.

The goal of the survey was to understand Old Saybrook residents' (a) attitudes concerning coastal storms and flooding, (b) priorities for protecting built infrastructure and natural resources, and (c) preferences and values related to the protection of built infrastructure and natural resources. The survey included a wide range of attitudinal questions, along with referendum-style voting questions that enabled residents to vote for or against different types of hypothetical but realistic adaptation alternatives for the town. The results provide insight into the way that residents understand the risks facing their town and their preferences for how those risks should be addressed.

## SECTION 3

### Survey Implementation

The survey was implemented by mail from June through August, 2014. It was mailed to a sample of 1,728 randomly selected Old Saybrook residents, with systematic follow-up mailings to increase response rates. Out of 1,489 deliverable surveys, 489 were returned for a response rate of 32.8%. This is a relatively high rate of return for a mail survey, and suggests the relevance of the topic to the public.

<sup>1</sup> Groups of randomly selected Old Saybrook residents met with a moderator to freely discuss their perceptions, opinions, beliefs and attitudes towards coastal storms and flooding, and the types of resources whose protection they felt should be emphasized by coastal adaptation efforts.



## SECTION 4

## Key Findings

## 4.1 RESIDENTS' ATTITUDES TOWARD COASTAL STORMS AND FLOODING

The first sections of the survey asked respondents to agree or disagree with a variety of statements related to the future risk of coastal storms and flooding in Old Saybrook, and the degree to which the town is prepared for these hazards. These statements were evaluated on a 1 to 5 scale, where 1 = Strongly disagree and 5 = Strongly agree.

Responses to these questions often were similar, on average, across all types of Old Saybrook residents. However, in some cases, residents who live on coastal waterfront property (“coastal residents”)<sup>2</sup> answered these questions differently than other residents (“non-coastal residents”). For these questions, separate results are presented for the two groups. The survey sample includes 386 responses from non-coastal residents and 68 responses from coastal residents. The smaller sample of coastal waterfront residents is expected, and reflects the fact that a minority of Old Saybrook residents lives on coastal waterfront property.

The majority of both “coastal” and “non-coastal” residents agree or strongly agree that coastal storms and flooding are a major problem facing Old Saybrook, with “agree” being the most common response (Figure 1). Relatively few people, about 11% of non-coastal residents and 16% of coastal residents, disagree or strongly disagree with this statement.

Similar patterns are found for the statement regarding whether coastal storms are likely to increase in the future (Figure 2). Most coastal and non-coastal residents agree that coastal storms and flooding are likely to increase in Old Saybrook; a minority of coastal residents (about 22%) and non-coastal residents (less than 7%) disagree or strongly disagree. The relatively higher level of disagreement with this statement among coastal residents suggests that, on average, they are less concerned with the possibility of increased coastal storms and flooding in the future.

<sup>2</sup> Coastal residents are identified as those who answered “yes” to the survey question, “Is your home located on coastal waterfront property?”

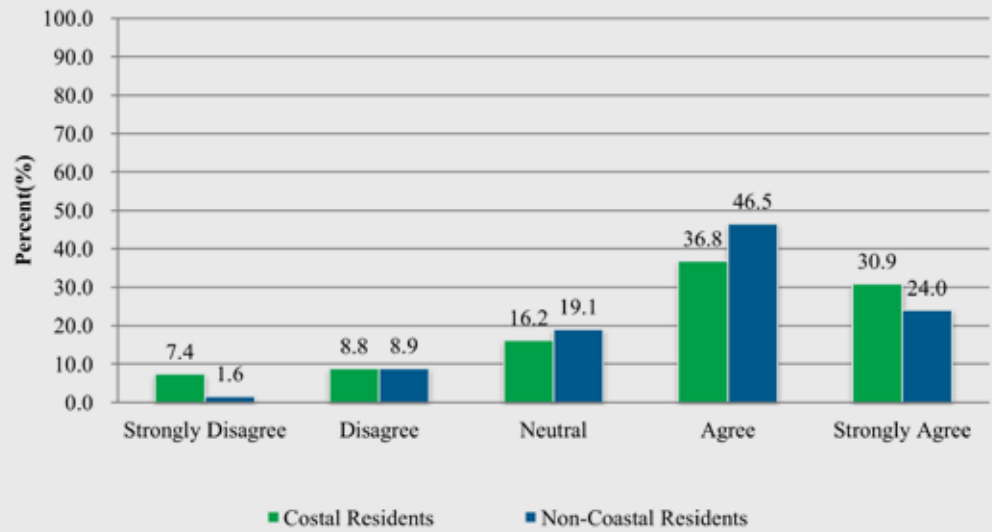


Figure 1: Question 1(a) Do you agree or disagree with the statement "Coastal storms and flooding are a major problem facing Old Saybrook?"

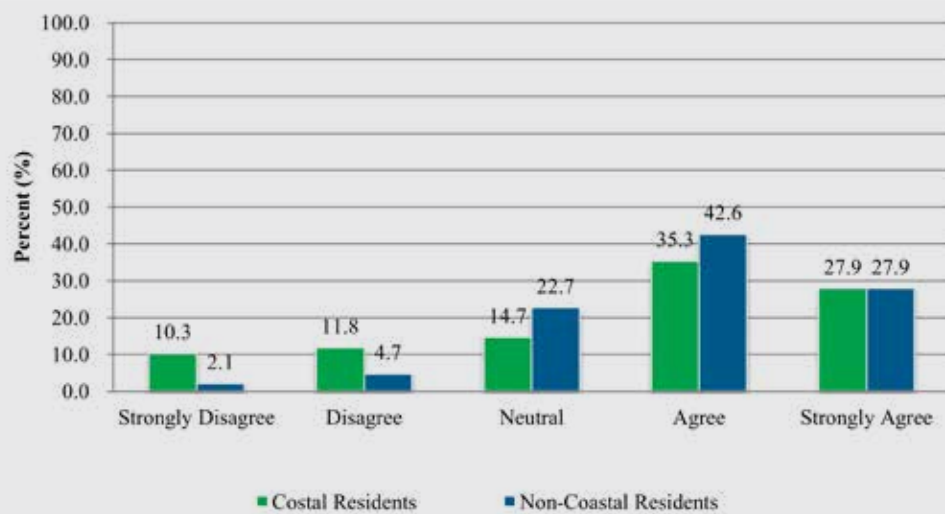


Figure 2: Question 1(b) Do you agree or disagree with the statement "In the future, coastal storms and flooding are likely to increase?"

