



# COMING STORMS: CLIMATE CHANGE AND THE RISING THREAT TO AMERICA'S COASTAL SENIORS

Part I: Senior Facilities at Risk

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# SENIOR FACILITIES AT RISK

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A new Climate Central sea-level-rise analysis identifies the assisted living and nursing homes at risk in five states. Experts say waiting to evacuate during storms is not the answer.

Flooding caused by sea level rise could affect thousands of elderly residents of nursing homes and assisted living facilities in coming decades, according to an analysis of five coastal states by Climate Central.

Elders in care facilities are among the most vulnerable to death and health setbacks due to hurricanes, storm surges, and other floods, according to researchers who study coastal disasters.

“Old people and these kinds of emergency situations don’t mix, particularly nursing home patients who are quite frail and have numerous comorbidities,” said [Dr. David Dosa](#), a gerontologist and associate professor of medicine at Brown University. “It’s quite clear from climate change that we’re seeing more and more of these events.”

Climate Central used its proprietary [Portfolio Analysis Tool](#) to screen nursing homes and assisted living facilities in Florida, New Jersey, Texas, North Carolina, and South Carolina, based on physical addresses in state licensing databases. For one point at each facility location, the tool computes the number of statistically expected flood risk events using a localized sea level rise model, local flood history, and high-resolution elevation data. The results show the exposure to potential flooding at each facility under current conditions and at sea levels projected in 2050, estimating rising waters based on heat trapping emissions continuing unchecked (the RCP 8.5 scenario). Results for lower emissions scenarios are similar, as sea levels between scenarios diverge most in the second half of the century.

Florida is projected to be the hardest hit, with a 67% increase in the number of beds potentially exposed to flooding after the 30-year period, amounting to over 5,900 beds in 91 facilities by 2050. Of the beds affected, 23% are projected to be in facilities subjected to frequent or chronic flood threats. Projections show serious impact in New Jersey, as well, with more than 700 beds in facilities exposed to frequent or chronic flood risk by 2050.

	2020				2050			
	EXPOSED TO OCCASIONAL RISK		EXPOSED TO FREQUENT OR CHRONIC RISK		EXPOSED TO OCCASIONAL RISK		EXPOSED TO FREQUENT OR CHRONIC RISK	
	FACILITIES	LICENSED BEDS	FACILITIES	LICENSED BEDS	FACILITIES	LICENSED BEDS	FACILITIES	LICENSED BEDS
<b>FLORIDA</b>	40	3,032	10	566	70	4,626	21	1,367
<b>NEW JERSEY</b>	5	978	3	298	6	1,128	5	723
<b>TEXAS</b>	4	70	1	150	5	267	2	166
<b>NORTH CAROLINA</b>	1	146	3	210	5	596	3	210
<b>SOUTH CAROLINA</b>	0	0	0	0	1	132	1	60

See [methodology](#) at the end of brief for table explanation

“This analysis certainly suggests there is a concern for the facilities in the states included in this study,” said [Samantha Montano](#), assistant professor of emergency management at Massachusetts Maritime Academy, who was not involved in the work. “Especially considering the population that relies on these types of facilities is particularly vulnerable to hazards like flooding, prioritizing mitigation for these facilities is important.”

Concern about coastal flooding impacts on senior facilities grew after the nursing home catastrophes of Hurricane Katrina in 2005, including the well-publicized deaths of more than [50 residents in two facilities](#) that did not evacuate. Surveys of death certificates after subsequent hurricanes have consistently shown that older people fare worse.

But Dosa's research has consistently found that those numbers vastly understate nursing home deaths. Using data from the federal Centers for Medicaid and Medicare Services, [his team studied](#) the fate of nursing home residents 30 and 90 days after Hurricane Katrina compared to similar periods without emergencies. Mortality rates increased following the storm, translating into an additional 148 deaths at 30 days and 230 deaths at 90

days. Their research also found increases in hospitalizations and declines in physical and/or cognitive functioning.

In another example, the Centers for Disease Control [published an official total](#) of 129 direct or indirect deaths from Hurricane Irma, which hit Florida in 2017, including [14 elders in a Hollywood Hills assisted living facility](#) which overheated during a power failure. But Dosa's [2020 study using health records](#) found more than twice as many died in Florida nursing homes alone—262 dead in the next 30 days, and 433 after 90 days.

