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Does a Rising Tide Lift All Boats? Sea Level Rise, Land Use, and Property Rights

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DOES A RISING TIDE LIFT ALL BOATS? SEA LEVEL RISE, LAND USE, AND PROPERTY RIGHTS

LAURA M. PADILLA

I.	Introduction	28
II.	Sea Level Rise: What (it is), How (it is measured and projections for future), and Why (we should be worried).....	31
	A. What Is Sea Level Rise and What Causes It?.....	32
	B. Measuring Sea Level Rise Today and Projections for the Future	35
III.	Impacts of Sea Level Rise	39
	A. Sea Level Rise and Physical Impacts	40
	B. Sea Level Rise and Economic Impacts.....	46
IV.	Sea Level Rise, Vulnerability Assessments, and Adaptation Strategies.....	49
	A. Sea Level Rise Planning in California Coastal Communities	49
	B. Adaptation Strategies	55
	1. Protect	55
	2. Accommodate	62
	3. Retreat	65
	4. External Forces that Influence Adaptation.....	76
V.	Legal Challenges	79
	A. Regulatory Takings Framework.....	79
	B. Protect: Seawalls	86
	C. Accommodate: Development Conditions	89
	D. Managed Retreat: Downzoning, Rolling Easements, and TDRs/PDRs..	94
	1. Downzoning	94
	2. Rolling Easements.....	97
	3. TDRs and PDRs	101
VI.	Conclusion	104

Imagine your client owns a blufftop home in Encinitas, California, valued at \$10,000,000, and calls you distraught because a portion of the bluff next door just collapsed.² Imagine now that you are the planning director for the same city charged with the task of preparing a sea level rise vulnerability assessment and adaptation plan as

1 The simple meaning of the saying “a rising tide lifts all boats” is when the tide rises, everyone is better off.

2 On August 2, 2019, a bluff collapsed on the beach below, killing three people. Alex Riggins, Gary Warth & Shelby Grad, *Encinitas Beach Cliff Collapse That Killed 3 Women Part of Larger California Coast Crisis*, L.A. Times (Aug. 3, 2019), <https://www.latimes.com/california/story/2019-08-03/encinitas-beach-cliff-bluff-collapse-california-coast-erosion>. A few months later, a bluff collapsed in a neighboring city, damaging train tracks. Wayne Palmour, *Train Service Disrupted Following Bluff Collapse in Del Mar*, The San Diego Union

part of its Local Coastal Plan (“LCP”) update.³ Finally, imagine you are an academic, representing neither position, so you are free to analyze how best to balance the many competing land use and property rights interests at stake when considering coastal communities’ futures in light of faster than predicted sea level rise.

This Article considers these competing interests; Part I describes the problem—sea level rise and its projected acceleration. Part II details sea level rise physical and economic impacts. Part III discusses a range of adaptation responses to the problem, and Part IV explores the sea level rise-adaptation strategies’ potential legal challenges. This Article focuses on California, but the problems, solutions, and challenges pervade coastal communities everywhere.

I. INTRODUCTION

Given current greenhouse gas emissions’ trends, sea levels are expected to rise at an accelerating rate in the future, and scientists project an increase in California’s sea level in coming decades.⁴ “Until mid-century, the most damaging events for the California coast will likely be dominated by large El Niño-driven storm events in combination with high tides and large waves.”⁵ Eventually, sea level will rise enough that even small storms will cause significant damage, and large events will have unprecedented consequences.⁶

While gradual sea level rise might not seem too significant, current projections of 2.4–6.9 feet of sea level rise over the next 100 years⁷ will create enormous problems, including extensive property damage, injury, and even loss of life. Unfortunately, the height of sea level rise is just the tip of the iceberg. “The California Coastal Commission

Tribune (Nov. 29, 2019) <https://www.sandiegouniontribune.com/news/public-safety/story/2019-11-29/bluff-collapses-in-del-mar-within-feet-of-train-tracks>.

- 3 In California, “[e]ach local government lying, in whole or in part, within the coastal zone shall prepare a local coastal program for that portion of the coastal zone within its jurisdiction.” CAL. PUB. RES. CODE § 30500(a) (West 2020). To prepare for sea level rise, the California Coastal Commission recommends that “local governments with coastal resources at risk from sea level rise certify or update Local Coastal Programs that provide a means to prepare for and mitigate these impacts. . . . [T]he impacts of accelerated sea level rise should be addressed in the hazard and coastal resource analyses, alternatives analyses, community outreach, public involvement, and regional coordination. . . . Although the existing LCP certification and update processes are still the same, sea level rise calls for new regional planning approaches, new strategies, and enhanced community participation.” *Sea Level Rise Policy Guidance*, CAL. COASTAL COMM’N 68 (Nov. 7, 2018), https://documents.coastal.ca.gov/assets/slr/guidance/2018/0_Full_2018AdoptedSLRGuidanceUpdate.pdf [hereinafter *CCC SLR Policy Guidance*].
- 4 Katie Weeman & Patrick Lynch, *New Study Finds Sea Level Rise Accelerating*, NAT’L AERONAUTICS & SPACE ADMIN. (Feb. 13, 2018), <https://www.nasa.gov/feature/goddard/2018/new-study-finds-sea-level-rise-accelerating>.
- 5 *CCC SLR Policy Guidance*, *supra* note 3, at 26.
- 6 *Id.* For a more general discussion of coastal issues related to climate change, see Margaret R. Caldwell & Eric H. Hartge, *Assessment of Climate Change in the Southwest United States*, SOUTHWEST CLIMATE ALLIANCE 168–96 (2013).
- 7 *CCC SLR Policy Guidance*, *supra* note 3, at 14.

reports that, as a rule-of-thumb, one foot of sea level rise corresponds to 50 to 100 feet of beach loss.⁸ The National Research Council highlighted that “[t]here is a large multiplicative effect: one vertical unit of higher water level results in an average of 100 units of horizontal retreat.”⁹ While each inch of sea level rise creates its own set of long-term issues, more disturbing is how that incursion is magnified by regularly-occurring events like flash floods, storm surges, and king tides,¹⁰ and frequent climate change-induced events like extreme weather, resulting in significant damage. “Higher sea levels mean that deadly and destructive storm surges push farther inland than they once did, which also means more frequent nuisance flooding. Disruptive and expensive, nuisance flooding is estimated to be from 300 percent to 900 percent more frequent within U.S. coastal communities than it was just 50 years ago.”¹¹ Given the rise in nuisance flooding to date and the future amount of nuisance flooding when sea levels are higher and extreme events occur more frequently,¹² the potential for serious impacts is distressing. “The future severity of coastal erosion, flooding, inundation, and other coastal hazards will increase due to sea-level rise and continued coastal development. . . . Any increased intensity and/or increased frequency of storm events will further aggravate the expected impacts.”¹³

Regardless of one’s view on whether the climate is changing, and, if it is, whether it is a problem, it is undisputed that oceans are rising. “Global sea level has been rising over the past century, and the rate has increased in recent decades. In 2014, global sea level was 2.6 inches above the 1993 average—the highest annual average in the satellite record (1993-present). Sea level continues to rise at a rate of about one-eighth of an inch per year.”¹⁴ More troublesome, sea levels are now rising at a much faster rate than recent predictions anticipated. “Global sea level rise has been accelerating in recent decades, rather than increasing steadily, according to a new study based on 25 years of NASA and European satellite data.”¹⁵ Simultaneously, while at a slower and imperceptible pace,

8 Megan M. Herzog & Sean B. Hecht, *Combating Sea Level Rise in Southern California: How Local Governments Can Seize Adaptation Opportunities While Minimizing Legal Risk*, 19 *Hastings Env’t L.J.* 463, 508 (2013).

9 STEPHEN P. LEATHERMAN & PATRICIA JONES KERSHAW, *SEA LEVEL RISE AND COASTAL DISASTERS* 3 (2002).

10 “A King Tide is a non-scientific term people often use to describe exceptionally high tides. . . . Higher than normal tides typically occur during a new or full moon and when the Moon is at its perigee, or during specific seasons around the country.” *What is a King Tide?*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (July 17, 2020), <https://oceanservice.noaa.gov/facts/kingtide.html>.

11 *Is Sea Level Rising?*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (Oct. 19, 2019) <https://oceanservice.noaa.gov/facts/sealevel.html>.

12 Matthew Heberger et al., *The Impacts of Sea-Level Rise on the California Coast*, CAL. CLIMATE CHANGE CTR. 8 (May 2009), <https://pacinst.org/wp-content/uploads/2014/04/sea-level-rise.pdf> [hereinafter *Impacts of SLR on the CA Coast*].

13 Caldwell & Hartge, *supra* note 6, at 169.

14 *Is Sea Level Rising?*, *supra* note 11.

15 Weeman & Lynch, *supra* note 4.

land is subsiding in many parts of the world—also contributing to sea level rise.¹⁶ Those who reside or work along the coast, own coastal property, or enjoy travel and beaches should be worried. In 2019, “[p]arts of Venice [Italy] were damaged by the most severe high waters the city has seen in over half a century, with six-foot high tide levels engulfing 85% of its streets and buildings, some of which are of tremendous cultural value.”¹⁷ The Washington Post reported later that week, “it marked the third time since Tuesday night’s six-foot flood—the worst in 53 years—that water levels in Venice had nearly reached five feet. Since records began in 1872, that level had never been reached even twice in one year, let alone three times in one week.”¹⁸ Rapidly rising sea levels might not trouble those not near the coast except at a theoretical level, but the potential problems spread far beyond coastal communities, impacting insurance availability and financing, military operations and readiness,¹⁹ and larger land use and property-related issues and questions.

