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The California coast is disappearing under the rising sea. Our choices are grim

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By ROSANNA XIA (HTTPS://WWW.LATIMES.COM/LA-BIO-ROSANNA-XIA-STAFF.HTML)

THE CALIFORNIA COAST GREW AND PROSPERED during a remarkable moment in history when the sea was at its tamest.

But the mighty Pacific, unbeknownst to all, was nearing its final years of a calm but unusual cycle that had lulled dreaming settlers into a false sense of endless summer.

Elsewhere, Miami has been drowning, Louisiana shrinking, North Carolina's beaches disappearing like a time lapse with no ending. While other regions grappled with destructive waves and rising seas, the West Coast for decades was spared by a rare confluence of favorable winds and cooler water. This "sea level rise suppression (http://scrippsscholars.ucsd.edu/pbromirski/content/dynamical-suppression-sea-level-rise-along-pacific-coast-north-america-indications-imminent-)," as scientists call it, went largely undetected. Blinded from the consequences of a warming planet, Californians kept building right to the water's edge.

But lines in the sand are meant to shift. In the last 100 years, the sea rose less than 9 inches in California. By the end of this century (https://www.documentcloud.org/documents/6168725-RISING-SEAS-SLR-FINAL-REPORT.html), the surge could be greater than 9 feet.

Wildfire and drought dominate the climate change debates in the state. Yet this less-talked-about reality has California cornered. The coastline is eroding with every tide and storm, but everything built before we knew better — Pacific Coast Highway, multimillion-dollar homes in Malibu, the rail line to San Diego — is fixed in place with nowhere to go.

But the world is getting hotter, the great ice sheets still melting, the rising ocean a slow-moving disaster that has already swept past California's front door. Seaside cliffs are crumbling in Pacifica, bringing down entire buildings. Balboa Island, barely above sea level, is spending $1.8 million to raise the wall (https://www.latimes.com/socal/daily-pilot/news/tn-dpt-me-seawall-contract-20171011-story.html) that separates it from the ocean.

Winter storms pummeled a Capistrano Beach boardwalk (https://www.latimes.com/local/lanow/la-me-ln-capistrano-beach-20181202-story.html), turning the idyllic shoreline into a construction zone as bulldozers rushed to stack boulders into a barricade. From San Diego to Humboldt counties, homeowners scramble to fend off increasing erosion and storm surges, pleading with officials for bigger seawalls that can hold back the even bigger ocean.

(https://www.latimes.com/projects/la-me-climate-change-ocean-game)

There are only so many ways to play against the rising sea. Seawalls are one option, but they come with a hidden cost — forcing the sand before them to wash away. For every new seawall protecting a home or a road, a beach for the people is sacrificed.

Adding sand to disappearing beaches is another tactic, but that race against nature lasts only so long as there's money and enough sand.

Then there's what scientists and economists and number-crunching consultants call "managed retreat": Move back, relocate, essentially cede the land to nature. These words alone have roiled the few cities bold

enough to utter them. Mayors have been ousted, planning documents rewritten, campaigns waged over the very thought of turning prime real estate back into dunes and beaches.

Retreat is as un-American as it gets, neighborhood groups declared. To win, California must defend.

But at what cost? Should California become one long wall of concrete against the ocean? Will there still be sandy beaches or surf breaks to cherish in the future, oceanfront homes left to dream about? More than $150 billion in property (https://www.latimes.com/local/lanow/la-me-california-coast-storm-damage-20190313-story.html) could be at risk of flooding by 2100 — the economic damage far more devastating than the state's worst earthquakes and wildfires. Salt marshes (https://www.latimes.com/local/lanow/la-me-salt-marsh-climate-change-20180221-story.html), home to shorebirds and endangered species, face extinction. In Southern California alone, two-thirds of beaches could vanish. (https://www.usgs.gov/news/sea-level-rise-could-double-erosion-rates-southern-california-coastal-cliffs)

Beaches are the state's pride and joy. Many could vanish by the end of the century, depending on how Californians choose to adapt to sea level rise. (Allen J. Schaben / Los Angeles Times)

The state has both no time and too much time to act, spiraling into paralyzing battles over the why, who, when and how. It's not too late for Californians to lead the way and plan ahead for sea level rise, experts say, if only there is the will to accept the bigger picture.

Returning after mudslides and wildfire. Rebuilding in flood zones. The human urge to outmatch nature is age-old. We scoff at the fabled frog that boiled to death in a pot of slowly warming water — but refuse to confront the reality of the sea as it pushes deeper into our cities.

We've all played by the shore and built castles in the sand, but seem to forget what happens next: The ocean always wins.

PACIFICA

A town on the edge

ON THE BLUFFS AND SHORES OF PACIFICA, a postcard stretch of coastal hamlets just south of San Francisco, residents fear that planning for sea level rise means condemning their own community to extinction.

Here, what other cities in California are only beginning to worry about in the abstract is already a much-lived reality. Powerful waves crest over the main pier and threaten roads with names such as Beach Boulevard and Shoreview Avenue. Blasts of sand batter walls and homes. Windows shatter. Cliffs collapse. Residents bear witness to entire chunks of hillside crumbling into the surf below.

In one part of town, the ocean chewed away more than 90 feet of bluff in less than a decade.

People were able to walk Pacifica as an entire stretch of beach in the 1970s, but the open shoreline shrank over the years as the city built seawalls, piled rocks, coated its fragile sandstone cliffs with special concrete to protect what nature was taking by force.

Today, most of Pacifica's coast is armored. But even with these defenses, the city still had to buy out a row of bluff-top homes, later converting the street into a trail. Down by the sand, more homes were removed and a public parking lot rebuilt 50 feet farther inland.

Along Beach Boulevard, signs caution dog walkers and joggers that waves may break over the seawall. The pavement is often wet from high surf. Cars are urged to keep moving. Locals are wise enough to not linger too long by the aging pier.

A woman who did was hit in 2006 by a wave that blew over. When she was finally able to breathe and open her eyes, she was stunned to find she had been swept to the back of someone's garage, her arm hooked through a barbecue pit.

The shocks continued. Years of drought followed by heavy storms in 2016 forced more than a dozen bluff-top residences to be tagged as unsafe. Three apartment buildings — suddenly dangling off the edge — could not be saved and were demolished.

Remnants of a bluff-top apartment building in Pacifica fell down to the beach, where large rocks form a barrier against the rising sea. (Carolyn Cole / Los Angeles Times)

> “If we don’t start managing retreat now, how much is it going to cost later?”
>
> — Charles Lester, director of UC Santa Barbara’s Ocean and Coastal Policy Center

Responding to just this most recent El Niño season has cost Pacifica $16 million — no small change for a town whose $36-million operating budget relies mostly on property taxes. Officials are still seeking funds to cover damage from 2016 and remain mired in an eminent domain battle over two of the buildings.

Pacifica has become this story of unplanned, forced retreat, experts say, and the public got stuck with the bill.

“There’s a public cost and a private cost in any choice that we make, and we need to start doing that cost-benefit analysis,” said Charles Lester, director of UC Santa Barbara’s Ocean and Coastal Policy Center, who has consulted for a number of towns, including Pacifica, on sea level rise planning. “If we don’t start managing retreat now, how much is it going to cost later?”

In hundreds of pages of planning documents (https://www.cityofpacifica.org/depts/planning/sea_level_rise.asp), officials concluded that moving inland in future decades might pencil out to be the most cost-effective option for a number of neighborhoods. Seawalls keep failing, they said, and the ocean is winning. Much of the shoreline protection could be overwhelmed with as little as 1 foot of sea level rise.

But many lambasted (https://www.nopacificaretreat.com/take-a-stand.html) the proposal, fired up by a property rights campaign by the real estate industry. Homeowners flooded city meetings, knocked on neighbors’ doors and plastered signs around town. The mayor became the town punching bag, and new leaders were voted in to help Pacifica stand its ground.

“‘Managed retreat’ is code word for give up — on our homes and the town itself,” said Mark Stechbart, who worries that Pacifica, and in turn his own home’s value, will be dismissed by future developers, insurers and buyers. “This is not just some intellectual exercise. These are real people and a real town at stake.”

For Suzanne Drake, a historical-society volunteer who cobbled together enough money during the recession to buy “the ugliest house on the prettiest street in town,” talk of managed retreat has kicked up an anger she didn’t know she had.

The words are like a scarlet letter, she said. How could anyone get a 30-year-mortgage if city documents say the entire street might be condemned in the future and turned into a beach? How will she get insurance or permits to remodel her home?

“The public has rights to the beach, but I apparently don’t have rights to my house,” she said after one particularly heated meeting that pitted homeowners against conservationists. “I’m a left-of-left Democrat, but these environmental zealots are next level.”