A minority of residents, about 31% of non-coastal residents and 29% of coastal residents, either agree or strongly agree that Old Saybrook is well-prepared for future storms and flooding (Figure 3). Very few residents either strongly agree or strongly disagree. The modal (or most common response) to this question is “neutral,” suggesting substantial ambivalence regarding the degree to which the town is prepared. This perception is shared by coastal and non-coastal residents.

#### 4.2 RESIDENTS’ PRIORITIES FOR PROTECTING BUILT INFRASTRUCTURE AND NATURAL RESOURCES

Other questions in the survey evaluated the general importance that residents place on protecting different types of community resources. These questions asked about the importance of each resource independent of others, so the answers cannot be used to calculate tradeoffs or relative values. Tradeoffs among different types of adaptation outcomes are discussed in Section 5.

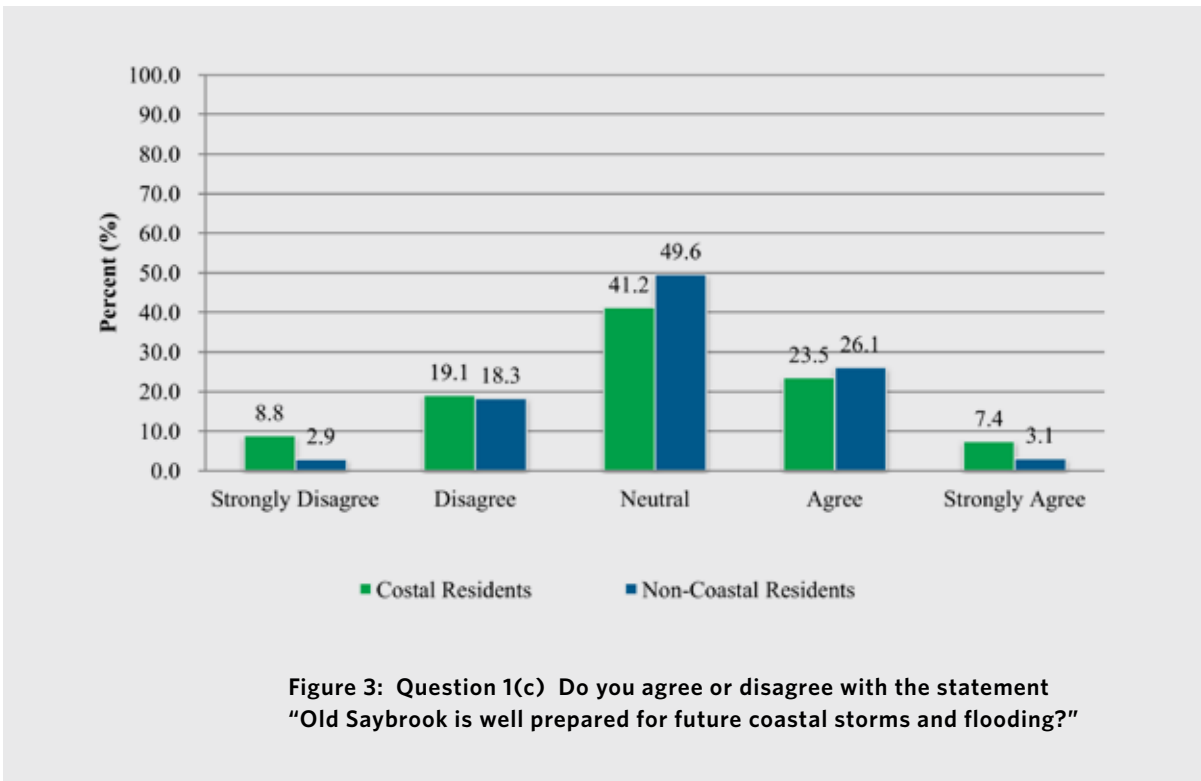
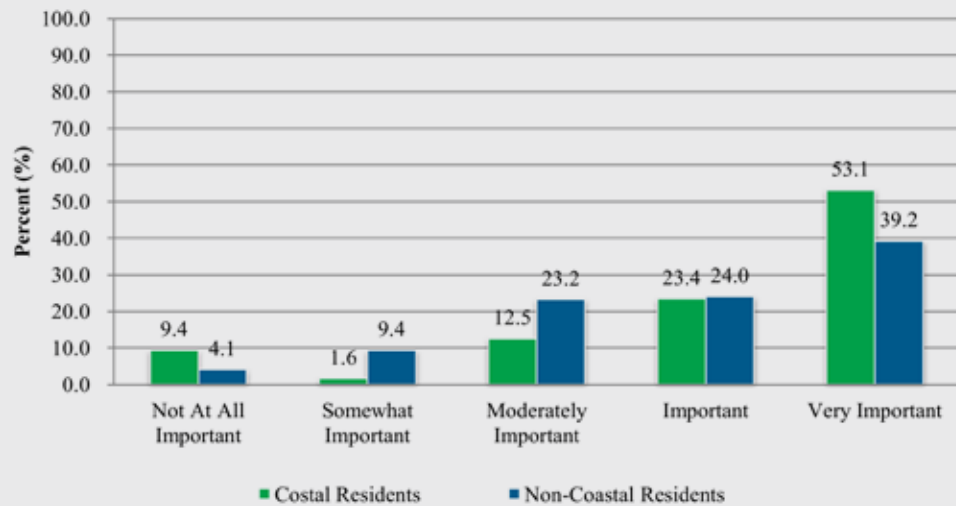


Figure 3: Question 1(c) Do you agree or disagree with the statement “Old Saybrook is well prepared for future coastal storms and flooding?”



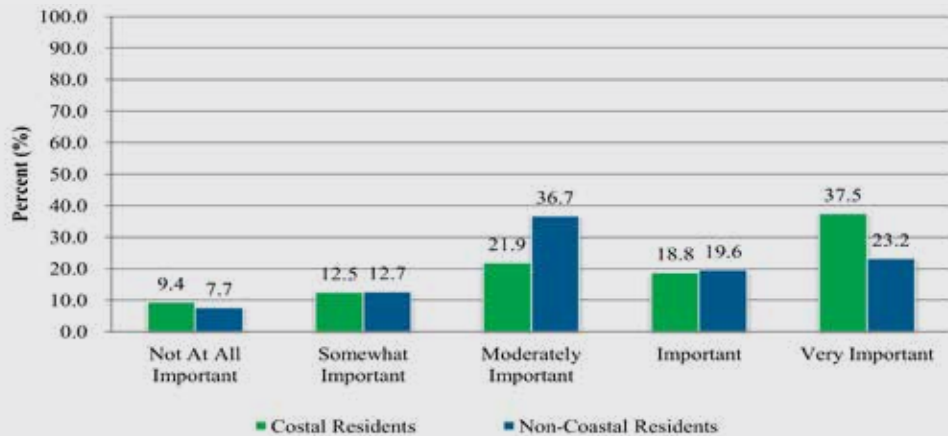
**Figure 4: Question 2(a) How important is it that “Private homes and property are protected?”**

#### 4.2.1 Protecting Built Infrastructure

Statements related to protecting homes, infrastructure and public services were rated on a scale of 1 to 5, where 1 = Not at all important and 5 = Very important. As in the previous section, coastal and non-coastal residents sometimes answered these questions differently. For such cases, separate results are presented for these two groups.