As coastal states, municipalities, policymakers, and land use professionals consider how to plan for sea level rise, they must address complex questions, policies, and proposed regulations, ultimately determining the tipping point where the risk of property damage and human safety outweighs property owners’ stick-in-the-bundle giving them the right to do as they please with their property.²⁰ Should development be prohibited in undeveloped, high-hazard coastal areas²¹ or limited based on appropriate mitigation? The

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- 16 *Understanding Sea Level: Subsidence*, NAT’L AERONAUTICS & SPACE ADMIN., <https://sealevel.nasa.gov/understanding-sea-level/regional-sea-level/subsidence> (last visited Nov. 27, 2020).
- 17 Scott McLean, *Record Flooding in Venice Threatens Historical Treasures*, CNN (Nov. 18, 2019), <https://www.cnn.com/videos/world/2019/11/18/venice-floods-italy-st-marks-basilica-intl-ldn-vpx.cnn>.
- 18 Associated Press, *Exceptionally High Tides Flood Venice for Third Time in One Week*, Wash. Post (Nov. 18, 2019), https://www.washingtonpost.com/lifestyle/kidspost/high-tides-flood-venice-for-third-time-in-one-week/2019/11/18/ad73a1f8-0701-11ea-ac12-3325d49eacaa_story.html.
- 19 See, e.g., MILITARY INSTALLATIONS AND SEA-LEVEL RISE, CONG. RSCH. SERV. 7-5700 (2019); General Ronald Keys et al., *Military Expert Panel Report: Sea Level Rise and the US Military’s Mission*, CTR. FOR CLIMATE & SEC. (Feb. 2018), https://climateand-security.files.wordpress.com/2018/02/military-expert-panel-report_sea-level-rise-and-the-us-militarys-mission_2nd-edition_02_2018.pdf; *The US Military on the Front Lines of Rising Seas: Growing Exposure to Coastal Flooding at East and Gulf Coast Military Bases*, UNION OF CONCERNED SCIENTISTS (July 27, 2016), <https://www.ucsusa.org/resources/us-military-front-lines-rising-seas>.
- 20 “[P]roperty is often described as a bundle of rights or more informally, a bundle of sticks. The Supreme Court echoed this view . . . when it referred to ‘the bundle of rights that are commonly characterized as property.’” JOHN SPRANKLING & RAYMOND COLETTA, *PROPERTY: A CONTEMPORARY APPROACH* 25–26 (4th ed. 2018). The “right to use” is one of the sticks or rights in the bundle. *Id.* See also *Kaiser Aetna v. United States*, 444 U.S. 164, 176 (1979) (characterizing property rights as “sticks in the bundle of rights that are commonly characterized as property”).
- 21 FEMA defines high hazard as: “An area of special flood hazard extending from offshore to the inland limit of a primary frontal dune along an open coast and any other area subject to high velocity wave action from storms or seismic sources.” *Coastal Flood Risk: Achieving Coastline Resistance*, FED. EMERGENCY MGMT. AGENCY (July 10, 2020), <https://>

issues in high-hazard, developed coastal communities are even thornier—with more complex solutions. Can coastal property owners be forced to relocate—and if they do not voluntarily relocate, can government agencies absolve themselves of liability for sea level rise-related damage, destruction, injury, or death? Should coastal property owners be deemed to have assumed the risk of buying coastal property and, thus, be precluded from seeking government assistance to protect, repair, or replace their property? When the mean high tide moves inland, does the public trust doctrine mandate that public beaches follow it,²² thus converting private property to public use? Do insurance companies have an obligation to insure real property in coastal areas?²³ Can lenders refuse loans for real estate in coastal areas?

The myriad issues posed by rising sea levels are complex and demand political will, creativity, and collaboration. While some issues will not be pressing for years, they are too important to ignore, requiring cooperation and long-term solutions. Part II provides a primer on sea level rise, providing a lens to see the potential magnitude of the problem and why it poses land-use planning and property-rights challenges.

II. SEA LEVEL RISE: WHAT (IT IS), HOW (IT IS MEASURED AND PROJECTIONS FOR FUTURE), AND WHY (WE SHOULD BE WORRIED)

This Part describes sea level rise and its major causes—including rising temperatures and resulting ocean expansion, ice melt, and land subsidence. It also explains how sea level rise is measured and the range of projections for sea level rise. However, this is not a scientific article²⁴—it simply provides enough information on sea level rise to frame the land use, property rights, and related legal issues that follow.

www.fema.gov/glossary/high-hazard-area. For purposes of this Article, I would extend the definition of high-hazard coastal areas to include those at risk of cliff and bluff collapse and erosion.

- 22 Prof. Joseph Sax's seminal article outlined the Public Trust doctrine, which prevents private ownership of the seashore as it should be preserved for public use, saying "[i]t has rather been a general rule that land titles from the federal government run down only to the high water mark, with title seaward of that point remaining in the states, which, upon their admission to the Union, took such shorelands in "trusteeship" for the public." Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 Mich. L. Rev. 471, 476 (1970).
- 23 One report studying the impact of sea-level rise in California and insurance said, "Properly designed insurance policies are vital for helping landowners choose whether to protect or abandon risky property. . . . [T]he government should not continue to subsidize flood insurance for properties that have suffered repetitive losses. Nor should insurance be available for properties highly likely to be inundated under future conditions." *Impacts of SLR on the CA Coast*, *supra* note 12, at 88. While the authors think floodplain insurance should remain available, they recommend that policyholders not be allowed to rebuild following damage. *Id.* at 88–89.
- 24 For readily accessible information about the science of sea level rise, *see generally* CCC SLR Policy Guidance, *supra* note 3, at 43–56 (describing the "best available science on sea level rise").

A. WHAT IS SEA LEVEL RISE AND WHAT CAUSES IT?

Sea level rise is exactly that—the phenomenon of ocean levels rising over time. As the planet has cycled through warming periods and ice ages, the global “sea level has risen and fallen dramatically. At times, there was no ice at the poles and the ocean was hundreds of feet higher than it is now; at other times, ice covered the planet and sea level was hundreds of feet lower.”²⁵ In modern times, sea level has risen at a fairly slow and steady pace, but that is changing. “Following a few thousand years of relative stability, global sea level has been rising since the late 19th or early 20th century, when global temperatures began to increase.”²⁶ Sea levels are projected to rise at an increasingly rapid rate, primarily because temperatures are rising, but the reasons are more complex.

[G]lobal average sea level rise is driven by the expansion of ocean waters as they warm, the addition of freshwater to the ocean from melting land-based ice sheets and glaciers, and from extractions in groundwater. However, regional and local factors such as tectonics and ocean and atmospheric circulation patterns result in relative sea level rise rates that may be higher or lower than the global average.²⁷

It is undeniably getting hotter, causing sea levels to rise.²⁸ The National Oceanic and Atmospheric Administration (“NOAA”) reported:

Planet Earth continued to sweat in unrelenting heat last month making October 2019 the second-hottest October recorded, just behind 2015. It was also the second-hottest year to date (January through October) on record for the globe. Continuing its melting trend, Arctic sea ice coverage shrank to its smallest size yet for October.²⁹

While modern attention has rightly focused on greenhouse gasses (“GHGs”) as the primary culprit in global warming,³⁰ the increase in GHGs started over a century ago. Developed countries began using coal and fossil fuels around the industrial revolution, and both temperatures and sea levels have risen since then.³¹

[S]ea level is on the rise again, rising faster now than it has in the past 6,000 years . . . sea level began to rise around 1850, which is right around the time people started burning coal to propel steam engine trains, and it hasn’t stopped since. The climate likely started warming as a part of a natural cycle, but the

25 The Ocean Portal Team, *Sea Level Rise*, SMITHSONIAN (Apr. 2018), <http://ocean.si.edu/sea-level-rise>.

26 NAT’L RSCH. COUNCIL ET AL., *SEA-LEVEL RISE FOR THE COASTS OF CALIFORNIA, OREGON, AND WASHINGTON: PAST, PRESENT AND Future 1* (2012) [hereinafter NATIONAL RESEARCH COUNCIL REPORT].

27 CCC SLR *Policy Guidance*, *supra* note 3, at 44.

28 “The 10 warmest years on record (since 1880) have all occurred since 1998, and all but one have happened since 2000.” *Changes in the Climate*, CTR. FOR CLIMATE & ENERGY SOLS., <https://www.c2es.org/content/changes-in-climate/> (last visited Nov. 27, 2020).

29 *Globe Had Its 2nd-Hottest October and Year to Date on Record*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (Nov. 18, 2019), <https://www.noaa.gov/news/globe-had-its-2nd-hottest-october-and-year-to-date-on-record>.

30 *Changes in the Climate*, *supra* note 28.

31 The Ocean Portal Team, *supra* note 25.

accelerated warming in the last two hundred years or so is due to a rise in atmospheric carbon dioxide. The resulting rise in sea level is likely twice what we would have seen without the increase in greenhouse gasses due to human activities.³²

Other significant land use changes leading to higher GHGs include the transition from family farms to large-scale agricultural practices and deforestation.³³ These activities strip the land's vegetation and trees, hampering their ability to perform the valuable function of absorbing CO₂.³⁴ While different theories abound about why carbon dioxide concentrations have intensified, there is no disagreement about its growth. "Carbon dioxide concentrations in the atmosphere have increased since pre-industrial times from 280 parts per million to over 400 parts per million."³⁵ Just from January 2005 to October 2019, CO₂ levels grew from 378 to 412 parts per million, with levels spiking dramatically in recent years as shown in the graph below from NASA's global climate change website.³⁶

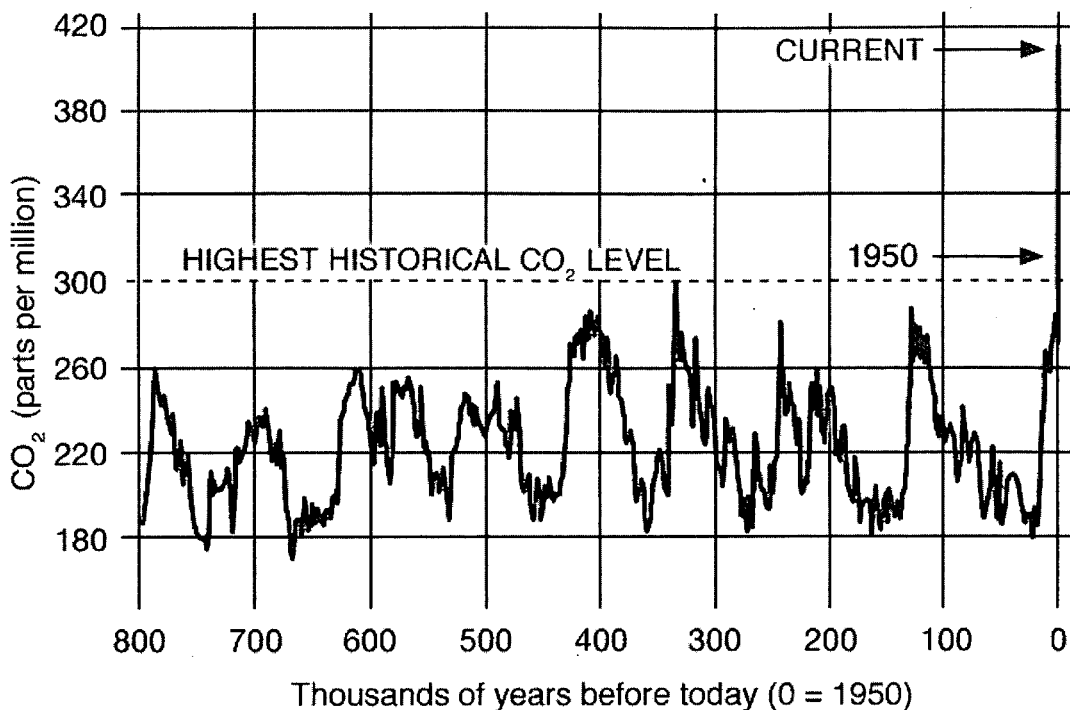
32 *Id.*

33 *See, e.g., How Does Agriculture Contribute to Climate Change?*, WORLD FUTURE (Oct. 21, 2012), <https://www.worldfuturecouncil.org/how-does-agriculture-contribute-to-climate-change/>; *Tropical Deforestation and Global Warming*, UNION OF CONCERNED SCIENTISTS, <https://www.ucsusa.org/resources/tropical-deforestation-and-global-warming> (last updated Dec. 9, 2012).