Many of those deaths did not result directly from coastal flooding, but Dosa said flooding is especially important because it forces evacuation. [His research](#) using Medicaid and Medicare records in 2011 showed that in four hurricanes, many more residents died after evacuation than after sheltering in place.

## GLOBAL WARMING AND SEA LEVEL RISE: THE BASICS

Oceans all over the world have been rising steadily higher—about eight inches higher, on average—since the early 1900s. Global warming is triggered by the heat-trapping greenhouse gases pumped into the atmosphere, especially carbon dioxide (CO<sub>2</sub>) from the burning of fossil fuels.

Sea level is rising at an accelerating rate and that by the end of this century it will stand somewhere between two to seven feet higher than it is today. Water expands as it warms, the oceans take up more space than they once did, and the only directions they can expand are up and out. And warmer temperatures cause increased melting of land-based ice, such as glaciers and ice sheets, adding to sea level rise.

Higher sea levels mean that devastating storm surges push farther inland than they once did, and nuisance or "sunny day" flooding occurs more frequently. According to NOAA, nuisance flooding is estimated to be from 300% to 900% more frequent within different U.S. coastal communities than 50 years ago, causing expensive destruction of property and infrastructure, and disruption to daily lives.

In interviews, caregivers told Dosa’s team that frail elders with medical needs are difficult to move and often suffer health setbacks due to the fear and stress of the experience.

“The common refrain was, ‘Every time we move somebody, we lose somebody,’” Dosa said. “It’s a question of whether I want Anderson Cooper on my front doorstep telling me that I should have left, or I want to kill people in silence and in secret, because every time we move patients from point A to point B, we lose them.”

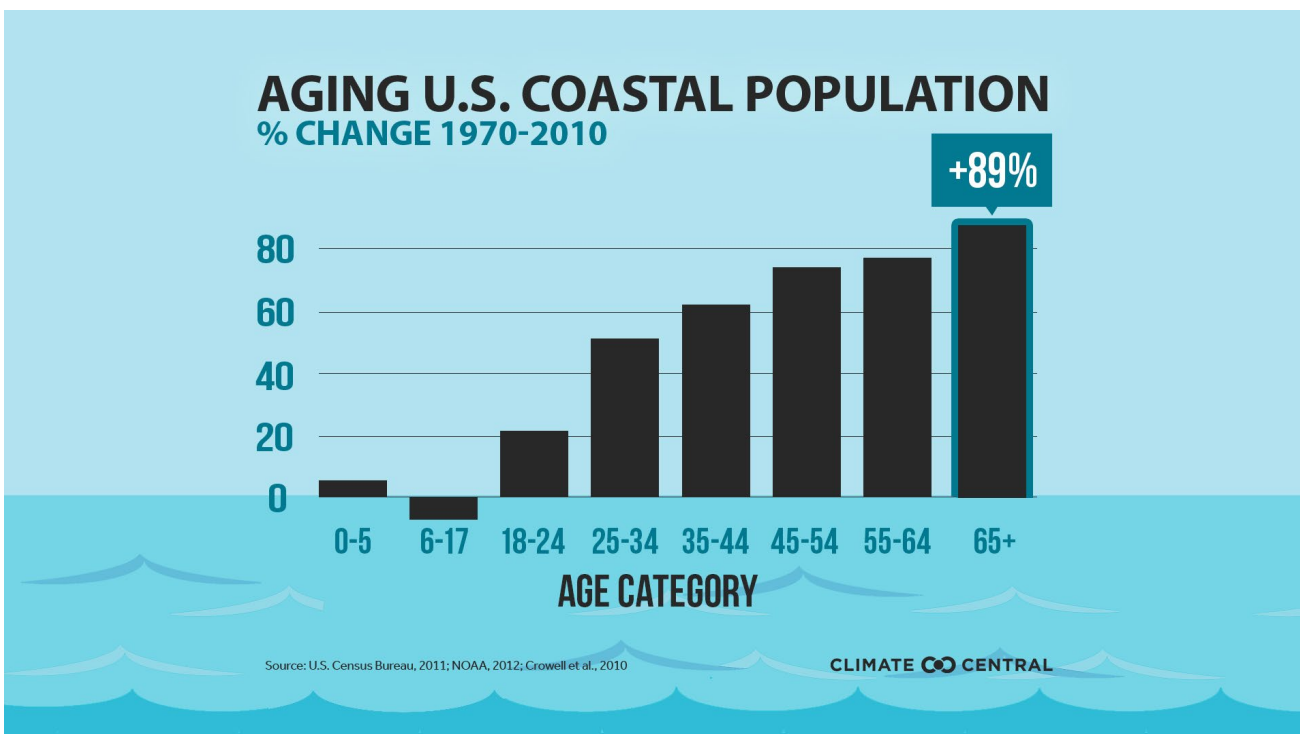
**Allison Hardin** has evacuation experience as an Emergency Medical Technician and as an emergency and community planner in Myrtle Beach, South Carolina. She also understands the fear felt by immobile nursing home residents, having felt helpless when she went through a long convalescence from an accident.