The majority of coastal residents (about 53%) and the plurality of non-coastal residents (about 39%) indicated that protecting private homes and property is very important (Figure 4). Approximately 11% of coastal residents and 14% of non-coastal residents rated the statement as somewhat or not at all important. Although this question shows concern for the protection of private homes and property, later questions show greater concern for the protection of other types of town assets and services.

Survey responses show that residents, on average, are ambivalent about protecting the right of coastal landowners to use and develop their land (Figure 5). This is particularly true for non-coastal residents. The most common response among non-coastal residents is “moderately



**Figure 5: Question 2(b) How important is it that “Government respects the right of coastal landowners to use and develop their land?”**

important” (with nearly 37% of responses). Although the most common response among coastal residents is “very important” (about 38% of responses), this proportion of “very important” responses is lower than for nearly all other priorities addressed by the survey.

Residents place very high importance on the protection of public services, facilities and infrastructure (Figure 6). The vast majority of Old Saybrook residents, almost 80%, consider the protection of facilities such as police stations and schools to be important or very important. A similar majority of residents, about 82%, rate the protection of roads and transportation facilities as important or very important. Approximately 88% of residents rate the protection of public services as important or very important—this was among the most important priorities identified by this section of the survey.

#### 4.2.2 Protecting Natural Resources

Statements related to protecting natural resources were also rated on a scale of 1-5, where 1 = Not at all important and 5 = Very important. Coastal and non-coastal residents rated these statements similarly.

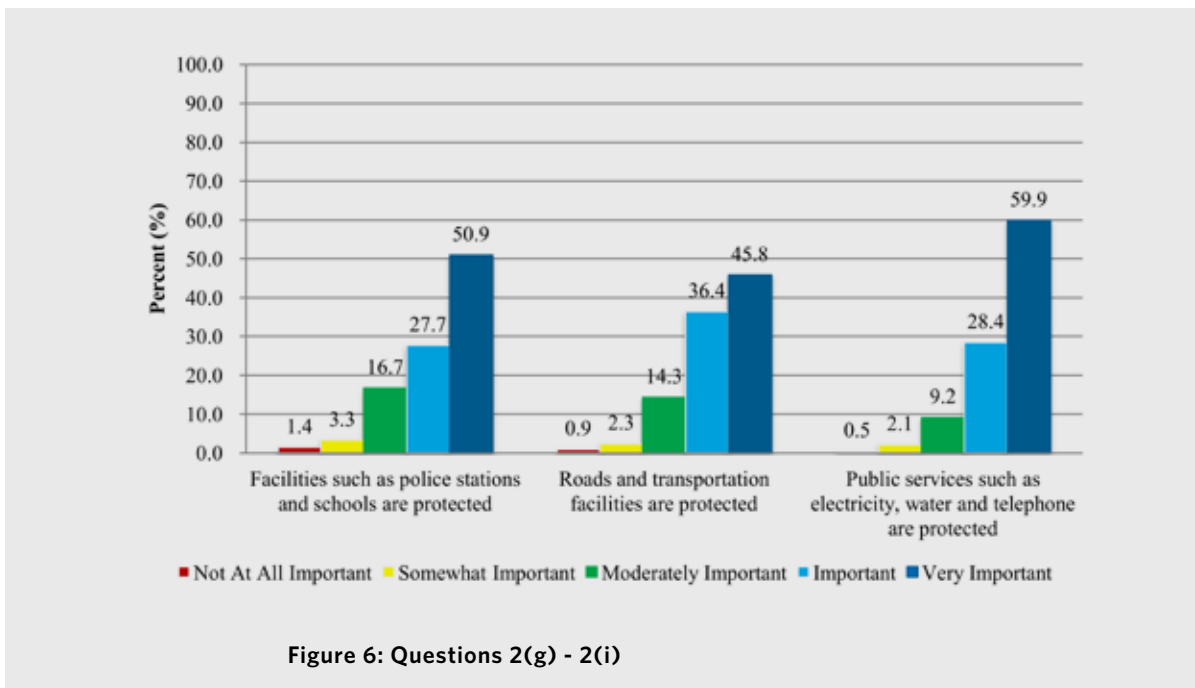
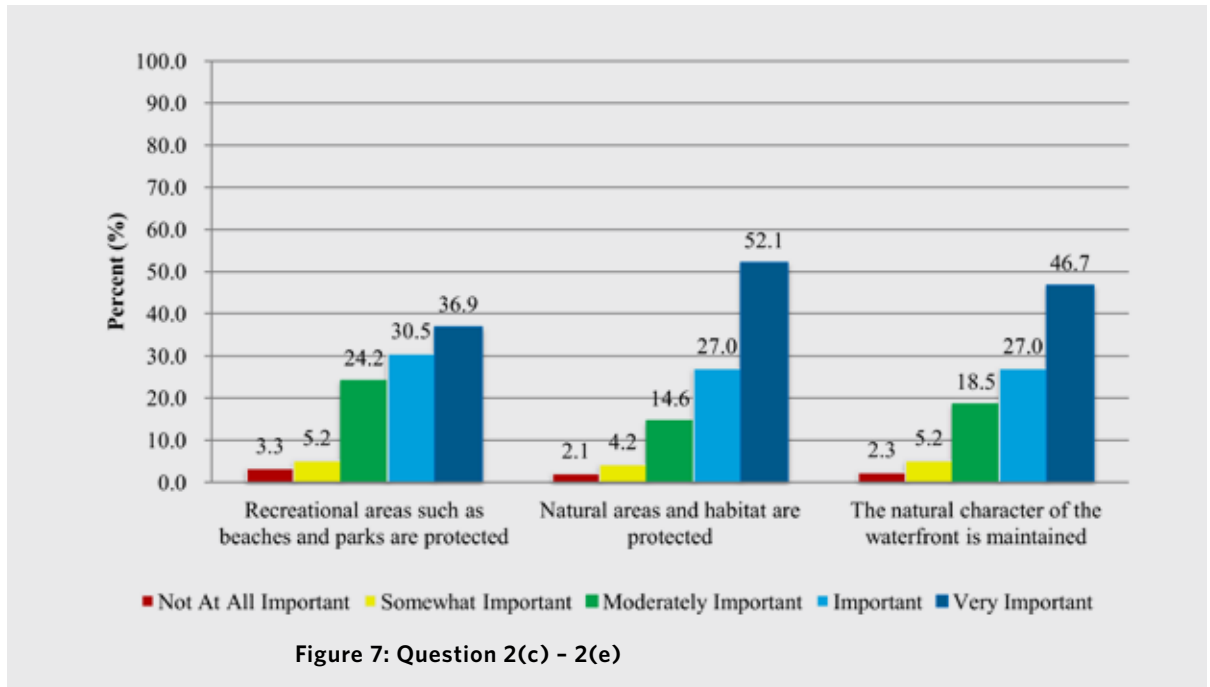