The issue has divided this close-knit town, whose residents open conversations by touting the number of years they’ve lived here and — in recent months — by how many feet they live above sea level. Outbursts at council meetings have become the norm, and depending on who’s angriest that day, environmentalists, the real estate industry, the city or the California Coastal Commission is Enemy No. 1.

The specter of managed retreat has galvanized retired engineers, policy wonks — even the president of the local Democrats club — to speak alongside real estate groups, worried that Pacifica will become “an economic wasteland” if the long-term vision is retreat. They accuse the city’s study of undervaluing homes, businesses, hiking trails and golf courses when calculating the public benefits of letting go. Preserving tourism, businesses and development opportunities, they said, should play into any future plan.

Others say Pacifica has already outlived its time. There’s a reason why an empty parcel by the water has failed for years to attract developers, they said, and why the Taco Bell can still afford prime oceanfront views.

How much Pacifica ultimately decides to retreat, both sides agree, could be the litmus test for what’s going to happen to the rest of California.

One recent morning, Drake stood on her second-story deck and talked over the roar of sand dozers clearing roads. The area floods whenever waves top the seawall or there’s a break in the berm. The city brings in a pump during the winter to push stormwater back into the ocean.

Without that seawall or berm, her neighborhood and the nearby golf course would easily flood. Without these kinds of defenses, sewage lines, wastewater treatment plants, schools and other public infrastructure would be at risk.

What officials need to do, Drake said, is build larger seawalls and commit to saving the town. She sees Pacifica on the cusp of becoming something special — a town that could finally have a nice library, perhaps, or a beautiful downtown with coffeehouses and places to shop.

The big white house next door sold not long ago for more than $1.5 million, she said. Pacifica is still worth something, so why would officials let it go?

City officials have heeded the backlash and rewritten their plan to address the rising sea. Key seawalls will be extended, and the words “managed retreat” have been replaced with references to environmental triggers for “adaptation strategies” in the coming decades.

Many still distrust where this document is headed. John Keener, who championed the issue as mayor before losing his bid for reelection, wonders how much will change under the new leaders in power.

Walking along Esplanade Avenue one recent afternoon, Keener points to the orange tape and bits of foundation still poking out from where apartment buildings once stood. Only the odd-numbered homes on this block remain, the even-numbered side making way for sweeping ocean views.

Along Esplanade Avenue in Pacifica, a walkway is all that's left of an apartment building. (Carolyn Cole / Los Angeles Times)

Keener, a retired biochemist, winces at the words “managed retreat” and said he didn’t want to devalue anyone’s home or give up on the town. He just looked at the data and tried to think ahead.

The city has little money to build bigger seawalls, no money for sand replenishment, no money to compensate homeowners for the loss of their property. So he reasoned that Pacifica had a better shot of getting outside funding by showing it had thought through every option and come up with a plan.

Worrying about what this planning document would do to home values is a privilege with an expiration date. He fears that by 2050, “this stuff will all become moot.”

“We’ll be in survival mode,” he said. “The other aspects of climate change are going to simply just overwhelm us as a society.”

He takes out his new business card, embossed with the words “Environmental Advocate.” “What kind of world,” he wondered, “are we leaving for our kids and grandkids?”

Homes along the cliffs of Pacifica are hanging on to time. Some have already been condemned or removed. (Carolyn Cole / Los Angeles Times)

SEAWALLS

Protection at what cost?

YOUR HOME IS YOUR CASTLE, the biggest investment most families make. So the impulse, of course, is to defend it.

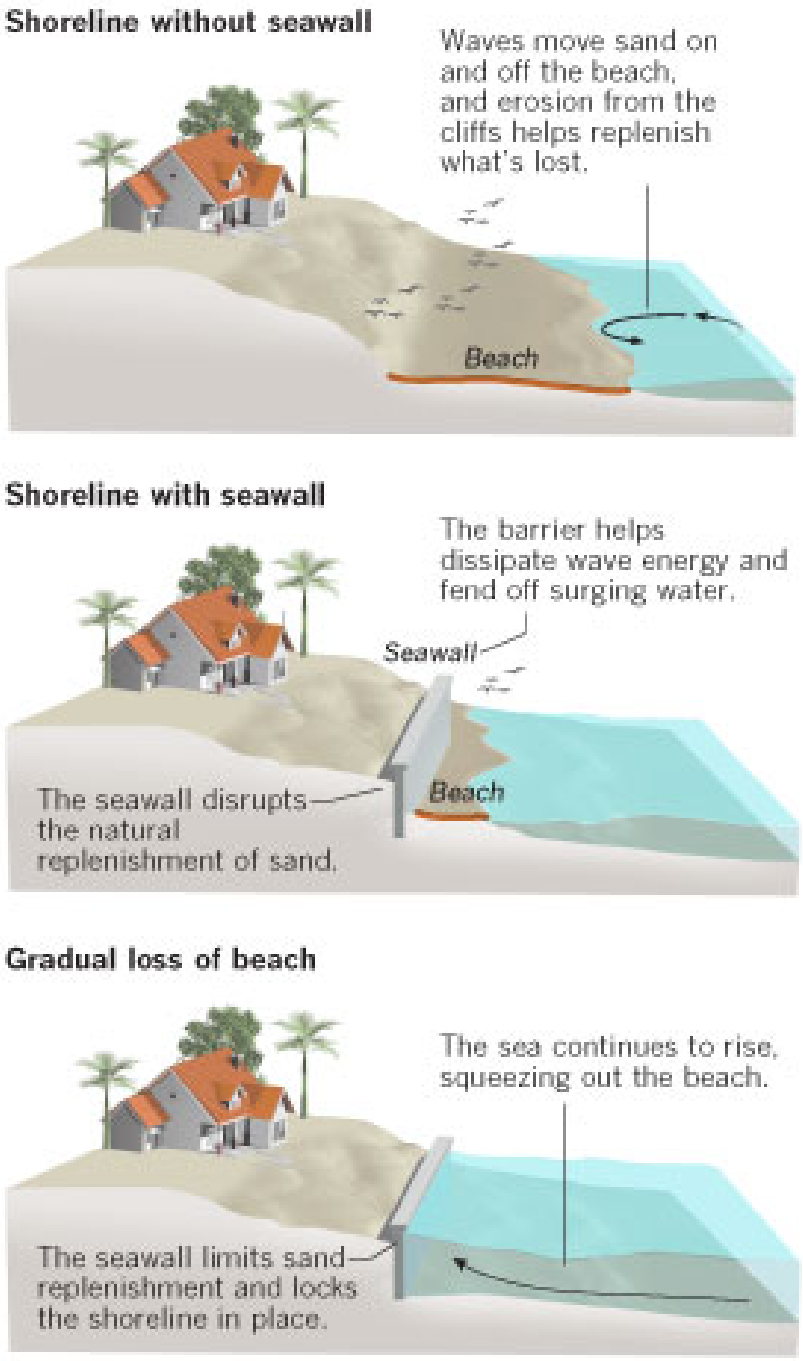
The go-to tactic is the seawall. Made from piles of boulders, gunite-coated cliffs or concrete slabs as high as two stories, seawalls dissipate wave energy and fend off surging water. But these defenses aren’t cheap. A single homeowner can spend as much as $200,000. A mile-long wall can cost taxpayers tens of millions of dollars. Repairs sometimes cost as much as the wall itself.

Defending the entire state could cost homeowners and taxpayers more than $22 billion in the next 20 years if the sea rises even a moderate amount, according to a recent study (http://www.climatecosts2040.org/costs/california) by the Center for Climate Integrity.

And each seawall is a choice, conscious or not, to sacrifice the beach in front. The barriers disrupt the natural replenishment of sand, stripping away beaches until they narrow or vanish altogether. Some states have banned new seawalls: Oregon, North Carolina, Maine. Others have imposed significant restrictions.

The hidden cost of seawalls

Seawalls form a line of defense against the rising ocean. But a beach gets sacrificed in the process.



Lorena Elebee / Los Angeles Times
Sources: Gary Griggs, UC Santa Cruz Institute of Marine Sciences, Kiki Patsch, Cal State Channel Islands

In California, environmentalists have called seawalls a coastal crisis. The Coastal Commission, in charge of regulating and shaping the state's 1,200-mile shoreline, has historically OKd them in emergencies — temporary solutions after a rough storm.

But temporary often becomes permanent. About 30% of Southern California's shoreline today (https://www.arcgis.com/apps/Cascade/index.html?appid=010d446134ec49a2bcd39881d2856a79) is behind some form of seawall — locking in Navy bases, rail lines, harbors and multimillion-dollar homes at the expense of open space.