“I feared things that were irrational in my brain, but that I couldn’t stop fearing because of my incapacity to take care of myself,” she recalled.

Hardin has used that knowledge to train first responders and caregivers.

“Having been involved in moving people through using litters and Stokes baskets and wheeled carts and in all kinds of facilities, it’s not that easy,” she said. “People panic. People grab on to you. People are disoriented. Wanting to be a good caregiver, but also wanting to be a good responder, you have to kind of pick one.”

As a planner, Hardin evaluated emergency plans from elder facilities in her coastal county and found a shared flaw: various facilities anticipated assistance from the same ambulances, but in a large-scale emergency, those services might not have capacity for all. In addition, destinations for evacuation could be unavailable—in two past hurricanes, the nearest hospitals closed.



Planning oversights like these are not unusual, said Montano of the Massachusetts Maritime Academy. Emergency planning varies among communities and states for nursing homes and assisted living facilities, often with no requirement for coordination.

“They may have in-house evacuation planning,” she said, “But generally government plans and the plans for those facilities aren’t necessarily well integrated.”

Plans must also consider that rising waters may block transportation routes for evacuation and for staff travel. Even if a facility doesn’t flood, it may not be able to properly care for residents if water cuts off roads, said [Michael Greenberg](#), a distinguished professor at Rutgers University who wrote a 2014 book titled, [Protecting Seniors Against Environmental Disasters](#), which included insights from Hurricane Sandy in 2012.

Here are considerations important for elders or their families when choosing a facility, according to experts interviewed for this report:

- Look at the coastal flooding potential of the facility’s location, which can be viewed using Climate Central’s Coastal Risk Screening Tool;
- Consider the facility’s preparations for a shelter-in-place response to a disaster, including a generator capable of cooling the entire building; and
- Request a detailed emergency response plan

“During Sandy, a huge number of people got cut off,” Greenberg said. “People really became extremely isolated. People who needed dialysis couldn’t get to dialysis.”

Given these hazards, Dosa said evacuation is not the best solution for sea level rise. Nursing homes and assisted living facilities should be sited where flooding will not occur so residents can safely shelter in place.

“I think we have to do a better job of building these places and preparing these places to harden and shelter in place, if at all possible,” Dosa said. “We shouldn’t be building buildings anymore that can’t withstand significant storms ... and [should] even potentially shut down places where frequent disasters occur.”

Before the widespread use of air conditioning, developers commonly located senior facilities close to the shore to avoid heat, Dosa said. But rising sea levels may mean some of those sites are no longer appropriate for elders. Some facilities vulnerable to flooding have already closed, Dosa said. Those shut-downs come amid a [multi-year national trend of nursing homes closures](#), which has been rapidly accelerated by the COVID crisis.

Greenberg noted that well-built, modern facilities generally can withstand storms and have staff and contingency plans to handle them. But older facilities, often serving low-income residents, may be built to lower standards or on sites subject to flooding, and may have fewer staff and resources to cope with disasters.

Dosa advised, “When I talk to people about nursing homes and assisted living, it really is the big bad wolf and the house of straw and the house of brick,” he said. “If you’re in a house of straw, then obviously you need to move.”