Figure 6: Questions 2(g) - 2(i)

Figure 7 shows that the majority of residents, almost 70%, rate the protection of recreational areas such as beaches and parks as important or very important. Few residents (less than 9%) considered this to be somewhat or not at all important. An even greater proportion of residents (nearly 80%) consider the protection of natural areas and habitat to be either important (27%) or very important (52%). Again, very few respondents (less than 7%) rate this as either somewhat or not important. Maintaining the natural character of the waterfront is similarly important to Old Saybrook residents—about 74% of respondents rate this statement as important or very important. As an average across these three questions, about 75% of residents rate the protection of natural resources as important to very important, making these among the most important priorities to Old Saybrook residents (along with the protection of public infrastructure and services, as shown in Figure 6).

#### 4.3 RESIDENTS' ATTITUDES TOWARD TAXES AND FLOOD INSURANCE RATES

Statements related to changes in taxes and flood insurance rates were also rated on a scale of 1 to 5, where 1 = Not at all important and 5 = Very



important (Figures 8, 9). Separate results are presented for coastal and non-coastal residents.

About 59% of non-coastal residents and 56% of coastal residents consider it important to very important (Figure 8) that “taxes and fees paid by my household do not increase.” However, nearly one-third of both groups consider this to be of only moderate importance. These findings suggest that minimizing taxes and fees is somewhat less important, on average, to Old Saybrook residents than other types of adaptation priorities.

Attitudes regarding potential changes in flood insurance rates were mixed (Figure 9). About 27% of non-coastal residents and 14% of coastal residents rated the statement “Flood insurance rates paid by residents do not increase” as somewhat or not at all important. However, the majority of residents, about 54% of non-coastal residents and 56% of coastal residents, ranked this statement as important or very important. These results suggest flood insurance rates are important to Old Saybrook residents, but are less important on average than most other types of coastal adaptation outcomes.

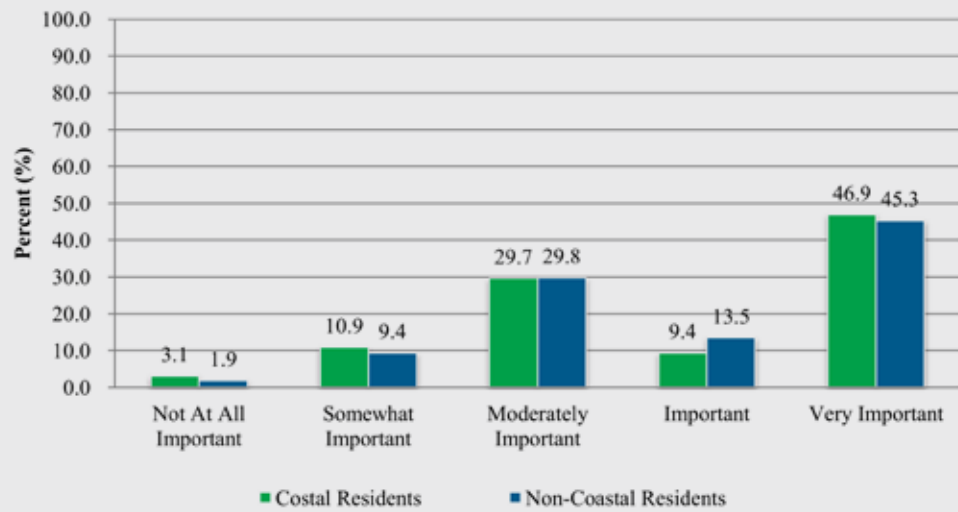


Figure 8: Question 2(f) How important do you think it is that “Taxes and fees paid by my household do not increase?”

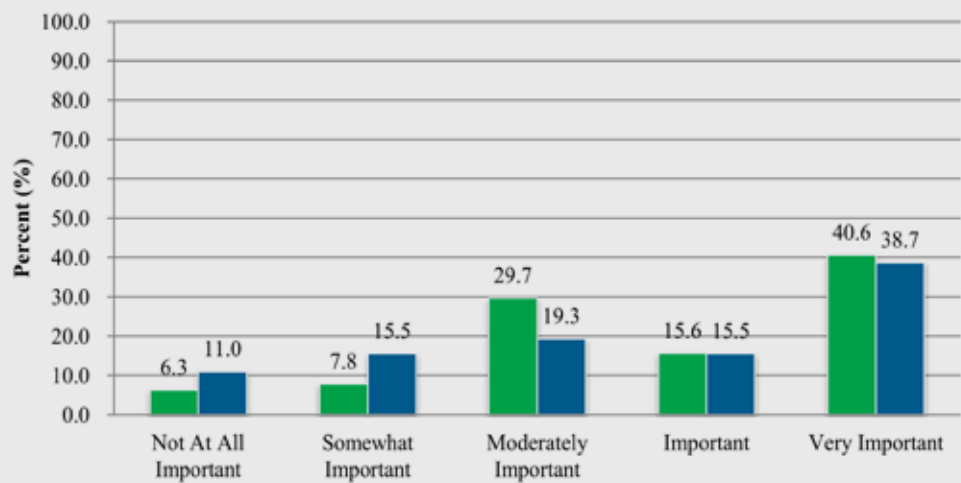


Figure 9: Question 2(l) How important do you think it is that “Flood insurance rates paid by homeowners do not increase?”



**SECTION 5**

## Support and Values for Coastal Adaptation

Adaptation to the risks of coastal storms and flooding is costly and requires tradeoffs. Within a given region, many different types of coastal adaptation may be possible, and available funds are rarely sufficient to protect all sites and resources equally. Thus, difficult choices must be made.