"Seawalls kill beaches," said Jennifer Savage, California policy manager for the Surfrider Foundation. "I feel like a broken record saying this, but there is still such a disconnect with the public on such a key, simple message: Sea level rise doesn't just impact homeowners; it impacts every person who wants to go to the beach."

And the beach, state law declares, belongs to everyone. So the Coastal Commission in recent years has gotten tougher on seawalls. It urged city leaders to do everything within their power to consider alternative options, including managed retreat.

But that position has not won the commission friends among homeowners and local planners. City leaders often blame the state and the commission when taking unpopular steps. But the commission, when confronted by the public, says it's just offering guidance.

High surf pummels homes along Faria Beach in Ventura County. Seawalls disrupt the natural replenishment of sand, squeezing away beaches until they narrow or vanish altogether. (Al Seib / Los Angeles Times)

More than 30 cities and counties are now left paralyzed, tugged left and right to do something — but not sure what that is. There's no clear set of directions, no one-size-fits-all solution.

For the homeowner, insurance policies, hazard grants and federal disaster relief are all set up in a way that encourages rebuilding rather than relocating. There's no incentive for owners to consider options beyond hunkering down with bigger and better walls. The way the state pushes down insurance prices also masks the true cost of living in a hazardous area.

But the more hazardous it gets, the more the public could pay: As rising seas and storms exacerbate property damage, experts worry that the inability of insurers to charge prices that reflect actual risk could lead them to stop offering coverage in California.

If insurers stop covering risky properties, the state becomes the last resort.

That happened with earthquake insurance (https://www.earthquakeauthority.com/About-CEA/CEA-History), when California stepped in to stabilize the market with insurance that companies could sell in lieu of their own. Officials are now confronting this in wildfire areas. Similar pressures are playing out in hurricane-prone states, according to a Stanford study (https://law.stanford.edu/wp-content/uploads/2015/07/CalCoastArmor-FULL-REPORT-6.17.15.pdf) led by a former coastal commissioner.

And so states, and ultimately taxpayers, are the ones subject to the biggest financial risks when a disaster hits.

Judy Taylor, a state director of the California Assn. of Realtors who has lived along the coast in the Half Moon Bay area for 45 years, said uncertainty over sea level rise planning has upended her world of clear rules and clean transactions.

Realtors are in a bind. Unlike other hazard zones in California, there are no mandatory disclosures for homes that might be subject to relocation or other sea level rise plans in the future. Clearly defined disclosures would help people better understand whether the home they're buying could actually be a long-term investment.

"Right now if we over-disclose, it's going to sabotage the seller's transaction," Taylor said. "If we under-disclose, then the buyer is going to have serious heartburn."

> "... we have never before dealt with the fact that Mother Nature's going to do what she's going to do, and we can't do anything about it. "
>
> — Judy Taylor, California Assn. of Realtors

What's debated by her industry is not so much climate change, she said, but how much longer owners can extend the life and value of homes — and how they can do so while navigating the bureaucratic system of coastal permits.

"We have dealt with property being taken for bridges, for roads, for even shopping centers. But we have never before dealt with the fact that Mother Nature's going to do what she's going to do, and we can't do anything about it," Taylor said. "So how do we treat this issue sanely and fairly? Do these policies actually further the goal, do they create a better environmental outcome — and is your ox getting gored and mine left free?"

SAN FRANCISCO

Choosing casualties

ON ONE SIDE OF SAN FRANCISCO, a century-old seawall keeps the city's iconic towers and skyscrapers firmly on land.

On the other side, a rock wall protects a road, a parking lot and a sewage treatment system — squeezing away one of the city's few beaches.

Projected flood risk in San Francisco

Minimum Maximum

Slide for different sea level rise scenarios:

0.5 meter

Sources: U.S. Geological Survey's Coastal Storm Modeling System (CoSMoS), Nearmap. (Thomas Suh Lauder / Los Angeles Times)

Something needs to give. But even in a city as climate-aware as San Francisco, making sacrifices is not easy.

What is now the the city's commercial core was once mostly a marsh — the shoreline a muddy half-mile farther inland. Over the decades, settlers filled in these wetlands and created more than 500 acres of new land atop old coves and abandoned ships.

Holding back all the water is the Embarcadero, doubling as a tourist attraction and bustling today with visitors and schoolkids, markets and museums. Humming beneath their feet is a network of critical infrastructure — sewer and water systems, utility lines, public transportation, communication cables — that could cave to the ocean without this seawall.

There's no doubt defenses here must survive. This colossal feat of rock and concrete keeps San Francisco Bay from drowning the financial district and Market Street, safeguarding some $100 billion in business and buildings.

But the wall is crumbling and in desperate need of backup. High tides routinely spill over and flood sections of the boardwalk. With just 3 more feet of sea level rise, the iconic Ferry Building could flood every single day.

Updating this seawall will cost at least $2 billion, probably much more. Scientists from the U.S. Geological Survey recently found (https://www.latimes.com/local/lanow/la-me-california-coast-storm-damage-20190313-story.html) that the cost of building levees, seawalls and other measures to withstand 6 ½ feet of sea level rise and a 100-year storm could cost as much as $450 billion for San Francisco Bay.

The Embarcadero, a seawall doubling as a tourist promenade, often floods during winter high tides. (Jeff Chiu / Associated Press)

Making people care has not been an overnight process. Lindy Lowe, the Port of San Francisco's resilience officer, reflected on all the neighborhood meetings, family nights and door-knocking to get taxpayers to understand (https://www.sfseawall.com/) the issue.

It was crucial, she learned, to actually work with the community from the beginning rather than doing all the research behind the scenes and then dropping a report full of government mumbo-jumbo declaring the city doomed.

"Never start a conversation with sea level rise is what we learned. Start the conversation with: 'What do you care about? What do you want your community to look like?' " Lowe said. "We're asking people to do some really big things, and we need to make sure we're not asking them to do it all at once."

So San Francisco started by asking voters for $425 million to lay the foundation for a bigger seawall (https://www.sfseawall.com/). Last fall, 82% of them said yes — a huge feat in a world where shelling out this much money usually comes only after a big disaster.

Defense proved to be a feasible sell, but retreat on the other side of town took much more convincing.

At South Ocean Beach, a popular spot for big surf and bonfires, more than 275 feet could disappear by 2100. The waves once devoured more than 40 feet of bluff in one season. For years, city officials fought (https://www.latimes.com/local/la-xpm-2012-jan-02-la-me-san-francisco-strand-20120102-story.html) — even sued the state — to keep a protective rock wall.

Ocean Beach is popular for big surf. Efforts to preserve the beach while also protecting critical infrastructure are now underway. (Ezra Shaw / Getty Images)

There was Great Highway to defend, they argued, and also critical facilities underground. The city, in compliance with the Clean Water Act, had just spent close to $1 billion building infrastructure (https://sfwater.org/index.aspx?page=1216) to prevent untreated sewage from overflowing into the ocean. Utility officials balked at the thought of retreat. But with each season, more beach disappeared.

It was a choice between two environmental imperatives: Preserve a popular beach or have clean water? SPUR, the San Francisco Bay Area Planning and Urban Research Assn., finally stepped in to referee all the city, state and federal agencies as they picked their casualties.

They had few examples to look to for guidance. Only a handful of managed retreat efforts were underway in California at that time — and each was a lesson in the cost and time it takes to give something up.

More than 200 miles south on the coastal highway, by Hearst Castle and the Piedras Blancas Light Station, Caltrans spent $57 million moving a 2.8-mile stretch of Highway 1 more than 400 feet (https://documents.coastal.ca.gov/reports/2014/10/F18a-10-2014.pdf) inland. Coastal bluffs by then were eroding an average of almost 5 feet a year. Planning and approvals took almost 15 years.

Moving the roadway and three homes was a win for the public, adding 75 acres to Hearst San Simeon State Park and creating new coastal trails. The open area is now a popular stop for motorists, who marvel at the many elephant seals returning each year to mate and care for their pups.

Moving a stretch of Highway 1 has allowed the beach near Piedras Blancas to grow back. The open areas are now a popular stop for elephant seals, who return each year to mate and care for their pups. (Brian van der Brug / Los Angeles Times)

Officials in Ventura County spent nearly two decades getting all the pieces in place to turn (https://www.adaptationclearinghouse.org/resources/surfer-s-point-managed-shoreline-retreat-project.html) an eroding parking lot and collapsing bike path into a cobble beach backed by vegetated dunes. This has fended off storm surges, and the beach is now one of the most popular in the county.

And across the nation, buyout programs so far have occurred mostly after disasters and predominantly in less wealthy communities. These, too, have taken time. Two years after Hurricane Harvey, some residents

in Texas are still waiting their turn. In New York, numerous neighborhoods begged for buyouts after Superstorm Sandy — but officials could afford only so many. And even with $120 million, which bought out 300 homes on Staten Island (https://stormrecovery.ny.gov/sites/default/files/crp/community/documer that funding would probably amount to 10 or so homes in Malibu.