## METHODOLOGY

Climate Central's proprietary Portfolio Analysis Tool (PAT) combines sea level rise science with local flood history data and high quality elevation data to estimate the number of statistically expected future coastal flood events at specific locations. A flood event is defined as the occurrence of nearby coastal water levels exceeding the elevation of the ground at a specific inland location (defined by latitude and longitude coordinates), with an unobstructed pathway for the water to reach the location. Flood water heights are statistically derived from local flood history combined with projected sea level rise. Ground elevation is determined from a NOAA database of LiDAR-derived elevation data. Elevation of structures above the ground are not known or evaluated. Local flood history comes from the nearest NOAA tide station with at least 30 years' history of hourly water level data. Tide stations that have not experienced a hurricane in their recorded history may not adequately represent the risk of a future hurricane. Projected sea level rise is derived from a sea level rise model ([Kopp 2014](#)). Inputs to the model include an assumption that carbon emissions continue unchecked in the so-called business-as-usual scenario (RCP 8.5). PAT estimates the expected annual number of flood events each year and reports the results in decadal increments starting in 2020. Our analysis is based on the statistically expected number of future flood events during the course of a year. "Occasional risk" denotes at least 0.01 expected flood event per year, corresponding to approximately a 1% annual chance of flood risk event. This is the level commonly used to establish flood hazard zones. One can statistically expect a 26% chance of a 100-year flood during a 30-year period. "Frequent risk" denotes at least 0.1 expected flood risk event per year, corresponding to approximately a 10% annual chance of a flood risk event. "Chronic risk" denotes at least 1 expected flood risk event per year, corresponding to approximately a 99%+ annual chance of a flood risk event. Special thanks to Kelly Van Baalen and Regina Stasser de Gonzalez for assisting in the research and writing of this report.





# COMING STORMS: CLIMATE CHANGE AND THE RISING THREAT TO AMERICA'S COASTAL SENIORS

Part II: Climate-driven emergencies threaten seniors' health and lives

Source: Volunteer Liz Degen, left, helps people get on a bus: Steve Bisson/Savannah Morning News via AP

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# CLIMATE-DRIVEN EMERGENCIES THREATEN SENIORS' HEALTH AND LIVES

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Coastal storms are far deadlier for seniors, including the majority who age in place, while 'sunny day' tidal flooding can cut them off from needed services and social connections.

Older Americans are in the bullseye for coastal flooding driven by sea level rise, suffering higher rates of death in storm surge events because of age and frailty and because they frequently live on the coast, mostly in their own homes.

Death records from major hurricanes consistently show higher mortality among older adults. In Hurricane Katrina in 2005, more than 70 percent of deaths were people over age 60, even though they represented just 15 percent of the population, [according to the Centers for Disease Control](#). Meanwhile, as the population ages, more elders are living in coastal communities than ever before—[census data shows](#) the coastal population over 65 went up by 89 percent from 1970 to 2010 (this includes counties directly adjacent to the open ocean, major estuaries, and the Great Lakes).

“In addition to choosing coastal destinations as retirement destinations, there is a new trend which is called aging in place, where more and more older individuals intentionally choose to live independently,” said [Anamaria Bukvic](#), an assistant professor of geography at Virginia Tech.

That trend is colliding with the climate change trend of rising seas, said Bukvic, who led a [2018 study of the issue](#).

“We are seeing, in addition to more severe and more frequent episodic events like tropical storms and nor’easters, that many of these communities are experiencing nuisance and high tide flooding,” Bukvic said. “That can prevent older individuals from going to their doctor appointments or seeking services they need, or even sometimes leads to isolation that can then have some psycho-social implications on their well-being.”

High tide flooding in the U.S. has [doubled since 2000](#), according to the National Oceanic and Atmospheric Administration, and could potentially triple in the next 10 years. Even low levels of [nuisance or “sunny day” flooding](#) can have serious consequences for coastal communities, by closing roads, degrading infrastructure, and reducing property values.

Bukvic’s team looked at senior citizen vulnerability in all 271 counties along the U.S. east coast, drilling down on three counties with more than 20 percent of residents over 65 and with varying characteristics of income and urban or rural settings: Cape May in New Jersey, Pamlico in North Carolina, and Brevard in Florida.

Each of the three counties contained census tracts where more than 30% of seniors had ambulatory difficulty. In Cape May and Pamlico, a Category 2 hurricane would be sufficient to flood more than 50% of seniors’ homes, while more than 15% would be flooded by just two feet of sea level rise. In Brevard, on Florida’s Space Coast, the percentages of seniors affected were lower, but the density of the overall population and frequency of tropical storms much higher.