34 *See Tropical Deforestation and Global Warming*, *supra* note 33. Among the GHGs, "[c]arbon dioxide (CO₂) is an important heat-trapping (greenhouse) gas, which is released through human activities such as deforestation and burning fossil fuels, as well as natural processes such as respiration and volcanic eruptions." *Carbon Dioxide*, NAT'L AERONAUTICS & SPACE ADMIN. (Aug. 2020), <https://climate.nasa.gov/vital-signs/carbon-dioxide/>.

35 *Changes in the Climate*, *supra* note 28.

36 *See Carbon Dioxide*, *supra* note 34.



Climate change—resulting in hotter average ocean surface temperatures—creates many problems that are beyond this article’s scope; but one is at the heart of this article—its impact on sea levels. Warmer global temperatures lead to thermal expansion, which “is responsible for one-third of sea level rise to date.”³⁷ When oceans heat up, seawater expands and sea levels rise.³⁸ Although thermal expansion is a key reason sea levels rise, it is not the most important reason—glacial melt is much more significant:³⁹

Glaciers and ice sheets, large land-based formations of ice, are melting as global temperatures rise. That meltwater drains into the sea, increasing the ocean’s water volume and global sea level. Melting ice has caused about two-thirds of the rise in sea level to date, one-third from land ice in Greenland and Antarctica and one third from melting ice on mountains.⁴⁰

Moving forward, melting ice will “dominate sea level rise.”⁴¹ “Warming has already caused major changes in the ice sheets, continental masses of ice which hold a greater volume of ice than glaciers and ice caps combined. . . . [t]hese changes are irreversible in the short term . . . and it would take centuries to reverse the trail of ice retreat.”⁴²

37 The Ocean Portal Team, *supra* note 25.

38 *Id.*

39 *Id.*

40 *Id.*

41 *Id.*

42 The Ocean Portal Team, *supra* note 25. “In addition to polar ice, the melting of mountain glaciers, like those in the Andes and Himalayas, has caused an equal amount of sea level rise to date. However, because mountain glaciers include only one percent of all land ice, polar ice will eventually greatly surpass their contributions to global sea-level rise.” *Id.*

Ice melt and its impact on sea level rise varies globally.⁴³ Given this article's focus on California, it is worth noting that

North America experiences more sea-level rise from a given meltwater contribution from Antarctica than from Greenland, and if the ice loss is from West Antarctica, the impacts are exaggerated even further. . . . [F]or California, there is no worse place for land ice to be lost than from the West Antarctic Ice Sheet. For every foot of global sea-level rise caused by the loss of ice on West Antarctica, sea-level will rise approximately 1.25 feet along the California coast In addition, the West Antarctic Ice Sheet is considered the most vulnerable major ice sheet in a warming global climate, and serious irreversible changes are already underway⁴⁴

Thus, California is particularly impacted by melting from the ice sheet most at risk from global warming.⁴⁵ State leaders, policymakers, and city planners should be very worried, and take the ice sheet melt into account when making decisions about sea level rise, land use, and property rights.

Climate change is the most direct cause of sea level rise but another less significant cause, land subsidence, is also responsible. "Sinking coastal land can cause a rise in relative sea level. Groundwater and hydrocarbon extraction, as well as microbial oxidation and soil compaction related to agriculture, are among the human contributions to subsidence. Tectonic forces, including post-glacial rebound, are among the natural causes."⁴⁶ Taken together, warmer temperatures, oceanic expansion, ice melt, and land subsidence, cause sea levels to rise. How much is it rising, and what are the projections for future sea level rise? The next Section addresses those questions.

B. MEASURING SEA LEVEL RISE TODAY AND PROJECTIONS FOR THE FUTURE

Global warming, ice melt, and subsiding land have contributed to sea level rise, which has been steadily increasing for over 100 years. This chart shows a significant uptick in sea level measurements from 1870–2013.⁴⁷ Although there are occasional dips, the general trend reveals a steeper ascent over time.

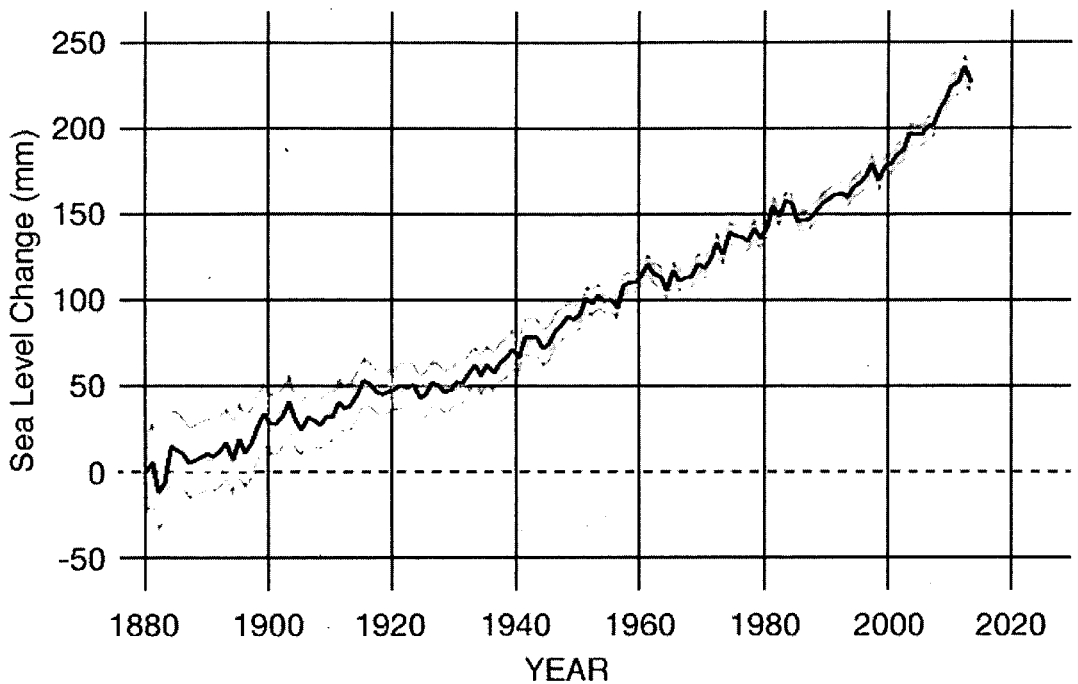
43 See *id.*

44 Gary Griggs et. al., *Rising Seas in California: An Update on Sea-Level Rise Science*, CAL. OCEAN PROT. COUNCIL 13 (Apr. 2017), <http://climate.calcommons.org/sites/default/files/rising-seas-in-california-an-update-on-sea-level-rise-science.pdf>.

45 See *id.*

46 See *Understanding Sea Level: Regional Sea Level: Subsidence*, NAT'L AERONAUTICS & SPACE ADMIN., <https://sealevel.nasa.gov/understanding-sea-level/regional-sea-level/subsidence> (last visited Nov. 29, 2020) (providing more detail about forces that contribute to subsidence).

47 See *Sea Level*, NAT'L AERONAUTICS & SPACE ADMIN. (Mar. 2020), <https://climate.nasa.gov/vital-signs/sea-level/>.



Scientific data shows sea levels have risen at faster rates in recent decades than the slow, steady rate preceding that.⁴⁸ “The global mean water level in the ocean rose by 0.14 inches . . . per year from 2006–2015, which was 2.5 times the average rate of 0.06 inches . . . per year throughout most of the twentieth century. By the end of the century, global mean sea level is likely to rise at least one foot . . . above 2000 levels, even if greenhouse gas emissions follow a relatively low pathway in coming decades.”⁴⁹ Not only is the sea rising at a faster rate, the rate also seems to be accelerating.⁵⁰ Based on an analysis of several sea level rise studies, NOAA scientists predicted that “global sea level is very likely to rise at least 12 inches . . . above 2000 levels by 2100 even on a low-emissions pathway. On future pathways with the highest greenhouse gas emissions, sea level rise could be as high as 8.2 feet . . . above 2000 levels by 2100.”⁵¹ One foot of sea

48 See *id.*

49 Rebecca Lindsey, *Climate Change: Global Sea Level*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (Aug. 2020), <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>; see also The Ocean Portal Team, *supra* note 25 (“Between 1900 and 1990 studies show that sea level rose between 1.2 millimeters and 1.7 millimeters per year on average. By 2000, that rate had increased to about 3.2 millimeters per year and the rate in 2016 is estimated at 3.4 millimeters per year. Sea level is expected to rise even more quickly by the end of the century.”).

50 See, e.g., Charlotte Jee, *Global Sea Levels Are Rising Even Faster Than Predicted, Warns the UN’s Climate Committee*, MIT TECH. REV. (Sept. 25, 2019), <https://www.technologyreview.com/2019/09/25/132873/global-sea-levels-are-rising-even-faster-than-predicted-says-uns-climate-committee/>; Weeman & Lynch, *supra* note 4.