After years of deliberation, San Francisco finally agreed to take down the rock wall, remove two lanes of the coastal highway and turn the open space into a coastal trail.

Even this plan (https://sfplanning.org/ocean-beach) for retreat came with some compromises: A shorter, "low-profile wall" will protect the wastewater treatment facilities. Sand replenishment, on the order of 2 million cubic yards every few decades, will balance any beach loss from this wall.

Homes and personal fortunes weren't even at stake in this case, but choosing one public good versus another proved similarly fraught.

"Nobody was in charge of thinking about the big picture," said Benjamin Grant, who led SPUR's Ocean Beach Master Plan (https://www.spur.org/sites/default/files/wysiwyg/OB_Coastal_Protection "But if you start early, it can be considerably less painful … than waiting for a crisis."

Officials have since convened (http://default.sfplanning.org/plans-and-programs/planning-for-the-city/sea-level-rise/sea-level-rise-action-plan-final-draft-full.pdf) a sea level rise task force, created an action plan (http://default.sfplanning.org/plans-and-programs/planning-for-the-city/sea-level-rise/sea-level-rise-action-plan-final-draft-full.pdf), established new regional (http://https//www.spur.org/publications/spur-report/2019-05-

02/san-francisco-bay-shoreline-adaptation-atlas) strategies. Finding the long-term answers, many now say, requires thinking beyond parcel by parcel and instead coordinating across city boundaries and looking at the entire shoreline.

“The whole region is going to need to see these trade-offs on a grand scale. It may well be that you wipe out beaches in one section of coast and preserve them on other sections of coast … but we’re ill-equipped for that,” said Aaron Peskin, a San Francisco supervisor who serves on both the California Coastal Commission and San Francisco Bay Conservation and Development Commission. “It’s either planned retreat or unplanned retreat. One way or another, we’ll have to give something up. … So if we’re going to do it right, shouldn’t we have a sensible set of plans?”

Big-picture planning has proved possible elsewhere. In the state of Washington, leaders are pledging no overall net loss (https://ecology.wa.gov/Water-Shorelines/Wetlands/Tools-resources/Wetland-program-plan) of the coast’s remaining wetlands. A similar approach in California could help decide what to save and what to abandon: Destroy a beach here to protect critical infrastructure; move back elsewhere and restore a beach.

David Revell, a coastal geomorphologist who has consulted for a number of cities, said this kind of policy forces leaders to consider what sacrifices could be made versus where along the coast must be defended.

“Pick where,” he said. “Just don’t say everywhere.”

REPLENISHING BEACHES

A race against nature

PEOPLE OFTEN TALK ABOUT THE BEACH as a thing, a place, an area that doesn’t move. In reality, a beach is more of a process.

Imagine a river of sand moving parallel to the shore, from Malibu to Santa Monica to Manhattan Beach, until the ocean pulls it offshore. This sand is always on the move, flowing down from mountain streams and waterways and stopping only temporarily on any specific beach.

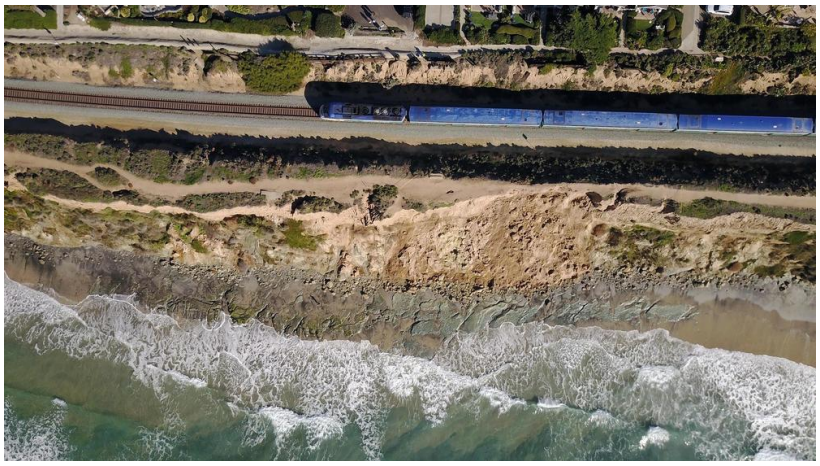
Any human disruption to this river of sand could reveal itself elsewhere. Pacifica may be eroding so quickly in part because of all the sand dredging farther up the coast in San Francisco Bay. Many Malibu beaches have lost significant amounts of sand after the building of Pacific Coast Highway. In Santa Monica, fresh sediment rarely reaches the coast now that humans have dammed up the creeks and turned the L.A. River into a concrete channel.

Los Angeles responded to these alterations of nature with more alterations. Adding sand to the beach began as early as the 1930s in Santa Monica Bay. Breakwaters, jetties and other retention structures have also been constructed to help hold in all the sand. As a result, these iconic beaches are 150 to 500 feet wider than normal.

Beach towns like Del Mar, a tiny affluent enclave north of San Diego, have all but declared this to be their survival tactic.

Tucked among sandstone bluffs, two lagoons and the rarest pine trees in America, the picturesque town bustles every summer when the fairgrounds and horse track come to life. Prime real estate clusters around where the San Dieguito River meets the Pacific.

Dry sand here was once abundant, the beach twice as wide today. Private seawalls now protect multimillion-dollar homes that early settlers had built right on the sand. On the southern end of town, train tracks run (https://www.sandiegouniontribune.com/news/environment/story/2019-06-14/senate-leader-atkins-secures-major-funding-to-stabilize-crumbling-del-mar-cliffs) precariously close to the edge of rapidly crumbling cliffs.



On the southern end of Del Mar, train tracks run precariously close to the edge of rapidly crumbling cliffs. (John Gibbins / San Diego Union-Tribune)

But as word got out that those in charge were considering managed retreat, the town exploded. Relocating could mean allowing the ocean to claim as many as 600 homes.

If you start retreating, residents demanded, where do you stop?

“If you let the first row of homes go, the whole area behind it floods,” said Jon Corn, a resident and attorney representing dozens of homeowners in the Del Mar Beach Preservation Coalition (https://www.delmarbpc.org/mission). “And then what about the next road? And the road after that? … At some point, everyone is going to say: ‘No, we’re not just going to retreat away from the ocean.’”

City leaders finally agreed and said they would keep an open mind about relocating the rail line, the fire station and other city-owned infrastructure — but took out any mention of private property. The land here is too valuable, they reasoned, and the threat of lawsuits too high. Adding sand will be the solution for now.

Terry Gaasterland, a data scientist who led the sea level task force and ended up running for office over the issue, said she’s confident more studies and more time will uncover ways to coexist with the ocean and save the town.

Del Mar can afford to both protect homes and save the beach, said Gaasterland, who's now on the City Council. "We're not going to be packing our bags."

But if past sand projects are any indicator, Del Mar and its neighbors might be in for a surprise. For every jetty and breakwater that has helped keep Santa Monica and Venice wide and sandy, Dockweiler and beaches farther down the coast in turn needed their own supply of sand, which then disappeared and flowed onto beaches farther south.

Sand, although it might seem limitless, is not free. It's the most exploited and consumed natural resource in the world after fresh water. Federal agencies, states, cities and private companies across the nation are all trying to stake their claim.

And because sand is always on the move, adding more of it is anything but permanent. Erosion runs its course all the same.

This makes "beach nourishment" difficult to sustain. Adding 240,000 cubic yards of sand — the amount, for example, to make a half-mile-long beach about 100 feet wide — requires 24,000 dump trucks full of sand. Even working seven days a week, it would take more than 16 months to bring in that much sand. Depending on how fast the sand washes away, a project of this scale would need to be repeated every few years, according to reports by Gary Griggs, who has studied (https://www.documentcloud.org/documents/6172228-CSMW-LIttoral-Cells.html) coastal systems across California and taught at UC Santa Cruz's Institute of Marine Sciences for more than 50 years.

In 2001, officials in San Diego County pumped about 2 million cubic yards of sand from offshore onto 12 beaches — the first large-scale attempt by California officials to add sand to disappearing beaches. It cost city, state and federal taxpayers $17.5 million.

The effort was short-lived. Most of the beaches had narrowed significantly by the following year. The extra sand, Griggs found, “was removed within a day when the first large waves of the winter arrived.” A second attempt by the county — with twice as much money — yielded similar results.