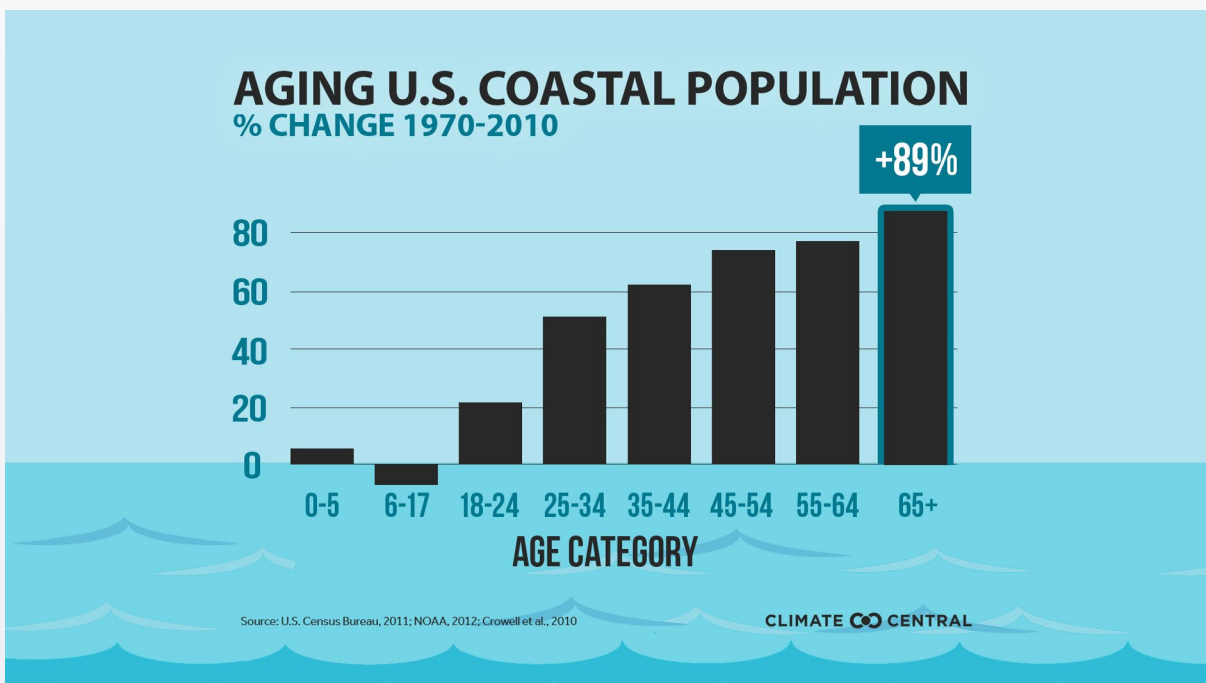
Elders face many climate-change hazards living near the coast, said Michael Greenberg, an expert in environmental health and risk analysis at Rutgers University, whose 2014 book catalogued these liabilities for the first time. Only by looking at deaths individually did he find causes that otherwise might not have been categorized as related to a disaster.

"After Hurricane Sandy struck, I managed to get access to death certificates in the area, in New Jersey and adjacent areas in Pennsylvania and New York that were affected," he said. "The part that really was stunning, that nine people, nine seniors, were killed when they fell down the stairs and didn't have a flashlight with them. It was just awful to read that."

Power outages from storms can also expose elders to dangerous heat or cold while flooding traps them at home. In addition, 14 percent of older adults in the U.S. use medical devices that require electricity that could be at risk during an outage, according to a 2015 survey by researchers at the University of Iowa.

The survey found 12% of those over 80 would not be able to evacuate in an emergency without help and 13% had hearing difficulties that would keep them from hearing warning sirens. Researchers at the University of Kentucky found flood evacuees with Alzheimer's Disease showed increased symptoms, with those housed in emergency shelters exhibiting "agitation, anxiety, aggression, general discomfort, emotional distress, increased disorientation, and repetition."

"People become more frail, and that manifests itself typically after the age of 75, as I am now finding out," Greenberg said. "So the kinds of things you could do during a hurricane are hard to do even when you have time to prep. And that has to do with the fact that your muscles are not as strong, your heart is not as strong, all sorts of things that come with age that seem to suddenly sneak up on us and we just can't do what we thought we could do."



Elder homeowners may also have more difficulty preparing for rising seas. Many coastal residents have raised their homes to stay above flood waters, but for seniors adding a flight or more of stairs to the front door can isolate them at home, as the climb becomes a barrier to casual trips, Bukvic said. In addition, older adults often need to leave their homes to access medical care and pharmacies, and may need to be visited by home health aides or other caregivers. Either could become a problem during extended periods of high water, even in an elevated home.