51 Lindsey, *supra* note 49.

level rise will create problems, but over eight feet, combined with its ripple effects, will be catastrophic.⁵²

Scientists measure sea level and estimate future rise in many recognized ways.⁵³ Regardless of methodology, the field is rapidly evolving and will continue to change with technological and scientific advancements. One body measures sea level rise by analyzing data from multiple sources, including “tide gage measurements, which in some places date back to the 17th century, and satellite altimetry measurements of sea-surface heights, which have been available for the past two decades. Gravity Recovery and Climate Experiment (“GRACE”) satellite measurements, beginning in 2002, offer a possible additional estimate of global sea level.”⁵⁴ The USGS developed the Coastal Storm Modeling System (“CoSMoS”), a quasi-interactive approach designed to provide more detailed coastal flooding and shoreline change predictions resulting from both sea-level rise and storm activity.⁵⁵ “CoSMoS is a suite of coupled hydrodynamic models that utilize a total water level approach which includes . . . sea level rise; tides; waves; storm surge; freshwater discharge from rivers; and seasonal influences such as El Niño.”⁵⁶ CoSMoS allows analysis under ten different sea level rise scenarios and four storm scenarios,⁵⁷ for a total of 40 scenarios to predict flooding and alterations to the shoreline.⁵⁸ Its wide range of scenarios, from worst to best and everything in between, give decisionmakers several permutations to assist with planning.

Sea level rise models can only make best guesses based on many factors, including two especially important but hard to predict ones: GHG emissions and land ice melt rates.⁵⁹ The process is further complicated because collecting sea level rise data is relatively new.⁶⁰ With rapidly increasing sea level rise in recent years and no reliable comparative tools, it is difficult to extrapolate to accurately estimate what is next. Even existing data can be challenging to analyze, sometimes for unexpected reasons. While preparing a recent monthly climate report, NOAA scientists were puzzled about an im-

52 *Id.*

53 See The Ocean Portal Team, *supra* note 25.

54 NATIONAL RESEARCH COUNCIL REPORT, *supra* note 26, at 23.

55 See COASTAL STORM MODELING SYSTEM FOR SOUTHERN CALIFORNIA, U.S. GEOLOGICAL SURV. (2016).

56 *Id.* at 2.

57 The ten sea level rise scenarios include: “0-2 meters (m) at .25 m increments, and an extreme 5 m scenario.” *Id.* at 1. The four storm scenarios include “average conditions; 1-year return; 20-year return; and 100-year return intervals.” *Id.* at 1–2.

58 “Additionally, the CoSMoS model uses information about historical shoreline positions and how beaches change in response to waves and climate cycles such as El Niño, to improve estimates and improve confidence in long-term prediction of coastline changes in Southern California.” *Disappearing Beaches: Modeling Shoreline Change in Southern California*, U.S. GEOLOGICAL SURV. (Mar. 2017), <https://www.usgs.gov/news/disappearing-beaches-modeling-shoreline-change-southern-california>.

59 See, e.g., CCC SLR Policy Guidance, *supra* note 3, at 51 (“The two primary sources of uncertainty in global sea level projections include: 1) Uncertainty about future greenhouse gas emissions and concentrations of sulfate aerosols, which will depend on future human behavior and decision making, and 2) Uncertainty about future rates of land ice loss”). See also NATIONAL RESEARCH COUNCIL REPORT, *supra* note 26, at 101.

60 See CCC SLR Policy Guidance, *supra* note 3.

portant climate monitoring station in Barrow, Alaska, when the data for a reporting period apparently disappeared.⁶¹ While the station and its data did not literally vanish, “[t]he temperature in Barrow had been warming so fast this year, the data was automatically flagged as unreal and removed by the climate database.”⁶²

Even with uncertainty, answering how quickly sea levels are expected to rise remains critical for land use planning. The National Research Council projects that the sea level along the California coast south of Cape Mendocino will rise by 17–66 inches by 2100; north of Cape Mendocino, sea level may rise 4–56 inches.⁶³ Under CoSMoS models “with limited human intervention, 31 to 67 percent of Southern California beaches may become completely eroded (up to existing coastal infrastructure or sea-cliffs) by the year 2100 under scenarios of sea-level rise of one to two meters.”⁶⁴ More specifically, the models predict “sea level rise in Southern California is expected to match global projections with an increase of . . . (5-24 inches) from 2000-2050 and . . . (17-66 inches) from 2000-2100.”⁶⁵

Decisionmakers responsible for their communities’ health, safety, and welfare need valid sea level rise science,⁶⁶ data, and the types of modeling tools described in this Section to guide them when forecasting, planning, and developing adaptation strategies.⁶⁷ This approach “helps to identify tipping points indicating if, or when, sea level rise will become a serious issue in a particular location. Using multiple sea level rise scenarios can help planners anticipate the types of hazards that need to be prepared for, including those to coastal resources and human health and safety.”⁶⁸ The end user can manipulate the inputs to produce numerous scenarios. For example, NOAA created the sea level rise viewer project that allows the user to control variables for the purpose of visualizing a variety of sea level rise situations.⁶⁹ The viewer includes several criteria

61 Deke Arndt, *Alaskan North Slope Climate Change Just Outran One of Our Tools to Measure It*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. (Dec. 6, 2017), <https://www.climate.gov/news-features/blogs/beyond-data/alaskan-north-slope-climate-change-just-outran-one-our-tools-measure>.

62 Angela Fritz, *This City in Alaska Is Warming So Fast, Algorithms Removed the Data Because It Seemed Unreal*, Wash. Post (Dec. 12, 2017), https://www.washingtonpost.com/news/capital-weather-gang/wp/2017/12/12/barrow-is-warming-so-fast-algorithms-removed-the-data-because-it-seemed-unreal/utm_term=.E540467c0fda.

63 NATIONAL RESEARCH COUNCIL REPORT, *supra* note 26, at 3.

64 *Disappearing Beaches: Modeling Shoreline Change in Southern California*, *supra* note 58.

65 COASTAL STORM MODELING SYSTEM FOR SOUTHERN CALIFORNIA, *supra* note 55.

66 The California Coastal Commission “recommends using the best available science (currently the 2012 National Research Council’s report) and scenario-based analysis to accommodate the uncertainty in sea level projections.” *Sea Level Rise: Science and Consequences*, CAL. COASTAL COMM’N (2019), <https://www.coastal.ca.gov/climate/slr/science/>.

67 They must consider a range of scenarios to better “analyze vulnerabilities, generate new ideas and adaptation options, and/or test strategies. In the context of sea level rise, it involves selecting several possible sea rise levels as starting points to evaluate impacts to coastal resources and potential risks to development over time.” *Id.*

68 *Id.*

69 *Sea Level Rise Viewer*, NAT’L OCEANIC & ATMOSPHERIC ADMIN., <https://coast.noaa.gov/digitalcoast/tools/slr.html> (last updated May 12, 2020).

utilized in the project, which allows for consistency,⁷⁰ and if preparing a vulnerability assessment for a given coastal community, one can:

Use this web mapping tool to visualize community-level impacts from coastal flooding or sea level rise (up to 10 feet above average high tides). Photo simulations of how future flooding might impact local landmarks are also provided, as well as data related to water depth, connectivity, flood frequency, socio-economic vulnerability, wetland loss and migration, and mapping confidence.⁷¹

While the viewer does not predict sea level rise, it allows one to plug in variables and view impacts, with the caveat that “the data in the maps do not consider natural processes such as erosion, subsidence, or future construction.”⁷² Thus, it may be overly conservative in its estimate of sea level rise impacts. Regardless, it reinforces that planners and policymakers must consider a range of factors and possible outcomes when commissioning thorough vulnerability assessments and creating tailored adaptation plans.⁷³

While sea level may be measured multiple ways, each arrives at the same conclusion: it is rising and at an accelerated pace. It is a quickly changing subject with many methodologies, frequently updated data, and constantly emerging technology. Projections are further complicated because there is a dearth of historical data of both industrialization’s and carbon emissions’ impact on sea level rise. Thus, scientists can only estimate based on historical data related to global warming from other causes, then predict likeliest future outcomes based on such data, current and projected GHG emission rates, and ice melt rates. Even with all the variables, given the certainty of continued sea level rise, it is essential to consider its impacts, which Part III addresses.

III. IMPACTS OF SEA LEVEL RISE

[S]ea level rise will cause flooding and inundation, increased coastal erosion, changes in sediment supply and movement, and saltwater intrusion to varying degrees along the California coast. These effects in turn could have a significant impact on the coastal economy and could put important coastal resources and coastal development at risk, including ports, marine terminals, commercial fish-

70 The criteria include the following: “Use publicly, best available and accessible elevation data that meet FEMA mapping standards; Map literature-supported levels of sea level rise (SLR); Map SLR on top of mean higher high water (MHHW); Incorporate local or regional tidal variation of MHHW for each area; Evaluate inundation for hydrological connectivity; Preserve hydrologically unconnected areas greater than one acre in size but display separately from hydrologically connected inundation.” DIGITAL COAST SEA LEVEL RISE VIEWER: FREQUENT QUESTIONS, NAT’L OCEANIC & ATMOSPHERIC ADMIN. 8 (2017).

71 See *Sea Level Rise Viewer*, *supra* note 69.

72 DIGITAL COAST SEA LEVEL RISE VIEWER: FREQUENT QUESTIONS, *supra* note 700.

73 “Rates of sea-level rise provide important context for the time needed to plan and implement adaptation options. They are also an important consideration in evaluating when and where natural infrastructure is a feasible and prudent choice for helping to mitigate the effects of sea-level rise.” Griggs et al., *supra* note 444, at 27.

ing infrastructure, public access, recreation, wetlands and other coastal habitats, water quality, biological productivity in coastal waters, coastal agriculture, and archaeological and paleontological resources.⁷⁴

Sea level rise seriously affects safety, property, and commerce, but it occurs over such a long arc that decisionmakers may be tempted to ignore these negative impacts as they involve politically difficult and unpopular decisions. However, many impacts will likely occur much sooner, requiring immediate attention. The economic impacts alone are mind-boggling.

The potential for future losses is great, with continued and often expensive development at the coasts increasing exposure . . . Shoreline counties hold 49.4 million housing units, while homes and businesses worth at least \$1.4 trillion sit within about 1/8th mile of the coast. Flooding from rising sea levels and storms is likely to destroy, or make unsuitable for use, billions of dollars of property by the middle of this century. . . . Recent economic analysis finds that under a higher scenario . . . , it is likely . . . that between \$66 billion and \$106 billion worth of real estate will be below sea level by 2050; and \$238 billion to \$507 billion, by 2100.⁷⁵

This Part's first Section details how sea level rise, combined with forces like severe storms or high tides, can wreak destruction on built and natural environments. The second Section provides a snapshot of the economic impact of sea level rise on coastal communities. The physical and economic impacts provide some context for the difficult decisions land use experts, policymakers, and politicians must make when planning for their cities' future safety and resiliency.