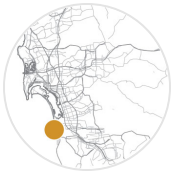
A number of homes at Broad Beach are supported by concrete columns. Rock walls and sandbags have also been deployed as protection from the sea. (Mel Melcon / Los Angeles Times)

These costs have also paralyzed communities along Malibu’s disappearing shoreline. Broad Beach, once so wide that dunes had room to grow along the sand, now hardly lives up to its name. Building mansions on the sand also took up about 200 feet of the beach and dunes, leaving only a narrow buffer against the rising sea.

Sand was disappearing so rapidly that a rock wall was built to protect the septic system and the homes. These days, there is little beach left during high tide. The public stairs drop straight down into water.

Owners years ago agreed to pay $19 million (https://www.latimes.com/local/california/la-me-broad-beach-sand-20151022-story.html) to add sand to the beach. The project has been delayed by disputes over the source of sand and legal challenges over the costs, which keep going up. The current price tag to save this stretch of beach: $65 million.

A rock wall protects homes along Broad Beach, which is more narrow than broad these days. Stairs to the beach often drop straight down into water during high tide. (Christina House / Los Angeles Times)



IMPERIAL BEACH

Grappling with retreat

AT THE VERY SOUTHERNMOST EDGE OF CALIFORNIA, a world away from Malibu, the border town of Imperial Beach seems to be living on borrowed time.

One-fifth of the residents here are lower-income. High tide soaks the road every winter. Sewage spilling from Tijuana regularly shuts down the beach. Those living below sea level recall floodwaters so high in the 1980s that they had to use canoes.

Today, they board up windows and brace for storms. Surrounded by the ocean, a bay and a river, Imperial Beach is looking at losing one-third of the town if nothing is done, one official said. Hazard maps show (https://www.imperialbeachca.gov/vertical/sites/%7B6283CA4C-E2BD-4DFA-A7F7-

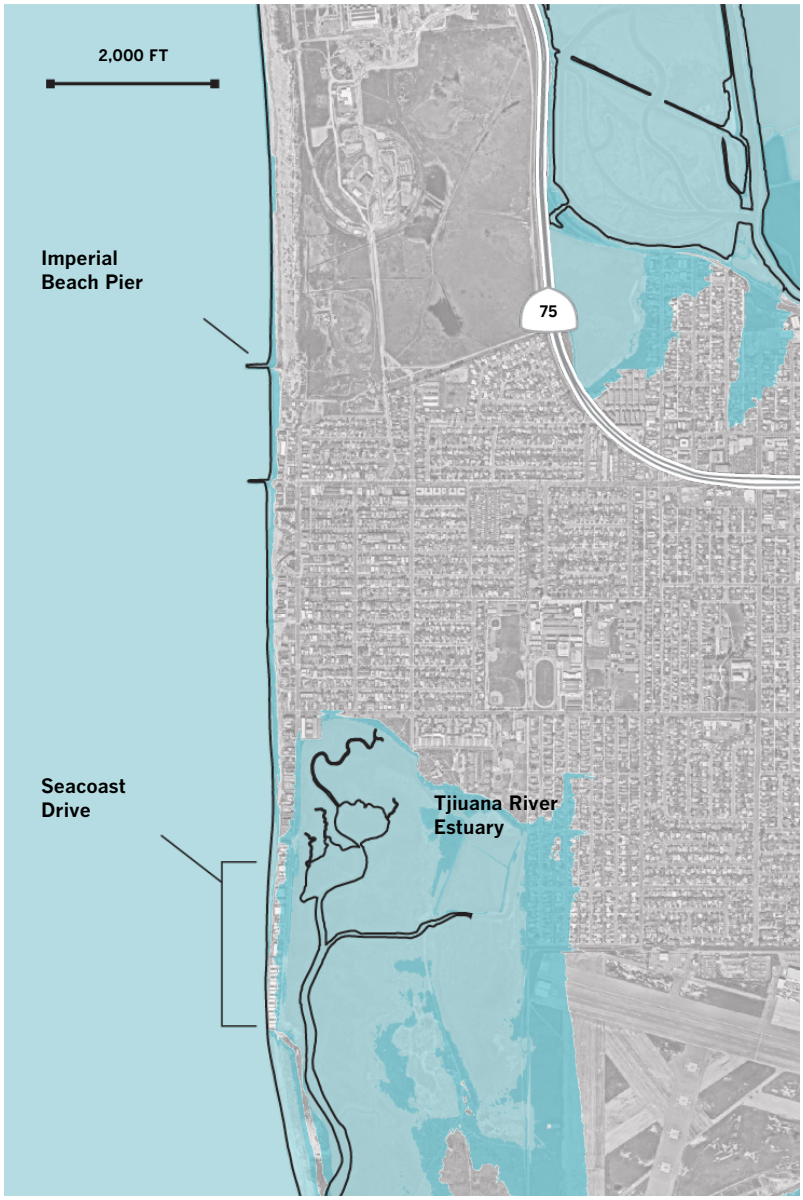
8D4ECD543E0F%7D/uploads/100516_IB_Sea_Level_Rise_Assessment_F (1).pdf) blocks and blocks of homes that could be flooded by 2100. A beach nourishment effort seven years ago went awry because the sand grains were too coarse. Sand berms and rock walls will last only so long. Moving back seems inevitable, even if the community isn't ready to say so.

Projected flood risk in Imperial Beach

Minimum Maximum

Slide for different sea level rise scenarios:

0.5 meter



Sources: U.S. Geological Survey's Coastal Storm Modeling System (CoSMoS), Nearmap. (Thomas Suh Lauder / Los Angeles Times)

The reptilian frenzy over managed retreat has overtaken Imperial Beach, as it has in other cities. Fear overwhelms reason. Conspiracy theories and misinformation abound. Some think the mayor, an environmentalist known for his history of preserving open space, just wants to turn the town into one giant lagoon.

With the city barely able to scrap together a $20-million budget every year, others say letting go of prime real estate means abandoning the whole town.

“If you get rid of the waterfront, the municipal tax base, how do you support the city?” said City Councilman Ed Spriggs, who lives along the water and questioned managed retreat as a strategy. He points to the city’s first upscale hotel, which was built in 2013 with coastal defenses, as a sign that Imperial Beach has time to survive and thrive well into the future.

As chair of the coastal cities group (https://www.cacities.org/Policy-Advocacy/Hot-Issues/Coastal-Cities-Group-(CCG)) for the League of California Cities, Spriggs sees what’s been happening across the state and calls managed retreat an ideology being pushed by extreme environmentalists with no rules or standards.

“Nobody has explained how urbanized managed retreat works, what it would look like and how it would be paid for,” he said. “We need time to build a consensus. We don’t even have money for … more detailed studies on what the actual costs will be.”

But time is ticking. Earlier this year, a group of scientists from the Scripps Institution of Oceanography gathered on an apartment balcony and watched in awe as the ocean devoured more than 3 feet of sand in one morning.

High surf and king tides in January flooded the southern end of Seacoast Drive in Imperial Beach. (Howard Lipin / San Diego Union-Tribune)

“When that surge came over the seawall, it was just a blanket of water. There was so much force,” said Mark Merrifield, director of Scripps’ Center for Climate Change Impacts and Adaptation. “It was just crazy.”

His team has been studying ways to forecast floods (https://scripps.ucsd.edu/news/new-sea-level-rise-and-flood-alert-network-launches-city-imperial-beach) and were watching that morning because they knew the waves would be particularly powerful. Their data had projected that this would come just ahead of a king tide — when the sun, moon and Earth are aligned closest together, creating a higher-than-high tide. They had alerted Imperial Beach, which filled more than 500 sandbags just in time and warned residents to board up their homes.

These king tides are becoming a new normal, said Merrifield, whose team hopes to fill in data gaps that could help more communities better understand their risks. Imperial Beach doesn’t even track the number of times the ocean tops the seawall — crews just clean the road before most residents wake up.

During the king tides in January, large waves swept over seawalls and flooded streets in Imperial Beach with water and sand. (Howard Lipin / San Diego Union-Tribune)

Tracking the frequency of flood events, and how much it's increasing, will make these truths harder to ignore. There's no debate, he said. "Sea level rise is the heart of climate change. That's where all the heat is going: into the ocean."

That rising ocean, for decades, had spared California. Much of the state's coastal development took place in the years after World War II, during the less stormy period of a climate cycle known as the Pacific Decadal Oscillation. Favorable winds pulled warmer water offshore and the West Coast had cool, denser water that took up less volume — suppressing the rate of sea rise below the global average.

But scientists in the last decade have seen a dramatic shift: The waters off the West Coast are now much warmer; the sea is now rising faster here than elsewhere in the world.