One of the primary goals of the survey was to evaluate the types of coastal adaptation tradeoffs that would be supported by Old Saybrook residents. This includes residents' willingness to pay additional taxes and fees to support different types of community adaptation programs, with different effects. Among the advantages of this approach is an ability to quantify specific tradeoffs and relative values that residents would place on different types of hazard mitigation outcomes (for example, protecting homes versus protecting other town assets such as beaches). It also provides a perspective on the values of a random sample of all residents.

To evaluate the tradeoffs supported by residents, surveyed households were asked to choose among different types of hypothetical coastal adaptation programs, within referendum-style voting questions (called choice experiments). Each adaptation program was described in terms of projected effects on coastal homes, natural resources such as beaches and wetlands, coastal armoring and annual household costs. Each of these voting questions asked the respondent to choose between two adaptation programs with different effects and costs, and a "business as usual" alternative with no additional cost (i.e., Option A versus Option B versus Neither [N], or A-B-N). Seventy-two hypothetical A-B-N choices were developed, and divided randomly among surveys sent to different households. Each household was asked to answer three of the 72 A-B-N choices. The combined votes of all households over all of these hypothetical A-B-N choices were used to calculate the tradeoffs households were willing to make, based on their observed votes.

The projected effects of each hypothetical program through the 2020s ("What it Means"—Figure 10) used as a basis for the A-B-N choices were derived from coastal flooding scenarios for Old Saybrook available through the Coastal Resilience decision-support tool

(see <http://coastalresilience.org/>). Figure 11 shows an example of the type of A-B-N choices included in the survey. The annual household costs presented in each A-B-N choice are hypothetical. Some programs include higher costs and others include lower costs, to evaluate how changes in these costs affect residents' votes for or against different types of programs.

Prior to each choice, the survey presented information on the situation facing Old Saybrook, as well as the different types of adaptation actions that could be used. Particular emphasis was given to differences between hard and soft defenses. Maps and graphics were also included to illustrate flooding scenarios and effects in Old Saybrook (e.g., Figure 12). All materials were subjected to extensive pretesting and revision over a two-year process. This pretesting ensured that survey information and questions were clear and easily understood, and that questions addressed hazard mitigation effects that were potentially important to community residents.







Among the central issues evaluated by this portion of the survey was the relative value placed on protecting the town's natural assets such as beaches and wetlands, compared to the value of protecting private homes. The survey also evaluated relative values placed on the protection of homes that are at different levels of risk—specifically higher-risk homes that are likely to flood in less intense Category 2 storms, compared to lower-risk homes that are predicted to flood only in a Category 3 storm or higher.

### 5.1 COASTAL ADAPTATION TRADEOFFS AND VALUES

The A-B-N choices of Old Saybrook households show support for coastal adaptation, even if it requires new taxes and fees. The choices also demonstrate the relative values of different types of adaptation outcomes. One way to illustrate these results is to calculate the economic values that are implied. Table 1 shows the value of each adaptation outcome (described in Figure 10) to an average Old Saybrook household. These may be interpreted as the amount that an average household would be willing to pay per year, in additional and reoccurring town taxes and fees, to obtain each of these outcomes. These are average values for each Old Saybrook household and reflect a willingness to pay per year, in perpetuity. These results show that the value placed on coastal adaptation by Old Saybrook residents depends on what is protected.

## COMPARING PROTECTION OPTIONS

Upcoming sections will ask you to compare different protection options for Old Saybrook and vote for the ones you prefer. You may also vote to reject the proposed options and retain the status quo. **The methods and effects of each option include the following:**

Methods and Effects of Protection	What it Means
 <b>Homes Flooded in Category 2 Storm</b>	The percentage of Old Saybrook homes at relatively high risk of flooding. These homes are expected to flood in a <b>Category 2 or higher</b> storm in the mid-2020s. With no new action, <b>28%</b> of homes (1,411 of the current 5,034 homes in Old Saybrook) will be in this higher risk category by the mid-2020s.
 <b>Homes Flooded Only in Category 3+ Storm</b>	The percentage of Old Saybrook homes at moderate risk of flooding. These homes are expected to flood <b>ONLY</b> in a <b>Category 3 or higher</b> storm in the mid-2020s. They are not expected to flood in a Category 2 storm. With no new action, <b>23%</b> of homes (1,174 of the current 5,034 homes in Old Saybrook) will be in this moderate risk category by the mid-2020s.
 <b>Wetlands Lost</b>	The percentage of Old Saybrook's coastal marshes expected to be lost by the mid-2020s due to flooding or erosion. With no new action, <b>5%</b> of Old Saybrook's coastal marshes (25 of 497 acres that exist today) are expected to be lost.
 <b>Beaches and Dunes Lost</b>	The percentage of Old Saybrook's beaches and dunes expected to be lost by the mid-2020s due to flooding or erosion. With no new action, <b>10%</b> of Old Saybrook's beaches and dunes (about 3 of 30 acres that exist today) are expected to be lost.
 <b>Seawalls and Coastal Armoring</b>	The percentage of Old Saybrook's coast shielded by hard defenses. With no new action, <b>24%</b> of Old Saybrook's coastline (12 of 50 miles) will have hard defenses by the mid-2020s. This is the same level as today.
 <b>Cost to Your Household per Year</b>	How much the option will cost your household per year, in unavoidable taxes and fees. Assume that these funds are legally guaranteed to be spent only on the coastal protection option that you vote for.






For homes, wetlands and beaches, higher numbers mean greater losses.