A. SEA LEVEL RISE AND PHYSICAL IMPACTS

Sea level rise, especially when coupled with extreme weather events,⁷⁶ will cause severe property damage. It will result in faster coastal erosion (including loss of beaches and bluff collapse),⁷⁷ rising water tables,⁷⁸ saltwater incursions into water tables (aquifers

74 CCC SLR Policy Guidance, *supra* note 3, at 17.

75 Fourth National Climate Assessment: Chapter 8: Coastal Effects, U.S. GLOBAL CHANGE RSCH. PROG. (2018), <https://nca2018.globalchange.gov/chapter/8/>.

76 "While sea level itself undoubtedly affects the land-ocean interface, the most significant coastal damages are often witnessed during extreme storms and episodic events, which are projected to occur more frequently under a changing climate." Philip G. King, Aaron R. McGregor, & Justin D. Whittet, *The Economic Costs of Sea-Level Rise to California Beach Communities*, CAL. STATE PARKS 6 (2010) (available by request at <https://dbw.parks.ca.gov/pages/28702/files/CalifSeaLevelRise.pdf>) [hereinafter *Economic Costs of SLR*].

77 See Rob L. Evans, *Rising Sea Levels and Moving Shorelines*, WOODS HOLE OCEANOGRAPHIC INSTIT. (Nov. 16, 2004), <https://www.whoi.edu/oceanus/feature/rising-sea-levels-and-moving-shorelines/>.

78 See, e.g., *Sea-Level Rise Linked to Higher Water Tables Along California Coast*, UNIV. OF ARK. (Aug. 21, 2020), <https://news.uark.edu/articles/54458/sea-level-rise-linked-to-higher-water-tables-along-california-coast/>.

and surface waters that flow into salt water),⁷⁹ shoreline changes which can be debilitating for native flora and fauna,⁸⁰ and cause human injury, even loss of life.⁸¹

With a little imagination, one can visualize the impacts of sea level rise. Picture yourself at an oceanfront home at the narrowest part of the beach, where mere feet of sand separate the house from high tide. As the sea level rises, the lap of the ocean gets closer to the house until there it is, at your doorstep. But that could take 100 years or more. What will likely happen much sooner is acute damage caused by sea level rise exacerbated by more frequent, intense weather phenomena. “Recent climate and oceanographic studies indicate that a warming climate may increase the intensity, duration, and frequency of extreme storms.”⁸² One reason these events will wreak so much destruction is because of pervasive build-out in coastal regions.⁸³

Extensive development has occurred in areas already threatened by erosion and floods along the California coast. . . . Additionally, high-value commercial, industrial, and transportation facilities are also located along the coast. Such facilities make use of the waterfront for waste disposal, movement of goods or people, or commercial activities. Among the most common coastal facilities are airports, railroad tracks and terminals, highways, power plants, waste-disposal sites, waste-treatment plants, ports and docks, warehouses, salt ponds, and marinas.⁸⁴

One major storm coinciding with king tides would unleash millions of dollars’ worth of damage on coastal structures.⁸⁵

Imperial Beach detailed four hazards that would be exacerbated by sea level rise: coastal flooding, coastal erosion, tidal inundation, and nuisance stormwater flooding.⁸⁶ Its vulnerability assessment indicated that “with 1.0m SLR, areas that currently flood

79 See, e.g., *Climate Adaptation and Saltwater Intrusion*, U.S. ENV’T PROT. AGENCY, <https://www.epa.gov/arc-x/climate-adaptation-and-saltwater-intrusion/> (last updated Sept. 29, 2016).

80 See, e.g., Christina Nunez, *Sea Level Rise Explained*, NAT’L GEOGRAPHIC (Feb. 19, 2019), <https://www.nationalgeographic.com/environment/global-warming/sea-level-rise/#close> (“When sea levels rise as rapidly as they have been, even a small increase can have devastating effects on coastal habitats farther inland, it can cause destructive erosion, wetland flooding, aquifer and agricultural soil contamination with salt, and lost habitat for fish, birds, and plants.”).

81 See, e.g., sources cited, *supra* note 2. The California Coastal Commission listed the most common sea level rise impacts as “increased flooding, inundation, wave impacts, coastal erosion, changes in sediment dynamics, and saltwater intrusion.” CCC SLR Policy Guidance, *supra* note 3, at 52–53 (citations omitted).

82 See *Economic Costs of SLR*, *supra* note 76, at 19.

83 See *Climate Impacts on Coastal Areas*, U.S. ENV’T PROT. AGENCY, https://19january2017snapshot.epa.gov/climate-impacts/climate-impacts-coastal-areas_.html#main-content (last updated Jan. 19, 2017).

84 See *Impacts of SLR on the CA Coast*, *supra* note 12, at 23.

85 See Daniel Cusick, *As Seas Rise, King Tides Increasingly Inundate the Atlantic Coast*, SCIENTIFIC AM. (Nov. 6, 2019), <https://www.scientificamerican.com/article/as-seas-rise-king-tides-increasingly-inundate-the-atlantic-coast/> (discussing damage from king tides in the Florida Keys).

86 See 2016 CITY OF IMPERIAL BEACH SEA LEVEL RISE ASSESSMENT, IMPERIAL BEACH 4-1 (2016).

under high tide about 20% of the time . . . are likely to be flooded almost 40% of the time.”⁸⁷ It also noted that nuisance floods would “fill in low-elevation storm drains blocking their ability to drain storm waters into the ocean, the San Diego Bay, and the Tijuana Estuary. . . . Imperial Beach’s pipelines . . . would be flooded 50% of the time, due to tide elevation.”⁸⁸ As a low-lying coastal city, it is already subject to damage from these hazards,⁸⁹ thus it would not take much sea level rise to increase the number and gravity of existing hazards.

Imperial Beach provides a glimpse of just four hazards made worse by sea level rise, but it barely scratches the surface. To truly get a sense of the problem’s magnitude on the built environment, consider how much is at risk, even when limited to vital infrastructure just within California.

A wide range of critical infrastructure, such as roads, hospitals, schools, emergency facilities, wastewater treatment plants, power plants, and more will . . . be at increased risk of inundation in a 100-year flood event. This infrastructure at risk includes: nearly 140 schools; 34 police and fire stations; 55 healthcare facilities; more than 330 [U.S. EPA]-regulated hazardous waste facilities or sites . . . ; an estimated 3,500 miles of roads and highways and 280 miles of railways; 30 coastal power plants, with a combined capacity of more than 10,000 megawatts; 28 wastewater treatment plants . . . with a combined capacity of 530 million gallons per day; and . . . airports.⁹⁰

Advanced planning is required to ensure continuous access to utilities, water, and transportation that can withstand sea level rise, which planning is already underway. “Recently, the Coastal Commission and Caltrans co-developed a framework for addressing sea level rise for transportation infrastructure along the coast. [They] identified and agreed upon points of engagement to ensure that Coastal Commission input on sea level rise is addressed at all stages of the highway planning process.”⁹¹ This type of collaborative work is vital for the safety and well-being of coastal communities.

Even though rising sea levels alone will not lead to serious flooding in the short run, sea level rise coupled with storm surge or high tide will.⁹² “Along the California coast, wave-induced storm surge can exceed 1.5 m, flooding low-lying areas and eroding coastal bluffs. Increases in mean sea level are expected to increase the frequency and intensity of

87 *Id.* at 4-7. Imperial Beach combined CoSMoS and SPAWAR models and data to create projections underlying its vulnerability assessment. *Id.* at 4-5.

88 *Id.* at 4-7. “Nuisance floods are minor recurrent events, which take place right at high tide and presently cause minor inconveniences, such as flooded street corners, and in some rare occasions, road closures.” *Id.* at 4-6.

89 *E.g.*, *id.* at 4-7 (“[I]n some areas of the city, storm drains are being filled by salty waters during high tides.”).

90 *Impacts of SLR on the CA Coast*, *supra* note 12, at 2–3 (citations omitted); see also Louise Bedsworth et al., *California’s Fourth Climate Change Assessment*, CAL. ENERGY COMM’N 54 (2018), https://www.energy.ca.gov/sites/default/files/2019-11/Statewide_Reports-SUM-CCCA4-2018-013_Statewide_Summary_Report_ADA.pdf.

91 See CALIFORNIA COASTAL COMMISSION STATEWIDE SEA LEVEL RISE VULNERABILITY SYNTHESIS, CAL. COASTAL COMM’N 17 (2016) [hereinafter CCC SLR *Vulnerability Synthesis*]; see also CCC SLR *Policy Guidance*, *supra* note 3, at 140–43.

92 Griggs et al., *supra* note 4444, at 17.

these extreme events.”⁹³ Such surges cause significant property damage with huge price tags attached, and future storm surges are expected to cause even more damage when combined with high tides and sea level rise.⁹⁴ “When a storm surge arrives at the same time as high tide . . . it can raise water levels 20 feet or more above mean sea level. As a result of global sea level rise, storm surges that occur today are eight inches higher than they would have been in 1900.”⁹⁵ Coastal development is clearly at higher risk for serious, even catastrophic, damage whenever storm surge coincides with high tides—exemplified in New York during Hurricane Sandy:

Climate change may not cause a particular storm, but rising sea levels can worsen its impact. In 2012 a nine-foot storm surge from Hurricane Sandy hit New York City at high tide, making the water 14 feet higher than normal at the tip of Manhattan. Flooding destroyed neighborhoods and beaches in outer boroughs. The sea level in this area is rising by more than an inch each decade—twice as fast as the global average—and is predicted to rise 11 to 21 inches by 2050.⁹⁶

While severe storms have always packed the potential for devastation, experts predict that with climate change, we will see more severe storms, resulting in skyrocketing physical and financial damage.⁹⁷

Destructive flooding is all but guaranteed. “[P]eople, infrastructure, and property are already located in areas vulnerable to flooding from a 100-year event. Sea-level rise will cause more frequent and more damaging floods to those already at risk and will increase the size of the coastal floodplain, placing new areas at risk where there were none before.”⁹⁸ One study of five California coastal communities looked at 100-year coastal flood impacts and concluded: “Sea-level rise exacerbates coastal storm damage by both increasing the reach of a flood as well as the depth of flooding within the base hazard zone. These compounding effects result in damage increases . . . ranging between 70 percent at Torrey Pines to 640 percent at Venice Beach.”⁹⁹ Damage increases of 640% would cause irreparable damage and the possible death of a neighborhood. Sea level rise and major weather events also exacerbate wave impact damage:

93 *Impacts of SLR on the CA Coast*, *supra* note 12, at 8.