The morning after the worst of the surge, Imperial Beach Mayor Serge Dedina parked his Prius and hopped around puddles still pooling down Seacoast Drive. Waves, still breaking over the rock barriers, spewed sand across the road. A maintenance worker sprinted toward the nearest driveway, startled by yet another rush of water.

An avid surfer, Dedina has watched this ocean obsessively his whole life. But taming the water has been all-consuming. Cleaning up just from this king tide cost Imperial Beach $16,000 and left 350 hours of calls unanswered and other work unattended to around town.

Imperial Beach Mayor Serge Dedina, right, gets hit by large waves that crashed over the berm at the southern end of Seacoast Drive during the king tides in January. (Howard Lipin / San Diego Union-Tribune)

Imperial Beach can't afford more seawalls, more sand, more meetings filled with 150 people yelling at him about managed retreat, he said. The town doesn't even have a Parks Department. It just got its first real grocery store.

The city and its consultants have come up (https://www.imperialbeachca.gov/vertical/sites/%7B6283CA4C-E2BD-4DFA-A7F7-8D4ECD543E0F%7D/uploads/100516_IB_Sea_Level_Rise_Assessment_F (1).pdf) with some big ideas — but lack the political support and capital to get started. Buy out these first few row of homes along the coast, for example, and rent them at market value. Three decades of rent should be enough to recoup the costs. The city or a land trust at that time could then decide what to do with the properties.

For now, Dedina is focused on relocating some public infrastructure and building more homes and businesses further inland. He's also suing a number of oil companies in hopes of funding, arguing that they should be held responsible for the costs of coastal flooding because their emissions contribute to sea level rise.

"Ultimately, the city can't protect private property owners. We need to be upfront about that," he said. "The insurance industry or the state needs to figure that one out."

The state has taken some action but is largely still confronting this 21st century problem with decades-old laws and thinking. The California Coastal Act — the defining road map to managing the state's shoreline — did not factor in sea level rise when it was written in 1976.

> "Right now, managed retreat is just a slogan. It needs to become a reality where we actually talk about: How are we going to actually manage the retreat?"
>
> — Phil King, beach economist

Lawmakers are aware of the problem, and they have told cities they must start addressing climate adaptation in their planning. But Sacramento has otherwise shied away from issuing mandatory directions. The California Coastal Commission, through modest grants and some general guidance, has been encouraging local officials to consider "everything in the toolkit, including managed retreat," when updating city policies.

Phil King, an economist and professor at San Francisco State University who has consulted for a number of beach cities, said that what Californians need is a clear statewide plan. Managed retreat sounds scary, but it just means retreating with everyone knowing what the rules are, he said. Will there be a public subsidy, how is it going to be applied, who's going to get it, and does everyone think it's fair?

Bankruptcy law could be a model, he said, because it makes a messy process as orderly as possible. Managed retreat is similar: Dealing with a loss and making sure that everyone absorbs the loss in the most reasonable, equitable way.

"Right now, managed retreat is just a slogan. It needs to become a reality where we actually talk about: How are we going to actually manage the retreat?" said King, whose studies showed that retreat does end up penciling out for many communities as the most cost-effective solution in the long run. "If we start to think about managed retreat today, we can avoid the problems that people had with the fires in Paradise, where all of a sudden everything just disappears."

Imperial Beach's buyback-and-rent proposal is one idea, he said. And if a seawall has to exist in the short term to protect private property or infrastructure, perhaps a greater authority like the State Lands Commission could charge rent for it. These funds could then be used toward other efforts to manage and preserve the coastline.

Much of California's climate change efforts have centered on reducing carbon emissions and the rate of global warming, rather than dealing with how to live with these increasing hazards, said Heather Cooley, research director of the Pacific Institute, an Oakland think tank that has studied the economic impact of sea level rise.

"We need to do both," she said. "We're already locked into a certain amount of climate change, and we need to adapt to the effects that we know we're going to be experiencing."

A few bills under consideration now in Sacramento acknowledge these problems — appointing (http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB168) a chief climate resilience officer, calling for a plan to reuse dredged sand (https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB69) for coastal restoration projects, creating an inventory (https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200SB69) of the state's wetlands and a special fund (https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB552) for "coastal adaptation, access and resilience" — but none tackles managed retreat head-on.

"Living shorelines," which substitute seawalls with vegetation that could serve both as protection and public open space, has been gaining popularity as a less politically fraught approach. Some lawmakers see this as a way to buy more time as the backlash over relocation continues.

The fear of political suicide should not paralyze those in power from studying the how, where and why of managed retreat, said Katharine Mach, a senior research scientist at Stanford who has helped lead national and global climate change assessments.

In the same way state leaders paved the way on other environmental issues, what California does now on managed retreat could help set some standards for others across the country, she said.

Jack Ainsworth, executive director of the Coastal Commission, points to the work his agency has done within its legal power.

Commissioners are tough on any new construction that gets in the way of the rising sea. They passed a resolution (https://documents.coastal.ca.gov/reports/2018/8/th5/th5-8-2018-exhibits.pdf) last year pledging that seawalls would be permitted only if absolutely necessary. They're butting heads with homeowners and real estate groups, drafting a new guidance document (https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/residential/) for cities to use to balance preserving coastal resources and protecting homes.

> "People have to understand that this is a crisis."
>
> — Jack Ainsworth, California Coastal Commission executive director

Beyond that, he said, the commission is stuck. Only lawmakers can establish new disclosure laws. Only state, city and federal leaders can determine how much money they are willing to spend to come up with a clear plan for the future, and ultimately, how to pay for the retreat where necessary.

Across the state, and the nation, many people know the sea is coming and exactly what's at risk — but no one seems ready to drop that first domino and rattle the status quo. "This conspiracy of silence," as one economist from the Union of Concerned Scientists publicly called it, can go on for only so long. Society as a whole saves (https://www.nibs.org/news/381874/National-Institute-of-Building-

Sciences-Issues-New-Report-on-the-Value-of-Mitigation.htm) $6 in avoided costs for every $1 spent to acquire or demolish flood-prone buildings before disaster hits, Ainsworth said.

When staff is short or pressure comes from those wealthy enough to fight back in perpetuity, the Coastal Commission has in the past pushed tough issues down the road. But Ainsworth said California cannot afford that with sea level rise.

“People have to understand,” he said, “that this is a crisis.”

GLEASON BEACH

A lost coast

A FEW WINDING TURNS PAST BODEGA BAY, about an hour north of San Francisco, relentless waves pound against a stretch of coastline whose fate has been paralyzed by political inaction.

Once referred to as Malibu North, Gleason Beach now feels more like the edge of the world — a window into the future if California does not change course. Nine homes perch on crumbling cliffs that drop 30 some feet onto a beach that appears only during low tide. A pile of seawalls, smashed into pieces, clutters the shore.

Rebar and bits of concrete poke out here and there — a graveyard of more than 10 other homes that once also faced the sea. Highway 1, hanging inches from the edge, had to shut (https://www.pressdemocrat.com/news/9591905-181/highway-1-to-temporarily-lose) one traffic lane this year.

“Behold your highway tax dollars falling into the ocean,” locals say. But efforts to move 0.6 miles of this critical road about 400 feet inland have taken more than a decade. Residents, environmentalists, and state, county and transportation officials are still arguing over the details.

At Gleason Beach, remnants of homes and piles of seawalls, smashed into pieces, clutter the coastline. (Carolyn Cole / Los Angeles Times)

Mary Cook remembers moving into a seaside cottage from the 1930s. Photos back then showed the house with a 20-foot yard. Stairs led down to the beach.

Her husband, an architect, made a few additions to their home as the bluff continued to erode about a foot a year. They put up a seawall. But then in the winter of 1997 (https://documents.coastal.ca.gov/reports/1998/9/T11-9-1998.pdf), one big storm took out the entire cliffside. Officials came in and declared an emergency.

When Cook opened her sliding door, “there was nothing,” she said. “You looked straight down into the ocean.”

Life for her neighbors eventually carried on. The storm ebbed from memory. The sun re-emerged. The Cooks, however, were tired of buying time.

They jacked their home up from its foundation, called in a truck and moved to higher ground.

Credits: Production by Vanessa Martínez (https://twitter.com/vnessamartinez) and Priya Krishnakumar (https://twitter.com/priyakkumar).

MUST READS LOCAL

Destruction from sea level rise in California could exceed worst wildfires and earthquakes, new research shows

By ROSANNA XIA
MAR 13, 2019 | 5:00 AM

L.A. Times Today airs Monday through Friday at 7 p.m. and 10 p.m. on Spectrum News 1.

In the most extensive study to date on sea level rise in California, researchers say damage by the end of the century could be far more devastating than the worst earthquakes and wildfires in state history.

A team of U.S. Geological Survey scientists concluded that even a modest amount of sea level rise — often dismissed as a creeping, slow-moving disaster — could overwhelm communities when a storm hits at the same time.