Bukvic's study found many senior citizens live in housing built before 1980 that is more vulnerable to climate change due to lower construction standards. For example, in the rural, lowland areas of Pamlico County, North Carolina, her team found many low-income elders live in houses built on slabs that are impractical to raise. These homes may be distant from the shore, but are newly subject to flooding because of the combined effects of sea level rise, increased precipitation, and old, poorly functioning drainage systems.

In more affluent Cape May County, New Jersey, elders often live adjacent to the shore in older homes that were originally constructed as vacation properties, Bukvic said. Those houses tend to be less robust for withstanding storms and impractical to raise, and sometimes they have septic systems that can release sewage during flooding events, she said.

Regardless of their wealth, threats to the home are particularly frightening for elders, said Greenberg, who surveyed seniors affected by hurricanes. While evacuation can be traumatic, returning to a wrecked home can be even worse, he said, often leading to depression.

"One of the biggest problems after Sandy, but Irene as well, was the amount of psychological problems people faced, especially seniors when they couldn't go back," Greenberg said. "They lost their friends. They lost their neighbors. Many just couldn't ever recover from it, even if they could handle it financially."

On the other hand, some research has found that seniors have remarkable psychological resilience, perhaps due to prior life experiences that allow them to put losses in context. Remaining connected to a community seems to be a key factor, according to [one in-depth study](#).

Many of these risks are difficult to avoid for the millions of elders living in areas increasingly prone to flooding caused by climate change. In the next part of this report, we review how to choose a home safe from sea level rise.

#### HERE IS A TOOLKIT OF LINKS FOR SENIORS AND THEIR FAMILIES TO PREPARE FOR EMERGENCIES:

- [Centers for Disease Control: Emergency Preparedness for Older Adults](#)
- [AARP Operation Hurricane Prepare](#) (for groups or individuals)
- [National Institute on Aging: Disaster Preparedness for Alzheimer's Caregivers](#)



# COMING STORMS: CLIMATE CHANGE AND THE RISING THREAT TO AMERICA'S COASTAL SENIORS

Part III: The hidden climate threat to seniors' finances

Source: Necie Chenall, left, hugs her neighbor, Glenda Frascone. AP Photo/Marcio Jose Sanchez

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# THE HIDDEN CLIMATE THREAT TO SENIORS' FINANCES

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Older Americans in coastal zones face unique and growing hazards of financial loss due to rising seas and intensifying storms.

Climate change threatens the real estate nest eggs of senior citizens living on America's coasts, often in ways that are hidden or difficult for homeowners to assess.

Research shows the financial hazards extend well beyond actual flooding of homes. Anticipated sea level rise has depressed property values and increased insurance and property taxes, said [Jesse Keenan](#), an associate professor of real estate at the Tulane University School of Architecture. Retirees on fixed incomes may not foresee or be able to handle those increases.

"I think for seniors, these are real cost burdens that are on the horizon," said Keenan, who was editor of a major national report, "[Managing Climate Risk in the U.S. Financial System](#)," released in September by the U.S. Commodities Futures Trading Commission. The report looked at the emerging risks from climate change to the U.S. financial system, including banking institutions, markets, and the insurance sector.

Nationally, homes exposed to sea level rise are selling for an average of 7% less than equivalent houses, [according to 2019 research](#) by scientists at the University of Colorado and Penn State University. Keenan added that the downward pressure on prices affects the entire coastal market, including less vulnerable homes, through mechanisms in the banking, insurance, and municipal finance industries, which are often invisible to homeowners.

Many retired Americans live on low incomes but have substantial equity in their homes, said [Anamaria Bukvic](#), an assistant professor of geography at Virginia Tech who published [a 2018 study](#) of older adults living along the east coast. Those assets are at risk in areas that are newly vulnerable to coastal flooding.

"We see, in rural areas, advanced aging of the population, with younger, more educated people moving out of rural areas in search for better opportunities, leaving behind older residents," Bukvic said. "They basically aged in place, sometimes in multigenerational homes that don't have flood insurance."

Homeowners with mortgages typically are required to carry [flood insurance](#) if they live in a federally designated flood plain, but not those who own homes without debt.

"Insurance is very expensive, and increasingly expensive, and it's going to be more expensive in the future," Bukvic said. "So, a lot of older individuals may just forego purchasing insurance, just because they cannot afford it, in a hope nothing will happen."

In addition, judging the risk of future flooding can be difficult, because flood plain maps are inaccurate and outdated, and flooding records for individual properties are kept confidential by federal officials, said [Rob Moore](#), a senior policy analyst with the Natural Resources Defense Council. The [National Flood Insurance Program](#) will reveal past flood damage only after the current property owner requests it in writing.