94 *See Storm Surge*, U.S. CLIMATE RESILIENCE TOOLKIT (Mar. 2020), <https://toolkit.climate.gov/topics/coastal/storm-surge>.

95 *See id.* (noting that sea level rise will exacerbate storm surge damage).

96 *See Wild Weather*, NAT’L GEOGRAPHIC, <https://www.nationalgeographic.com/climate-change/how-to-live-with-it/weather.html> (last visited Nov. 27, 2020).

97 *See Extreme Precipitation and Climate Change*, CTR. FOR CLIMATE & ENERGY SOLS., <http://www.c2es.org/content/extreme-precipitation-and-climate-change/> (last visited Nov. 27, 2020); *Extreme Weather and Climate Change*, CTR. FOR CLIMATE & ENERGY SOLS., <https://www.c2es.org/content/extreme-weather-and-climate-change/> (last visited Nov. 27, 2020) (“One of the most visible consequences of a warming world is an increase in the intensity and frequency of extreme weather events. The National Climate Assessment finds that the number of heat waves, heavy downpours, and major hurricanes has increased in the United States, and the strength of these events has increased, too.”).

98 *See Impacts of SLR on the CA Coast*, *supra* note 12, at 38.

99 *See Economic Costs of SLR*, *supra* note 766, at 46.

[Waves] can cause some of the more long-lasting consequences of coastal storms, resulting in high amounts of erosion and damage or destruction of structures. The increase in the extent and elevation of flood waters from sea level rise will also increase wave impacts and move the wave impacts farther inland. Erosion rates of coastal cliffs, beaches, and dunes will increase with rising sea level and are likely to further increase if waves become larger or more frequent.¹⁰⁰

Even with strict measures to reduce climate change, sea levels will rise and wave impact damage will intensify. Thus, land use decisionmakers and lawmakers must thoughtfully consider how to mitigate damage with short-, middle-, and long-range plans.

The U.S. Climate Resilience Toolkit said “[a]s global sea level rises, the action of waves at higher elevations increases the likelihood for extensive coastal erosion. Already, coastal erosion costs roughly \$500 million per year for coastal property loss, including damage to structures and loss of land.”¹⁰¹ While some adaptation steps may mitigate erosion in the short run, coastal erosion will still intensify with sea level rise. “Large sections of the California coast consist of oceanfront bluffs that are often highly susceptible to erosion. With higher sea levels, the amount of time that bluffs are pounded by waves would increase, causing greater erosion. This erosion could lead to landslides and loss of structural and geologic stability of blufftop development such as homes, infrastructure, the California Coastal Trail, Highway 1, and other roads and public utilities.”¹⁰² Erosion and select adaptation measures will also detrimentally alter many beaches, even causing some to vanish.¹⁰³ From a social and tourism perspective, sea level rise has the potential to wield drastic changes by reducing beaches’ and recreation areas’ quantity and quality.¹⁰⁴ “The combined factors of sand supply deficiency, coastal armoring and sea-level rise, cause beaches that would typically migrate landward to become narrowed between the fixed backbeach and the landward movement of the shoreline. Many will eventually disappear, impeding access to and along the coast and exposing the backshore . . . to increased threats of wave damage and flooding.”¹⁰⁵ The physical impacts of erosion, intensified by sea level rise, are inevitable—ranging from minor to catastrophic and harming people and property alike.¹⁰⁶

Physical sea level rise impacts not only harm beaches, but also fundamentally alter beach access.¹⁰⁷ In San Diego County alone, “roughly a quarter of public access points on granted land will be exposed to flooding in the short term, and up to three-quarters

100 See CCC SLR Policy Guidance, *supra* note 3, at 53.

101 Coastal Erosion, U.S. CLIMATE RESILIENCE TOOLKIT (Mar. 2020), <https://toolkit.climate.gov/topics/coastal-flood-risk/coastal-erosion>.

102 CCC SLR Policy Guidance, *supra* note 3, at 53.

103 *Id.* at 36.

104 See *id.*

105 See *Economic Costs of SLR*, *supra* note 766, at 7.

106 See, e.g., sources cited, *supra* note 2.

107 See Carly Hart & Nina S. Roberts, *Sea-Level Rise and Vanishing Coastal Parks: A Call to Action for Park Managers and Leaders*, PARKS STEWARDSHIP FORUM (Jan. 6, 2020), <https://parks.berkeley.edu/psf/p=1589>.

may be exposed by 2100.”¹⁰⁸ Reducing public access hampers a California Coastal Act “key mandate to protect and maximize public access and recreation,”¹⁰⁹ the State Lands Commission’s duties,¹¹⁰ and public trust obligations. In California, public trust lands include “4 million acres of tide and submerged lands and the beds of natural navigable rivers, streams, lakes, bays, estuaries, inlets, and straits.”¹¹¹ The Coastal Commission is bound by the public trust doctrine to maximize public access to the coast, and to use and manage the state’s waterways for all Californians.¹¹² Thus, it cannot stand by and allow coastal hazards to ravage coastal communities.

Sea-level rise will alter and destroy wetlands, including some of the approximately “550 square miles, or 350,000 acres . . . [just] along the California coast”¹¹³ Wetlands provide important functions such as “flood protection, water purification, wildlife habitat, recreational opportunities, and carbon sequestration.”¹¹⁴ A USGS report found that “under moderate to high sea level rise projections of 2 to 3 feet by 2100, California, Washington and Oregon would lose at least 83 percent of their existing coastal wetlands.”¹¹⁵ If coastal wetlands are whittled away, many plant, bird, and animal species would disappear, wetlands’ water purification function would diminish, and communities would lose a buffer against flooding.¹¹⁶

Diminished wetlands are not the only sea level rise impact that would hamper water purification functions. Other sea level rise effects would result in environmental degradation, further impacting water quality and supply. For example, rising sea levels would allow saltwater to permeate freshwater sources¹¹⁷ and when coupled with storm surges or

108 See *State Lands Sea Level Rise Vulnerability Assessment*, CITY OF SAN DIEGO 15 (July 2019), https://www.sandiego.gov/sites/default/files/ab691_report_san_diego.pdf [hereinafter *San Diego State Lands SLR Vulnerability Assessment*]. “San Diego’s granted public trust lands include more than 4,000 acres of land and water, 27 miles of shoreline, and eight official swimming areas.” *Id.* at 3.

109 CCC *SLR Vulnerability Synthesis*, *supra* note 91, at 15.

110 *Id.* The State Lands Commission works to secure and safeguard “the public’s access rights to natural navigable waterways and the coastline and preserves irreplaceable natural habitats for wildlife, vegetation, and biological communities.” *Id.*

111 See *About the California State Lands Commission*, CAL. STATE LANDS COMM’N (2020), <https://www.slc.ca.gov/about/>.

112 See generally, CAL. PUB. RES. CODE § 30210 (West 2020) (codifying the Coastal Act); see also CCC *SLR Policy Guidance*, *supra* note 3, at 168. For a general discussion of the Coastal Act’s directive to provide public access to beaches, see Jordan Diamon et al., *The Past, Present, and Future of California’s Coastal Act: Overcoming Division to Comprehensively Manage the Coast*, BERKELEY LAW (2017).

113 See *Impacts of SLR on the CA Coast*, *supra* note 12, at 3.

114 *Id.* at 28; see also *Economic Costs of SLR*, *supra* note 766, at 6.

115 Bob Berwyn, *Sea Level Rise Threatens to Wipe Out West Coast Wetlands*, INSIDE CLIMATE NEWS (Feb. 22, 2018), <https://insideclimatenews.org/news/21022018/sea-level-rise-coastal-wetlands-global-warming-mitigation-wildlife-habitat-storm-surge-usgs>.

116 See *Conserving Coastal Wetlands for Sea Level Rise Adaptation*, NAT’L OCEANIC & ATMOSPHERIC ADMIN., <https://coast.noaa.gov/applyit/wetlands/understand.html> (last visited Nov. 27, 2020).

117 “An increase in sea level could cause saltwater to enter into groundwater resources, or aquifers. . . . Generally, the most vulnerable hydrogeological systems are unconfined aqui-

king tides, could cause flooding that overwhelms stormwater systems, compromising fresh water and leaking sewage and debris. “As the sea rises, saltwater moves into fresh-water areas Water infrastructure in coastal cities, including sewer systems and wastewater treatment facilities, faces risks from rising sea levels and the damaging impacts of storm surges.”¹¹⁸

As devastating as sea level rise-related property damage is, the most disturbing physical impact is risk to life. Many desirable coastal areas are developed with expensive improvements and hundreds of thousands of residents.¹¹⁹ Paradoxically, many vulnerable populations are especially at risk, even in costly coastal communities.¹²⁰

“As sea levels rise, the area and the number of people vulnerable to flooding will also rise. Rising sea levels will overwhelm the existing protection structures, putting the 260,000 people currently living in vulnerable areas at increased risk. In total, we estimate that a 1.4 m sea-level rise will put around 480,000 people (nearly half a million) at risk from a 100-year flood event. Continued development in these regions could put additional people at risk.”¹²¹ The National Environmental Education Foundation wrote that “[i]n 2010, 39% of the total population in the United States lived in counties along the coast. This population is expected to increase by 8% by 2020.”¹²²

In terms of sheer numbers, that would place just under 50% of the U.S. population at higher risk for sea level rise-related disasters.¹²³

As is clear from this Section, sea level rise will have ruinous effects on homes, infrastructure, access to water, utilities, and human safety. Such effects could indelibly alter how we live if we do not engage in difficult and serious planning to avoid and mitigate such impacts. For each physical impact, there is an economic counterpart, which is the subject of the next Section.