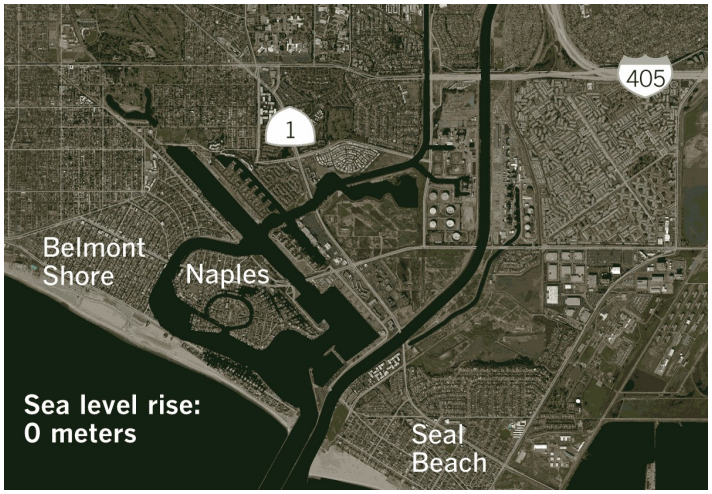
The study combines sea level rise and storms for the first time, as well as wave action, cliff erosion, beach loss and other coastal threats across California. These factors have been studied extensively but rarely together in the same model.

The results are sobering. More than half a million Californians and $150 billion in property are at risk of flooding along the coast by 2100 — equivalent to 6% of the state's GDP, the study found, and on par with Hurricane Katrina and some of the world's costliest disasters. The number of people exposed is three times greater than previous models that considered only sea level rise.

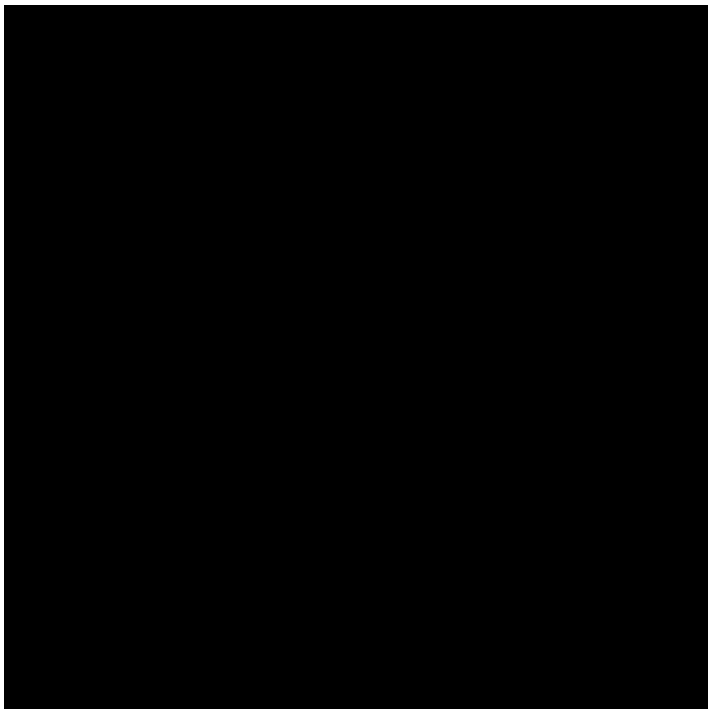
And at a time when marshes are drowning, cliffs eroding, beaches disappearing and severe storms likely to become more frequent, scientists say even a small shift in sea level rise could launch a new range of extremes that Californians would have to confront every single year.

"It's not just some nuisance that's going to pop its head up once in a while," said Patrick Barnard, research director of the USGS Climate Impacts and Coastal Processes Team and lead author of the study. "These are significant events that are going to recur and be ten times the scale of the worst wildfires and earthquakes that we've experienced in modern California history."

Potential flooding in Alamitos Bay



Sources: U.S. Geological Survey, Google Earth (Ellis Simani / @latimesgraphics)



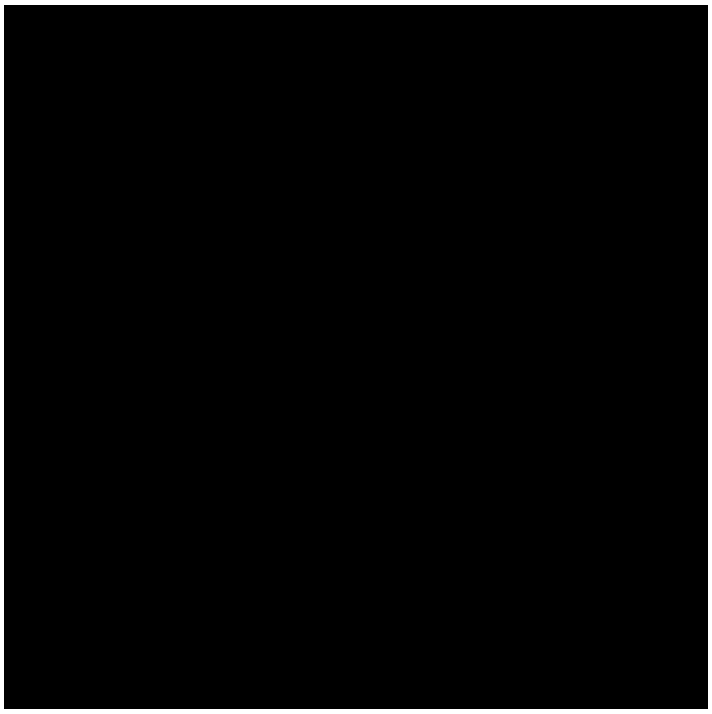
Orange County Public Works crews remove a boardwalk that was damaged in a recent storm at Capistrano Beach in Dana Point. (Allen J. Schaben / Los Angeles Times)

The stakes are high for the millions of Californians who have chosen to build and live along the edge of the Pacific. In recent months, winter storms eroded Capistrano Beach so much that a boardwalk collapsed and crews had to haul in tons of boulders to form a barrier that could protect the basketball courts from disappearing into the ocean.

In Imperial Beach, large waves coupled with some of the highest tides of the season sent water crashing past seawalls — flooding roads and garages and much of the Tijuana

River Estuary. From San Diego County to Humboldt County, coastal officials continue to grapple with increasing erosion, cliff collapses and emergency permits.

The new USGS study underscores how these events will continue along the coast — and amplify each other as the sea continues to rise.



(Ellis Simani / Los Angeles Times)

"This sort of science is absolutely critical to our planning," said Jack Ainsworth, executive director of the California Coastal Commission, which has used the USGS coastal modeling to plan for sea level rise. "It may seem like a slow-moving disaster, but we see how the fires amped up really quickly and destroyed communities… We

really need to work with a sense of urgency."

Translating sea level rise into economic risk and property loss advances a tricky issue that many communities have been reluctant to confront. A blockbuster study last year by the Union of Concerned Scientists analyzed Zillow data and found that hundreds of thousands of homes across the nation are at risk of chronic flooding in the coming decades. A Stanford study last month found that downtown Annapolis, Maryland's state capital, lost 3,000 visits in 2017 due to high-tide "sunny-day" flooding — as much as $172,000 in revenue for local businesses.

The latest National Climate Assessment, a major scientific report by 13 federal agencies, concluded $1 trillion in coastal real estate is threatened by rising sea levels, storm surges and high-tide flooding exacerbated by climate change.

"Scientists are getting more sophisticated in communicating this information to people so that they understand and care about the implications," said Heather Cooley, research director of the Pacific Institute, an Oakland-based think tank that has also

studied how sea level rise puts communities and critical infrastructure at risk.

"You're seeing more and more communities grapple with these impacts — what it's going to cost them, whether they should limit development in certain areas. Those are the real tough questions we need to be confronting."

Read more: Climate change will harm the entire nation if the U.S. doesn't act now, federal report warns »

In the USGS study, published Wednesday in the Nature journal Scientific Reports, researchers brought together a number of models that examined wave action, tides, coastal erosion and flooding in California under sea level rise scenarios ranging from 0 to 2 meters (6.6 feet). On top of these projections, they added four different storm

scenarios: average daily conditions, typical annual storm, 20-year storm, and 100-year storm.

They then overlaid these integrated projections, known as a dynamic model, with a sophisticated analysis of population data, property assessment values, as well as data from various state agencies, the U.S. Department of Homeland Security and the Department of Defense.

Previous efforts to understand potential coastal impacts of climate change have mainly focused on long-term sea level rise, with little consideration of how these other elements could affect the overall flood risk — in both the long and short term — to a built-out community.