Twenty-nine states require sellers to disclose whether the property is in a designated flood plain before completing a sale. But only 10 U.S. states require property sellers to disclose past flooding to buyers, and among east coast states only Delaware has adequate disclosure, according to [2018 research](#) by the Sabin Center for Climate Change Law at Columbia University.

“Areas inundated in Hurricane Sandy were far more extensive than the areas identified by FEMA as at risk of flooding on their flood maps, and that’s because the maps were almost 30 years out of date by the time Sandy hit,” Moore said. “And they don’t incorporate any assumptions about future climate conditions.”

The federal flood program can offer buy-outs for homes that flood, but experts said the process is so long and involved that seniors often cannot navigate it. Harris County, Texas, where Houston is located, already had 1,000 residents on a waiting list for buy-outs when Hurricane Harvey hit in 2017 and added many times more applicants, Moore said.

“Over time, a lot of those people just gave up,” he said. “They couldn’t afford to just wait for an uncertain ending, so they took their flip—they sold their flood-damaged home for a fraction of its value to a home flipper.”

In many cases, those investors could then resell the home without disclosing the flooding, because it did not occur during the period of their ownership, Moore said.

Many older adults whose homes were damaged by Sandy in 2012 also left the area, said Rutgers University Distinguished Professor [Michael Greenberg](#), who wrote [a book on seniors and disasters](#). Unable to afford repairs or improvements to prepare for another storm, they sold to developers who built for more affluent buyers, with expensive improvements such as an elevated first floor.

But other elders who lived through Sandy projected a fatalistic attitude about their exposure to sea level rise, Greenberg said. In interviews with surviving seniors some said, “I’m an old person. I love the place. I want to live here. I’m gonna die here. I’ll will whatever the property’s worth to my children and they can do whatever they want with it.”

Some experts describe coastal real estate ownership as a game of musical chairs, as property changes hands until sea level rise imposes significant losses on a final owner. But Tulane’s Keenan said losses also accumulate gradually, as forces gather to increase the cost of owning a coastal home and reduce the buying power of potential purchasers.

His research documented banks demanding higher down payments or quicker loan repayment to shield against sea-level-rise risk, changes that diminish what buyers can afford. Banks in coastal areas also are selling off more home loans to get them off their books compared to inland property, [Keenan and a colleague found](#).

As values fall, reverse mortgages become less viable, Keenan said. A reverse mortgage provides a homeowner over the age of 62 with monthly cash from a loan that will be repaid by the later sale of the house. But with declining values, these loans are smaller or could leave heirs without equity, Keenan said.

Climate change can also [drive up local property taxes](#), due to the costs of flooding, flood preparations, or the increased cost of borrowing money for municipal projects that could be at risk, Keenan said. He spoke to one large institutional trader of municipal bonds who routinely checked online sea level rise projections, such as those in Climate Central's [Coastal Risk Screening Tool](#), before buying debt for public facilities. The trader would only buy if the facility backing the debt was projected to remain above water until the debt was paid off.

While a number of coastal risk tools are available for public use, most analysis by banks, insurers, and investors is proprietary, Keenan said. Private companies are already making money, or shedding risk, in a "[climate intelligence arms race](#)" that is shielded from public view, he said. Indeed, [research shows](#) that coastal property values have been depressed more for homes purchased by sophisticated buyers, such as non-resident investors, while buyers planning to live in their houses were less likely to take sea level rise into account—and may not have understood it.

"Consumers are the pawns in this risk game," Keenan said. "They can't make risk-informed decisions. They just bear the consequences of less-than-optimally informed decision making."