B. SEA LEVEL RISE AND ECONOMIC IMPACTS

Overall, America’s coasts and oceans contribute a disproportionately high value per acre of land to the U.S. economy. In 2013, the ocean economy generated more than \$44 billion to California’s gross domestic product (“GDP”) and provided over 500,000 jobs and more than \$19 billion in wages and salaries.¹²⁴

In addition to the destructive physical impacts described in the previous Section, sea level rise will have a significant economic impact, causing untold billions of dollars’ worth of damage, destroying businesses, and altering countless lives. It will result in lost

fers along low-lying coasts, or aquifers that have already experienced overdraft and saline intrusion.” CCC SLR Policy Guidance, *supra* note 3, at 54.

118 *Climate Impacts on Water Resources*, U.S. ENV’T PROT. AGENCY, <https://archive.epa.gov/epa/climate-impacts/climate-impacts-water-resources.html> (last updated May 31, 2017).

119 *See generally Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate*, UNION OF CONCERNED SCIENTISTS (June 18, 2018), <https://www.ucsusa.org/sites/default/files/attach/2018/06/underwater-analysis-full-report.pdf>.

120 *See generally id.*

121 *Impacts of SLR on the CA Coast*, *supra* note 12, at 40 (citations omitted).

122 Nick Bradford, *Sea Level Rise*, NAT’L ENV’T EDUC. FOUND., <https://www.neefusa.org/nature/water/sea-level-rise> (last visited Nov. 27, 2020).

123 *See id.*

124 *See CCC SLR Vulnerability Synthesis*, *supra* note 91, at 4 (citations omitted).

revenues,¹²⁵ but this will pale in comparison to the economic costs posed by damage, destruction, and rebuilding. The California Coastal Commission summarized the mind-boggling losses as follows:

In addition to potential losses in revenue, [a 2009 study] estimate[d] that \$100 billion worth of property is at risk of flooding during a 100-year coastal flood with 4.6 ft . . . of sea level rise This property includes seven wastewater treatment plants, commercial fishery facilities, marine terminals, Coastal Highway One, 14 power plants, residential homes, and other important development and infrastructure.¹²⁶

More than 26 million people live in California's beach communities,¹²⁷ and trillions of dollars are generated in the state's coastal economy.¹²⁸ Moreover, some of the largest businesses involved in the coastal economy rely on ports, railroads, highways, and roads—all of which will be impacted by sea level rise.¹²⁹ "Among the most common coastal facilities are airports, railroad tracks and terminals, highways, power plants, waste-disposal sites, wastewater treatment plants, ports and docks, warehouses, salt ponds, and marinas."¹³⁰ When calculating damage costs to these facilities, buildings, and underlying infrastructure, in addition to the cost of rebuilding, one must add in downtime and revenue loss by people who rely on those facilities and infrastructure to conduct their own businesses.¹³¹

While this Article cannot detail all the economic costs associated with sea level rise and compounding events, it provides enough information to better understand the problem's scope and the urgent need for land use planning today. Floods alone can generate

125 For example, just in San Diego and limiting lost revenues to City-granted land, by 2100, with sea-level rise alone, San Diego projected revenue losses of \$7.5–7.8 million; adding storm surge to sea-level rise, the losses leapt to \$11.9–12.3 million. See *San Diego State Lands SLR Vulnerability Assessment*, *supra* note 108, at 30.

126 See CCC SLR Policy Guidance, *supra* note 3, at 26. Newer figures indicate "that statewide damages could reach \$17.9 billion." *Id.*

127 See, e.g., *Fast Facts: Economics and Demographics*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Aug. 2020), <https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html> ("California tops the coastal populations chart with 26.5 million people living in coastal counties . . .").

128 See, e.g., Jeffery Adkins et al., *The National Significance of California's Ocean Economy*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (2015), <https://coast.noaa.gov/data/digitalcoast/pdf/california-ocean-economy.pdf>. "California's 19 coastal counties generated \$662 billion in wages and \$1.7 trillion in GDP in 2012, which both account for 80 percent of their respective state totals." *Id.* at 1. These eye-popping figures reflect 2012 values, so today's numbers would be much higher.

129 *Id.*

130 See *Impacts of SLR on the CA Coast*, *supra* note 12, at 23.

131 As I am writing this, we are living through the global pandemic of COVID-19 and have a sense of what it is like to operate in a world where many businesses are shuttered. However, essential businesses remain operational. Imagine if essential businesses were destroyed and how we would function while they were being rebuilt. It would be very difficult without functional water and wastewater plants, waste-disposal sites, and basic utilities.

trillions of dollars' worth of damage.¹³² One study, which extrapolated continued global warming with limited adaptation, concluded that by 2100, annual flood costs would range from \$10.2 trillion to \$27 trillion, depending on temperature increases and actual sea level rise.¹³³

Flooding's economic harm results primarily from damage to the built environment.¹³⁴ A California study found that while a "majority of sea-level rise flooding impacts fall on residential structures and their contents," even more severe damage "to commercial structures and contents can be affected by increased flood depths."¹³⁵ The study found that "only a meter or so of flooding in retail or grocery stores can damage contents in amounts totaling more than the value of the buildings themselves."¹³⁶ The study predicted that in a San Francisco neighborhood, "a 100-year storm following a 1.4 m rise in sea level could result in approximately \$10 million and \$20 million (2010 dollars) in damages to structures and their contents in 2050 and 2100, respectively."¹³⁷ The study further predicted that "[i]f a 1.4 m sea-level rise is realized, accelerated landward erosion at unarmored reaches of the backbeach could result in \$100 to \$540 million (2010 dollars) in damages in 2050 and 2100, respectively."¹³⁸

Cliff, bluff, and beach erosion will also exact costly property damage. Sometimes property will be repairable but in cases of cliff or bluff collapse, destroyed structures may be irreplaceable. One study estimated that "the economic cost to property of erosion from a 1.4 m sea-level rise would total \$14 billion."¹³⁹ These are losses that largely cannot be recovered—there will no longer be any underlying land on which to rebuild. To the extent structures are occupied when cliffs or bluffs collapse, there is no compensation. I write this figuratively, not literally, as there may be insurance compensation. However, as sea level rise hazards materialize, high-risk areas like susceptible bluff and cliff properties may become uninsurable. Focusing on erosion's costs to the transportation segment, one study posited that approximately \$4.5 million worth of railroad tracks would be at risk of erosion-based damage by 2100, with historical erosion rates and no sea level rise.¹⁴⁰ "However, an acceleration of historical erosion rates from a 1.0 m, 1.4 m and 2.0 m sea-level rise increases the amount of railway at risk by approximately \$334, \$349, and \$374 million."¹⁴¹ Those are extraordinary increases in rail track damage costs just in one location. Imagine the extrapolated costs for all the state's at-risk railroad lines, then add the costs for all transportation-related infrastructure at risk. Then multiply it by all coastal states—the numbers are staggering.

132 See S. Jevrejeva et al., *Flood Damage Costs Under the Sea Level Rise with Warming of 1.5 and 2 Degrees Celsius*, 13 *Env't Rsch. Letters* 5 (2018).

133 *Id.*

134 *Id.*

135 *Economic Costs of SLR*, *supra* note 76, at 46.

136 *Id.*

137 *Id.* at 63.

138 *Id.*

139 *Impacts of SLR on the CA Coast*, *supra* note 12, at 86.

140 Philip G. King, Aaron R. McGregor, & Justin D. Whittet, *Can California Coastal Managers Plan for Sea-Level Rise in a Cost-Effective Way*, 59 *J. ENV'T PLAN. & MGMT.* 98, 111 (2015).

141 *Id.*

Although beaches will experience less economic damage than structures and infrastructure, they will still suffer. Monetary measurement is complicated, nonetheless “[b]each erosion can result in losses of recreation value, habitat value, tourism-related spending and tax revenue.”¹⁴² Economic losses are tied to many factors, and popular beaches offering more amenities and revenues stand to lose the most. “[T]he most significant impacts are experienced at beaches that experience high levels of beach loss and host large numbers of annual visitors. Combined local and state spending losses amount to \$608 million at Venice Beach following a 2.0 m sea-level rise by 2100. Corresponding local and state tax losses amount to \$16 million.”¹⁴³

While this Part just scratched the surface of sea level rise’s physical and economic impacts, it established that the costs will be astounding. They will be borne by many, including government, insurance companies, and property owners.¹⁴⁴ The price tag is almost incomprehensible, but with disciplined and thoughtful adaptation planning, risks and costs can be reduced. The next Part will discuss sea level rise land use planning and common adaptation strategies, keeping in mind the delicate balance with property rights.

IV. SEA LEVEL RISE, VULNERABILITY ASSESSMENTS, AND ADAPTATION STRATEGIES

Accelerating sea level rise combined with slow, steady land subsidence has serious consequences for coastal property. This Part starts with information on California’s sea level rise planning to represent steps coastal communities nationwide can take. Then, it describes common adaptation strategies and how those strategies might weaken venerated private property rights.

A. SEA LEVEL RISE PLANNING IN CALIFORNIA COASTAL COMMUNITIES

The California Coastal Act mandates that beach communities prepare Local Coastal Plans (“LCPs”).¹⁴⁵ LCP guidance shapes local land use policies and development decisions, ensuring that they align with Coastal Act goals.¹⁴⁶ The Coastal Commission recommends that coastal communities certify or update their LCPs to incorporate the impact of sea level rise,¹⁴⁷ and it prepared a six-step process to help local governments do

142 *Economic Costs of SLR*, *supra* note 76, at 52.

143 *Id.*

144 “Coastal property owners are likely to bear costs from sea level rise and storm surge, including those associated with property abandonment; residual storm damages; protective adaptation measures, such as property elevation; beach nourishment; and shoreline armoring.” *Fourth National Climate Assessment: Chapter 8: Coastal Effects*, *supra* note 75.

145 CAL. PUB. RES. CODE § 30500 (West 2019). A beach community can ask the Coastal Commission to prepare its plan, or any part of it, and the Coastal Commission may also do so if a community neglects to prepare a plan. *Id.*

146 *See id.*

147 *See generally CCC SLR Policy Guidance*, *supra* note 3, at 67–96 (discussing how to address sea level rise in LCPs).

so.¹⁴⁸ LCPs can address sea level rise by incorporating adaptation plans shaped by vulnerability assessments.¹⁴⁹ However, there is neither an enforcement protocol, nor penalties if communities do not provide such assessments or plans.¹⁵⁰ Cost is an additional hurdle, as “there is not currently adequate funding for addressing sea level rise in all LCPs and to begin implementing adaptation approaches. Without additional funding . . . local governments and other entities are reluctant to even consider all potential options for addressing sea level rise, because they are considered economically infeasible.”¹⁵¹ However, several grants and funding sources are available.¹⁵²

Even with hurdles, communities know comprehensive planning can mitigate harm caused by sea level rise; thus, many municipalities are updating LCPs to include sea level rise components. Effective updates can limit development in high hazard areas and condition development on enhanced resilience steps, each of which will ultimately save lives and property.