Emergency managers and planning officials, in turn, rarely incorporate 100-year storm models in tandem with sea level projections — vastly underestimating a city's risk.

For example, with only 0.25 meters of sea level rise projected to occur by about 2040, the number of Californians exposed to flooding might not seem too significant — but add a 100-year storm, and almost seven times as many people are at risk.

All told, with a 2-meter rise by 2100 and a 100-year storm, the projected flood risks could represent 6.3% of the state's GDP — despite only directly affecting 0.3% of the state's land area, according to the study, which did not speculate on future population growth or inflation rates.

Researchers noted these projections might even be on the conservative end, given that California policymakers are now considering 3 meters as the higher end of expected sea level rise.

They were also surprised by what the model showed with less severe storms. Under the same 2-meter sea level rise scenario, a typical annual storm also poses a sobering reality check: About 483,000 residents and $119 billion in property (based on 2010 census data and dollars) could be exposed

by 2100. That is many times higher than the costliest natural disasters in modern California history: the 1989 Loma Prieta earthquake ($10 billion) and the 2017 wildfire season ($18 billion).

Katrina, in comparison, cost about $127 billion. And a truly catastrophic earthquake could cause $200 billion in damage, more than 1,800 deaths and tens of thousands of injuries, according to a separate USGS study that examined the potential impacts of a magnitude 7.8 earthquake on the southern San Andreas fault.

Scientists and emergency planners, researchers acknowledged, often focus on extremes — 100-year storms, 1% chance disasters that people can't wrap their minds around.

"We need to focus more on the kinds of things that happen every month, every year," Barnard said. "For those annual storms to expose $50 billion to more than $100 billion of property by end of century, that's just a massive number. That's something that could happen every single year, not just maybe once a mortgage or once a lifetime."

The vulnerabilities from sea level rise combined with storms, both extreme and

annual, are particularly evident in areas like Alamitos Bay in Long Beach, Del Mar in San Diego County and other cities built on top of former marshes, near river mouths or in low-lying areas. Entire blocks of homes, parks and public facilities could be flooded under such projections.

Along the San Francisco Bay, which accounts for two-thirds of the flooding impacts projected for all of California, the cost of building levees, seawalls and other measures to withstand 2 meters of sea level rise and a 100-year storm could cost as much as $450 billion – twice as much as prior estimates looking at just the cost of defending against sea level rise.

In the model, scientists assume that the Bay Area's existing levees and lines of defense are stable and remain in place through 2100, but "the engineering integrity of most of these structures is poorly understood," the study said.

The same goes for sea walls, berms, rock revetments and other infrastructure across the state in smaller estuaries, according to the study. "There is no accommodation for the potential failure of these structures when stressed by future flooding events, yet some will undoubtedly fail and expose more

residents and assets to flooding than estimated here."

At the ports, where coastal flooding could affect rail lines and the movement of goods in and out and across the United States, the cost of adaptation is high. The Ports of Los Angeles and Long Beach alone, the study found, handle $478 billion in cargo annually and support 2.8 million jobs across the United States. The cost to elevate and retrofit the major commercial ports in California to adapt to 2 meters of sea level rise, according to the study, could be more than $9 billion.

Researchers hope this information will help communities better understand their short-term risks and the long-term consequences of their decisions. More studies and risk analysis will also continue to make these projections more accurate for specific communities.

Future population trends, economic conditions, human changes to shoreline infrastructure and greater understanding of El Nino cycles, for example, are all factors that could be added to make more sophisticated models.

The choices people make in the coming decades, of course, could also affect these

projections. As the Earth continues to get warmer and land ice continues to melt into the ocean — in large part fueled by human-produced greenhouse gases — efforts to rein in these emissions could play a role in temperature, wind patterns and how fast the sea will rise.

Then there are the "cascading" socioeconomic impacts that this study doesn't even get into.

"If you have a major flood event that shuts down the port for three to five days, what kind of effect does that have on the economy?" Barnard said. "How does flooding affect lost jobs and loss of income and distribution of goods and services throughout the country?"

"The effects I think are far, far greater than even what I think these numbers suggest. And these numbers," he said, "are already massive."

Interested in coastal issues? Follow @RosannaXia **on Twitter.**

Rosanna Xia

Rosanna Xia is an environment reporter, covering the California coastline for the Los Angeles Times. She writes articles that connect science and policy and previously reported on natural disasters. With a team of reporters, she published a series in 2013 that led to new laws confronting thousands of buildings at risk of collapse in a major earthquake. She has also covered higher education for The Times and reported for the Business section. An East Coast transplant, she graduated from Tufts University.

COMMENTS (102)

From:	Jacob Patterson
To:	Gonzalez, Joanna
Cc:	Jones, Marie
Subject:	Public Comment -- 7/10/19 PC Meeting, Item 5A
Date:	Tuesday, July 09, 2019 8:03:08 AM
Attachments:	LATimes Sea Level Rise 2.pdf LATimes Sea Level Rise 1.pdf

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Joanna,

Please add the two attached LA Times articles about the projected impacts of sea level rise to development along the California coast as public comments for Item 5A on tomorrow's Planning Commission meeting and distribute them to the commissioners.

Thanks,

--Jacob

From: Lemos, June
To: Gonzalez, Joanna
Subject: FW: Online Form Submittal: Contact Us (Dropdown)
Date: Monday, July 08, 2019 8:24:40 AM

Joanna:

This public comment was sent to us via the City's website and appears to be for the Planning Commission.

FYI.

June Lemos, CMC
City Clerk
City of Fort Bragg
416 N Franklin St
Fort Bragg CA 95437
707.961.2823 ext. 104

From: noreply@civicplus.com <noreply@civicplus.com>
Sent: Sunday, July 7, 2019 7:14 PM
To: Lemos, June <Jlemos@fortbragg.com>
Subject: Online Form Submittal: Contact Us (Dropdown)

Contact Us (Dropdown)

First Name	David
Last Name	Childs
Address1	444 N Corry St.
Address2	*Field not completed.*
City	Fort Bragg
State	CA
Zip	95437
Phone Number	2534411127
Email Address	dchilds13@gmail.com
	(Section Break)
Whom would you like to contact?	City Clerk

Question / Comment	I would like to submit this as a written public comment on the 7/10/19 planning comission meeting, regarding item 19-337 [mill site LUP], to be read allowed if possible: As much as I appreciate the mission and goals of the Noyo Science Center, I'm worried about a potential overreach in terms of how much we accomodate them. Project Sanctuary, the food bank, children's fund and others have received zero dollars from the city, yet 110 thousand tax dollars per year go to the Noyo Science Center on top of free land negotiated for them. Now they want to block ocean views from the coastal trail, all for free again, to build more stuff that solely benefits them? At what point do we say you've been given enough free stuff already and to stop demanding the public subsidize them for even more free treats? Give other non-profits the same treatment and then lets talk additional land grabs.

Time For A Re-Set On The LCP Process

Dear Friends on the City Council, Planning Commission and city staff,

Many of us in the coastal community have been following this LCP process closely. We have the utmost respect for the tremendous amount of work involved, and the high quality of much of this effort. It is however becoming quite chaotic, at times feeling rushed. With two new owners of what, until recently was accurately called “G-P’s former mill,” it is time to think of a re-set in how we are approaching this process. Not necessarily a halt, but a recognition that everything is changing very quickly. If there is any disagreement with our assessment that recent days have been chaotic we can give many examples.

We would like to make a few points that support a re-set of community strategy with regard to the planning for the Fort Bragg Headlands.

1. Our community has spoken forcefully through a recent petition signed by over 4000 people that the cleanup is of the highest priority.
2. The cleanup and restoration of open space and wetland areas should have just as high a priority as any hotel specifics.
3. A significant wildlife corridor is essential for any successful healthy restoration of the open space and wetland areas. We need a vision for planning around open space.
4. Connecting of all the wetland areas by designating the “donut hole” as a “restoration zone” — (not sure of the right designation and we appreciate the need of clarity in this.)
5. A “rolling easement” is one tool in the planning tool kit. This has become part of the CCC planning because of rapid coastal erosion. A significantly larger width should be considered for the wildlife corridor.
6. Area “P” is too big to be designated as “parking.”
7. The daylighting of Alder and Maple creeks is supported by much of the coastal community, science and the necessity for coastal adaptation and sea level rise. And therefor:
8. The small strip of development in back of Mendo Mill should go away.
9. No assumptions about the impossibility of ANYTHING out on the Headlands should be made because of asphalt.
10. Just about anything can be restored and many exciting and creative opportunities exist for our community to do this.
11. The vision enumerated above is fundable and supported by a large constituency here on the coast and around the world.

Thanks for your consideration.

George Reinhardt
(I am CCing the California Coastal Commission)