**Figure 10. Effects and Costs of Adaptation Included in Choice Questions**

# YOU WILL BE ASKED TO VOTE

After considering the current situation and possible protection effects and methods, which do you prefer? You will be given choices and asked to vote for the option you prefer by checking the appropriate box. **Questions will look similar to the example below.**

## EXAMPLE QUESTION

Methods and Effects of Protection	Result in 2020s with NO NEW ACTION	Result in 2020s with PROTECTION OPTION A	Result in 2020s with PROTECTION OPTION B
	No Change in Existing Defenses	More Emphasis on SOFT Defenses	SIMILAR Emphasis on Hard and Soft Defenses
 <b>Homes Flooded in Category 2 Storm</b>	<b>28%</b> 1,411 of 5,034 homes expected to flood in a Category 2 storm	<b>28%</b> 1,411 of 5,034 homes expected to flood in a Category 2 storm	<b>20%</b> 1,007 of 5,034 homes expected to flood in a Category 2 storm
 <b>Homes Flooded Only in Category 3+ Storm</b>	<b>23%</b> 1,174 of 5,034 homes expected to flood only in a Category 3+ storm	<b>27%</b> 1,359 of 5,034 homes expected to flood only in a Category 3+ storm	<b>16%</b> 805 of 5,034 homes expected to flood only in a Category 3+ storm
 <b>Wetlands Lost</b>	<b>5%</b> 25 of 497 wetland acres expected to be lost	<b>2%</b> 10 of 497 wetland acres expected to be lost	<b>5%</b> 25 of 497 wetland acres expected to be lost
 <b>Beaches and Dunes Lost</b>	<b>10%</b> 3 of 30 beach acres expected to be lost	<b>16%</b> 5 of 30 beach acres expected to be lost	<b>4%</b> 1 of 30 beach acres expected to be lost
 <b>Seawalls and Coastal Armoring</b>	<b>24%</b> 12 of 50 miles of coast armored	<b>15%</b> 8 of 50 miles of coast armored	<b>35%</b> 18 of 50 miles of coast armored
 <b>Cost to Your Household per Year</b>	<b>\$0</b> Increase in annual taxes or fees	<b>\$95</b> Increase in annual taxes or fees	<b>\$35</b> Increase in annual taxes or fees
<b>HOW WOULD YOU VOTE? (CHOOSE ONLY ONE)</b> I vote for	<input checked="" type="checkbox"/> <b>I vote for NO NEW ACTION</b>	<input checked="" type="checkbox"/> <b>I vote for PROTECTION OPTION A</b>	<input checked="" type="checkbox"/> <b>I vote for PROTECTION OPTION B</b>

↑  
If you prefer  
**No New Action**  
check here

↑  
If you prefer  
**Protection Option A**  
check here

↑  
If you prefer  
**Protection Option B**  
check here

Figure 11. Example Choice Question



# THE PREDICTED FUTURE RISK

This survey asks you to consider different options that Old Saybrook might use to protect against coastal storms and flooding, and choose the ones you prefer.

To help make choices such as these, scientists have developed forecasts of the type of flooding that would occur in the mid-2020s, under different scenarios.

For example, the map below shows the expected flooding in Old Saybrook under a high intensity (Category 3) hurricane in the mid-2020s. Conditions would approach this situation gradually. This is slightly more extensive than the flooding caused by Hurricane Sandy in 2012.

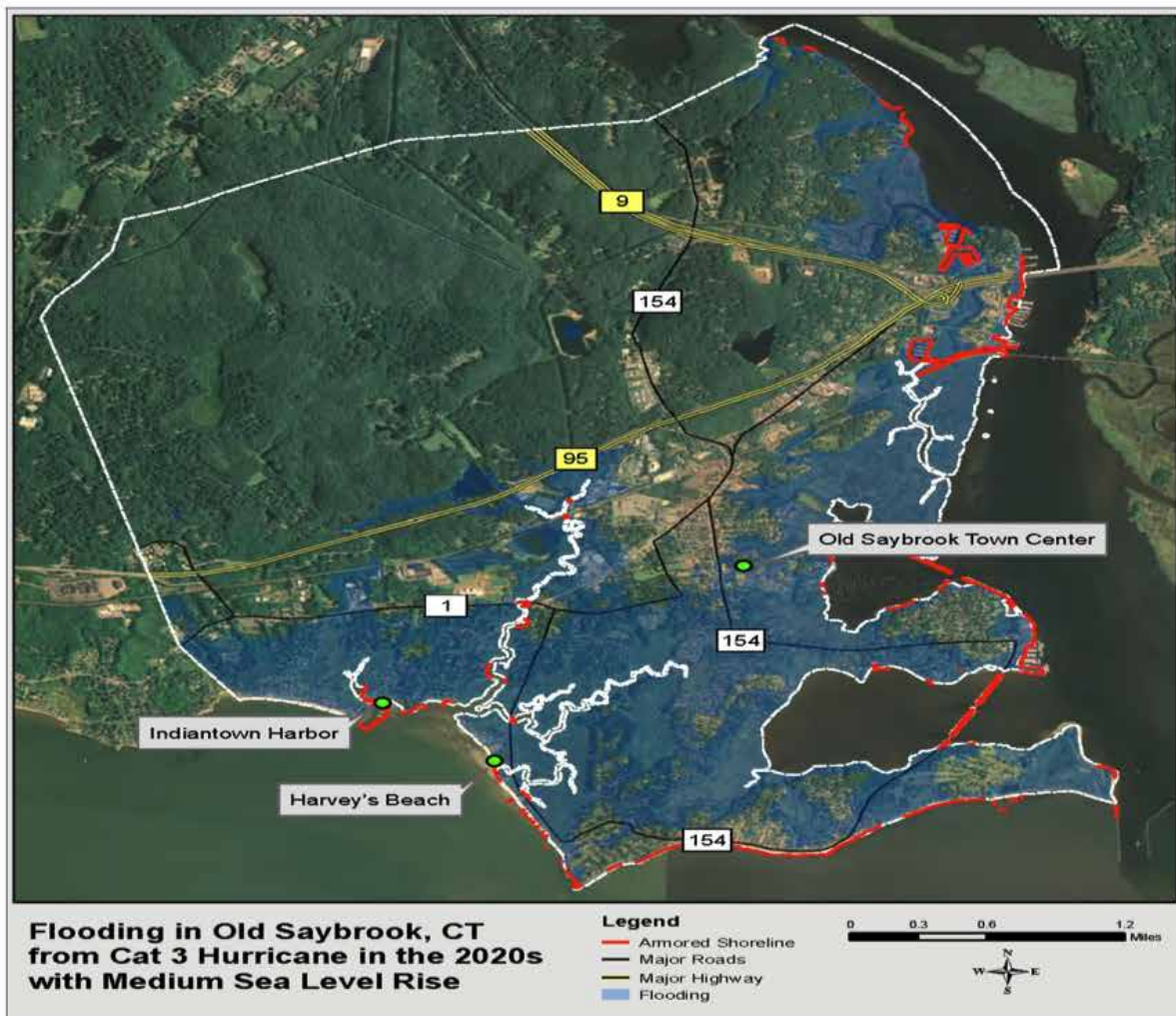


Figure 12. Storm Scenario Illustrated in Old Saybrook Survey

**Table 1. Value of Coastal Adaptation Outcomes to Old Saybrook Households**  
(Revealed by Votes over Adaptation Alternatives<sup>3</sup>)