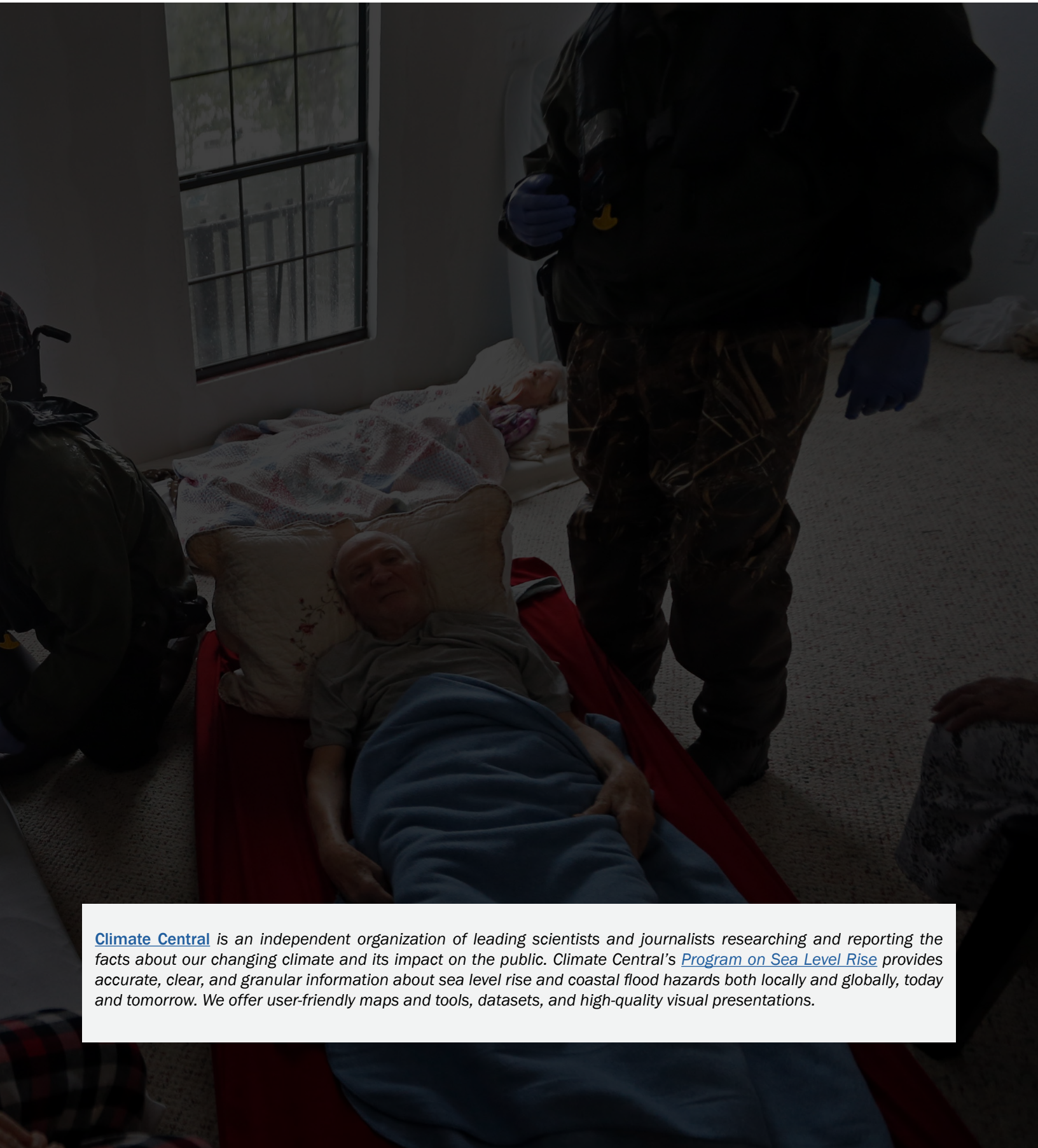
For older adults choosing a place to retire, one solution may be to avoid investing in coastal property. Keenan said long-term rentals that provide stable housing costs make sense for retirees.

"Homeowner equity is in peril," Keenan said. "Even if you want to live out your golden years close to the beach, you should be well aware that there's nothing wrong with being a renter. And it just may be a better idea."

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#### HERE IS A TOOLKIT OF SITES TO HELP IDENTIFY THE FLOODING RISK OF COASTAL PROPERTY:

- Climate Central's [Coastal Risk Screening Tool](#), provides maps of specific locations by decade and by water level, and a choice of varying sea level rise scenarios;
- Climate Central's [Surging Seas Risk Finder](#), shows detailed data on coastal communities' flood risks;
- First Street Foundation's [Flood Factor](#), offers a flood-risk score for individual property addresses.



[Climate Central](#) is an independent organization of leading scientists and journalists researching and reporting the facts about our changing climate and its impact on the public. Climate Central's [Program on Sea Level Rise](#) provides accurate, clear, and granular information about sea level rise and coastal flood hazards both locally and globally, today and tomorrow. We offer user-friendly maps and tools, datasets, and high-quality visual presentations.