Coastal Adaptation Outcome	Additional Taxes/Fees that Each Household Would Be Willing to Pay (per year)
Fewer Old Saybrook homes expected to flood during a typical Category 2 storm (These are higher-risk homes that are expected to flood in either a Category 2 or 3 storm.)	\$0.27 per additional home not expected to flood in a Category 2 storm <sup>4</sup>
Fewer Old Saybrook homes expected to flood only during a typical Category 3 storm or greater (These are lower-risk homes only expected to flood during a Category 3 storm, but not a Category 2 storm.)	\$0.30 per additional home not expected to flood during a Category 3 storm or greater
Fewer beach acres lost to flooding and erosion by the mid-2020s	\$28.90 per acre saved
Fewer wetland acres lost to flooding and erosion by the mid-2020s	\$2.47 per acre saved
Miles of sea walls <u>removed</u>	\$10.70 per mile removed
Emphasizing hard defenses (e.g., shoreline armoring; raising buildings on pilings) instead of soft (or natural) adaptation, in addition to other values	Negative \$103.86 in addition to other values (for emphasizing hard instead of soft adaptation) <sup>5</sup>

These values imply tradeoffs that Old Saybrook residents are willing to make. For example, the average Old Saybrook household values the preservation of beach acres almost twelve times as much as the preservation of wetland acres ( $11.7 = \$28.90 / \$2.47$ ). An adaptation plan would have to prevent the expected flooding of approximately 107 homes (per Category 2 storm) to have the same value as preserving

<sup>3</sup> 70% of respondents indicated that they would vote the same way in a binding public referendum.

<sup>4</sup> These are the values that Old Saybrook households would be willing to pay to prevent the flooding of other people's homes in Old Saybrook, not the value placed on protecting their own home. This can be interpreted as the amount that the average household would be willing to pay in annual bond payments for a hazard-mitigation plan that would protect a certain number of additional homes. For example, for a plan that would protect 100 additional homes from flooding in a typical Category 2 storm, the average Old Saybrook household would be willing to pay  $100 \times \$0.27 = \$27$  per year in additional taxes and fees.

<sup>5</sup> This finding implies that Old Saybrook residents are less willing to support (and pay for) an adaptation program that emphasizes hard defenses and shoreline armoring, compared to an otherwise similar program that emphasizes natural defenses.

Table 2. Illustrative Value of a Hypothetical Coastal Adaptation Plan

(A) Outcome of Hypothetical Adaptation Plan	(B) Additional Taxes/Fees that Each Household Would Be Willing to Pay—See Table 1	(C) Total Value per Household, Per Year (= A×B)
200 fewer homes are expected to flood in a typical Category 2 storm	\$0.27 per home	\$54.00
200 (additional) fewer homes are expected to flood in a typical Category 3 storm or greater	\$0.30 per home	\$66.00
Loss of 2 beach acres is prevented	\$28.90 per acre	\$57.80
Loss of 5 coastal marsh acres is prevented	\$2.47 per acre	\$12.35
Emphasizing soft adaptation	\$0.00 (no negative effect because hard armoring is not emphasized)	\$0.00
1 mile of sea wall removed	\$10.70 per mile removed	\$10.70
<b>Total Plan Value per Household Per Year</b> The amount that an average household would be willing to pay in additional taxes and fees, per year and in perpetuity, to obtain these combined outcomes		<b>\$194.85 per household, per year</b> (Equivalent to a total of \$1.1 million per year, in perpetuity, multiplied by all 5,602 Old Saybrook households.) <sup>6</sup>

one acre of beach habitat ( $107 = \$28.90 / \$0.27$ ). Similarly, protecting one acre of wetland habitat has the same value to residents as protecting 9.1 homes ( $9.1 = \$2.47 / \$0.27$ ). Results such as these demonstrate the relative importance of protecting natural assets such as beaches and coastal marshes to residents.

These results can be used to quantify the combined value of hazard-mitigation outcomes to Old Saybrook residents. For example, consider a hypothetical hazard-mitigation plan that would change coastal protection in Old Saybrook by the year 2025, so that (a) 200 fewer homes are expected to flood in a typical Category 2 storm, (b) an additional 200 fewer homes are expected to flood in a typical Category 3 storm, (c) the loss of two beach acres is prevented, (d) the loss of five coastal marsh acres is prevented, and (e) one mile of shoreline armoring is removed and replaced with natural shoreline. Also assume that this plan achieves these outcomes with an emphasis on soft (or natural) adaptation methods rather than hard adaptation. Table 2 shows the estimated total value of this plan.

<sup>6</sup>For example, over 20 years, this would imply \$22 million in additional taxes and fees.

As shown by Table 2, Old Saybrook residents hold considerable value for different outcomes of hazard mitigation, including value for the protection of at-risk homes, as well as value for the protection of natural assets such as beaches and wetlands. On average, residents place slightly higher values on the protection of homes that are at relatively lower risk—suggesting that residents do not prioritize the use of town funds to protect homes that are in very high-risk locations (this is viewed as the responsibility of the homeowner).

Residents' A-B-N choices also show a negative value for hard adaptation such as sea walls and other shoreline armoring. For example, consider a plan that is identical to that in Table 2, but that achieves these outcomes primarily via hard adaptation, including three additional miles of shoreline armoring. The value of this plan is shown by Table 3.

**Table 3. Illustrative Value of a Hypothetical “Hard Armoring” Adaptation Plan**

(A) Outcome of Hypothetical Adaptation Plan	(B) Additional Taxes/Fees that Each Household Would Be Willing to Pay—See Table 1	(C) Total Value per Household, Per Year (= A×B)
200 fewer homes are expected to flood in a typical Category 2 storm	\$0.27 per home	\$54.00
200 (additional) fewer homes are expected to flood in a typical Category 3 storm or greater	\$0.30 per home	\$60.00
Loss of 2 beach acres is prevented	\$28.90 per acre	\$57.80
Loss of 5 coastal marsh acres is prevented	\$2.47 per acre	\$12.35
Emphasizing hard versus soft defenses	Negative \$103.86 (because hard armoring is emphasized)	-\$103.86
3 miles of sea walls added	Negative \$10.70 per mile added	-\$32.10
<b>Total Plan Value per Household Per Year</b> The amount that an average household would be willing to pay in additional taxes and fees, per year and in perpetuity, to obtain these combined outcomes		<b>\$48.19</b> per household, per year (Equivalent to a total of <b>\$270 thousand per year</b> , in perpetuity, multiplied by all 5,602 Old Saybrook households.)



That is, the value of a hazard mitigation plan declines (by \$0.82 million per year) if the plan emphasizes hard defenses and shoreline armoring, and increases if the plan emphasizes natural defenses.

The survey also included questions to evaluate the validity of these results, and how respondents felt about the survey. The vast majority of Old Saybrook residents viewed the survey instrument favorably. Most indicated that the information and questions were easy to understand, that survey content was fair and balanced and that they were confident about their answers.

## SECTION 6

### Conclusion

Results of the survey predict the type of coastal adaptation that would be supported by Old Saybrook residents. Residents are concerned about a broad range of hazard impacts, including effects on private property, public infrastructure and natural resources. Survey respondents recognize the risks of coastal storms and flooding in Old Saybrook, and perceive a need to take actions to address these risks. When viewed from a comparative perspective, however, some priorities stand out. Some principal findings of this study include:

- Old Saybrook residents, coastal and non-coastal alike, perceive coastal storms and flooding as a major problem. Residents have split opinions regarding the degree to which the town is well prepared for these reoccurring events.
- Residents have strong opinions about methods and outcomes of coastal adaptation, and these opinions differ. However, on average, residents are more concerned with the protection of the town's natural and built resources than with potential changes in taxes/fees, flood insurance rates, or development restrictions.
- When asked to vote for or against hypothetical but feasible adaptation plans for Old Saybrook, residents' votes show support for coastal adaptation, even if this requires new taxes and fees. These votes reveal relatively high values for the protection of natural assets such as beaches and wetlands, as well as value for the protection of private homes. However, a large number of homes must be protected to have the same

value as protecting a single acre of beach or wetland—suggesting the relatively high value of natural and recreational services to Old Saybrook residents.

- Residents place slightly higher values on the protection of homes that are in lower-risk locations (i.e., homes that are projected to flood only in higher intensity storms).

Study results quantify the value that Old Saybrook residents place on hazard mitigation, and their willingness to support programs that protect important community resources. When interpreting results such as these, it is important to distinguish the private value that a homeowner might have for the protection of her own home, from values that residents have for public actions to protect the town resources. Both survey and focus group results suggest that most residents view the protection of homes as largely the responsibility of private homeowners, not the responsibility of the town. This is particularly true for homes built in very high-risk locations.

The results of this study do not indicate what types of coastal hazard adaptation are right or wrong, only those that are predicted to generate the greatest social value to town residents, and would hence be supported most strongly by these residents. These estimates are based on current information and projections regarding coastal hazards. When combined with information on the cost of different adaptation alternatives, results such as these can help identify adaptation strategies that best support the goals and values of residents.

APPENDIX I

DEMOGRAPHIC PROFILE OF THE SURVEY SAMPLE

The survey was mailed to a random sample of Old Saybrook residents. The following summarizes the characteristics of those who responded.

**HOME CHARACTERISTICS OF THE OLD SAYBROOK SURVEY SAMPLE**

Question 10: Is your home located north or south of Route I-95?		
North	South	Unsure
28.6%	68.6%	2.8%

Question 11: Is your home located within a Federally designated flood zone?		
Yes	No	Unsure
35.1%	53.1%	11.8%

Question 12: Is your home located on coastal waterfront property?		
Yes	No	Unsure
14.6%	82.7%	2.8%

Question 13: Is your home covered by any federal or private flood insurance?		
Yes	No	Unsure
30.6%	63.6%	5.8%

Question 14: Has your home suffered coastal flood damage in the past five years?		
Yes	No	Unsure
10.2%	89.3%	0.4%

## APPENDIX I (continued)

## SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE OLD SAYBROOK SURVEY SAMPLE

## Question 17: What is your gender?

Male 56.3%	Female 43.7%						
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## Question 18: What is your age?

19-29 0.9%	30-39 5.8%	40-49 13.3%	50-59 24.4%	60-69 27.3%	70-80 20.4%	Over 80 7.8%	
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## Question 19: What is the highest level of education you have completed?

Less than high school 0.9%	High School/GED 9.8%	Some college 17.6%	2-Year college 10.0%	4-Year college 30.2%	Graduate Degree (MS, PHD, etc.) 31.5%	
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## Question 20: How many years have you been a Old Saybrook resident?

Less than 5 12.0%	5-19 40.6%	20-34 26.6%	35-49 12.2%	50-65 7.0%	More than 65 1.5%		
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## Question 21: Are you currently employed?

Yes 60.3%	No 39.7%						
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## Question 22: What category best describes your total household annual income?

Less than \$10,000 1.2%	\$10,000 \$19,999 3.1%	\$20,000~ \$39,999 10.9%	\$40,000~ \$59,999 14.7%	\$60,000~ \$79,999 8.7%	\$80,000~ \$99,999 13.8%	\$100,000~ \$249,999 37.2%	\$250,000~ or more 10.4%
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## Question 23: Are you a seasonal or year-round resident of Old Saybrook?

Seasonal 3.7%	Year-round 96.3%						
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## APPENDIX II

## CHOICE MODEL RESULTS

Table A.1 shows the statistical results underlying the value estimates provided in Table 1. These results are calculated using a mixed logit model. The model predicts the choices (or votes) that were made by each survey respondent, as a function of the particular attributes (or characteristics) of the adaptation plans they considered. The model is statistically significant at  $p < 0.0001$ , with all coefficient estimates statistically significant at  $p < 0.10$ .

Table A1. Random Parameters Logit Model Results

ATTRIBUTE (OR RESOURCE)	COEFFICIENT	STANDARD ERROR
<b>Random parameters in utility functions</b>		
NNA (No New Action)	-2.623***	0.570
Beaches	-0.038**	0.016
Cost	-0.006***	0.002
<b>Non-random parameters in utility functions</b>		
Homes Flooded (per Cat. 2 storm)	-0.056***	0.018
Homes Flooded (per Cat. 3 storm)	-0.062***	0.020
Wetlands	-0.051**	0.025
Hard	-0.400**	0.024
Seawalls	-0.020*	0.011
<b>Standard deviation of random parameters (for Cost, limit of triangular bounds)</b>		
NNA (No New Action)	5.859***	0.835
Beaches Lost	0.096***	0.031
Cost	0.006***	0.002
<b>Model fit</b>		
No. of Observations (N)	805	
X <sup>2</sup> / Significance Level	352.775 (10 d.f.) / 0.0000	
AIC	1436.0	
LL Function	-707.99516	
Pseudo - R <sup>2</sup>	0.19945	

Note: \*\*\*, \*\* and \* imply statistical significance respectively at the 1%, 5% and 10% levels



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