Outdated LCPs continue to allow development in areas that will be subject to coastal hazards over their economic life. In the future, much of this development will either remain in hazardous shoreline areas, eliminating beaches, dunes and wetlands as they migrate inland, and impairing the associated economic and ecosystem services; or, development will be threatened or damaged, hurting private and public investments and requiring costly repair or removal—burdening the government and tax payers. Implementing LCP policies limiting development in hazardous areas and requiring property owners to bear future relocation and removal costs, will help avoid this coming statewide dilemma. It will also protect investment in new development by guiding it to areas safe from impending hazards.¹⁵³

Sufficient built-in rewards and government funds are available to incentivize local governments to update their LCPs in response to sea level rise, and more cities are actively engaged in the process.¹⁵⁴

Beyond Coastal Act obligations, federal and state mechanisms require cities to engage in hazard planning accounting for sea level rise. States must provide hazard mitigation plans in order to qualify for FEMA funds.¹⁵⁵ California’s State Hazard Mitigation Plan ensures FEMA compliance by requiring cities to prepare vulnerability assessments

148 “1. Choose range of sea-level rise projections relevant to LCP planning area/segment; 2. Identify potential sea-level rise impacts in LCP planning area/segment; 3. Assess risks to coastal resources and development in planning area; 4. Identify adaptation measures and LCP policy options; 5. Develop or update LCP and certify with California Coastal Commission; 6. Monitor and revise as needed.” *Id.* at 69 fig. 9.

149 *See id.* at 16.

150 *See CCC SLR Vulnerability Synthesis, supra* note 911, at 22 (“[L]ocal governments are not required by law to update LCPs to address sea level rise, and therefore, there is no legal mechanism to ensure that planning processes are completed to certification.”).

151 *Id.* at 22.

152 *See generally id.*

153 *See CCC SLR Vulnerability Synthesis, supra* note 91, at 22–23.

154 *See, e.g., id.*

155 *See generally* 44 C.F.R. §§ 201.4–201.5 (2020).

and update their local hazard mitigation policies.¹⁵⁶ In addition, California updated its general plan requirements—mandating that safety elements include location-specific climate adaptation and resiliency strategies given site-specific risks and topography.¹⁵⁷ Thus, between the Coastal Act and federal and state regulations, coastal cities must study sea level rise and plan for damage prevention and mitigation.

At the local level, LCPs remain one of the most important guidance tools to analyze sea level rise policies, decisions, and regulations. While some coastal communities resist preparing assessments or limit adaptation strategies,¹⁵⁸ many have embraced the process.¹⁵⁹ Vulnerability assessments consider a variety of sea level rise scenarios. One report, which analyzed and synthesized vulnerability assessments throughout California, found:

Beaches, coastal access, and coastal recreation areas will be vulnerable to sea level rise in all coastal counties. In more rural areas, the risks are from inundation of beach areas and roads, erosion of upland trails, and the loss of vertical access. In more urban areas, the largest threat to these areas arises from efforts to protect inland development from flooding and erosion.¹⁶⁰

Communities sometimes stumble when creating adaptation strategies. Effective adaptation plans can be politically risky. For example, if a city recommends managed retreat,¹⁶¹ it will undoubtedly raise oceanfront property owners' ire. Moreover, politicians who support strategies that diminish property values face dim reelection prospects:

156 See *Introduction to the California State Hazard Mitigation Plan*, CAL. OFF. OF EMERGENCY SERVS. (2018), https://www.caloes.ca.gov/HazardMitigationSite/Documents/001-General%20CA%20SHMP%20one-pager_4-11-18.pdf.

157 See CAL. GOV. CODE § 65302(g)(4) (West 2020) (“Upon the next revision of a local hazard mitigation plan . . . the safety element shall be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to the city or county. This review shall . . . include . . . a vulnerability assessment that identifies the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts. . .”).

158 Preparing vulnerability assessments and adaptation strategies is expensive and time-consuming. See, e.g., CCC *Vulnerability Synthesis*, *supra* note 91, at 22. However, grants and other resources are available to help coastal communities with the process. See, e.g., *Local Coastal Program: Local Assistance Grant Program*, CAL. COASTAL COMM'N, <https://www.coastal.ca.gov/lcp/grants/> (last visited Nov. 27, 2020). Even when a city proceeds, it may shy away from the most controversial strategies like managed retreat, as Del Mar recently did: “Residents strongly opposed the retreat option when it was discussed . . . As a result, the committee decided to exclude that strategy from the plan.” See Phil Diehl, *No “Retreat” From Rising Sea Level for Homes in Del Mar*, San Diego Union Tribune (Dec. 4, 2017), <https://www.sandiegouniontribune.com/communities/north-county/sd-no-sea-level-20171129-story.html>.

159 For details on the status of LCPs in California’s coastal communities, as well as which have completed vulnerability assessments and which have updated their LCPs to consider SLR, see CCC *Vulnerability Synthesis*, *supra* note 91, at app. A; See also *Local Coastal Programs*, CAL. COASTAL COMM'N, <https://www.coastal.ca.gov/lcps.html> (last visited Nov. 27, 2020).

160 See CCC *SLR Vulnerability Synthesis*, *supra* note 91, at 20.

161 Managed retreat is a strategy to “relocate or remove existing development out of hazard areas and limit the construction of new development in vulnerable areas.” See *Sea Level Rise*

State and local decision makers are often focused on the short term impacts they are faced with during their time in office and are sometimes hesitant to address the long-term challenges of sea level rise. Moreover, the constituents who are most often vocal in the public discourse are the property owners whose economic investments may be viewed as threatened by longer term adaptation options like planned retreat. This can lead to pursuit of adaptation strategies that protect development, but do not always protect coastal resources over the long term, which sustain the state's economy and way of life and support public access and recreational opportunities for a much larger portion of the populace.¹⁶²

Del Mar went through the labor-intensive exercise of developing an adaptation plan as part of its LCP update, yet managed retreat strategies barely made an appearance.¹⁶³ The city has gone back and forth with the Coastal Commission over its omission of managed retreat, and as of this writing, the Coastal Commission has not approved Del Mar's LCP Update.¹⁶⁴ This conflict illustrates a showdown that will likely become commonplace as coastal communities prepare LCP updates. The following exchange is illustrative of each side's respective position:

Del Mar initially submitted its adaptation plan to the commission for review last year. It relies primarily on maintaining its existing seawalls and the continual restoration of sand to its eroding beaches, and rejects the sometimes controversial strategy of managed retreat. Managed retreat, which calls for removing structures from the advancing sea, would not be practical in Del Mar because of the high property values there, the city said. The Coastal Commission countered with 25 suggested modifications "I was quite frankly surprised and very disappointed that the City Council summarily rejected all 25 of our suggested modifications without any discussion or consultation with us whatsoever," Ainsworth [Coastal Commission] said¹⁶⁵

To avoid managed retreat, any coastal community can legitimately argue that it has high value oceanfront properties. However, the seas will eventually come roaring forward anyway. The value of coastal properties should not close the door on managed retreat as an adaptation strategy because, after all, underwater property is worthless.

While there is some resistance to preparing comprehensive LCP sea level rise updates, many coastal communities have initiated studies and plans to address different

Adaptation Strategies, CAL. COASTAL COMM'N, <https://www.coastal.ca.gov/climate/slr/vulnerability-adaptation/adaptation/>. Managed retreat will be discussed in more detail in Section B subsection 3, below.

162 See CCC *Vulnerability Synthesis*, *supra* note 91, at 22.

163 Del Mar's draft plan only relocates the City of Del Mar Fire Station and Public Works Yard, and the LOSSAN railroad. See *ESA City of Del Mar Sea-Level Rise Adaptation Plan*, CITY OF DEL MAR ES-1-ES-2 (May 2018); <https://www.delmar.ca.us/DocumentCenter/View/3580/Revised-Adaptation-Plan-per-Council-May-21>.

164 See Phil Diehl, *California Coastal Regulators Blast Del Mar for Rejecting "Retreat" From Sea-Level Rise*, L.A. Times (Dec. 18, 2019), <https://www.latimes.com/environment/story/2019-10-18/coastal-commission-blasts-del-mar-for-stance-on-sea-level-rise> ("Two top officials at the California Coastal Commission blasted Del Mar . . . for continuing to reject 'managed retreat' as an option to deal with sea level rise").

165 *Id.*

hazards, topography, and scenarios, and the steps they can take to mitigate the dangers of sea level rise. The Coastal Commission's synthesis of vulnerability studies and adaptation strategies advised:

[A]daptation and LCP policies will need to phase approaches (such as protection, accommodation, or retreat) For example, beach nourishment along developed stretches of coast may be a feasible option to sustain sandy beaches for an interim period of time, while planned retreat will be necessary in the long run to ensure the protection of beaches and other coastal resources for future generations. In many areas, planned retreat might eventually be the only adaptation approach that will save beaches, dunes and wetlands from inundation and ensure safety of development.¹⁶⁶

Imperial Beach's adaptation study lists its vulnerabilities based on its specific geography, topography, natural environment, and built environment as follows:

- All of the beach accesses and oceanfront properties are in existing coastal erosion and coastal flood hazard zones associated with a 100-year wave event. From historic storm observations beach erosion of 50 to 150 feet in a single storm event is possible.
- Four primary neighborhoods face coastal and tidal flooding impacts. . .
- Coastal erosion will likely accelerate above historic erosion rates as sea level rises. Accelerating historic erosion rates based on 6.5 feet of sea level rise escalates erosion from 7.4 inches per year to 6.2 feet per year.
- Storm water and nuisance flooding associated with high tides will increase in frequency and duration as tidal elevations decrease the stormwater conveyance capacity.
- Land use impacts primarily impact residential properties and with 6.5 feet. . . of [sea level rise] approximately 30 percent of all structures and parcels in the City could be impacted during coastal flood events.
- Tidal inundation has a very small impact under existing conditions, but impacts escalate dramatically between 1 and 2 meters of sea level rise.
- Coastal hazards on top of 6.5 feet of sea level rise could potentially impact about 40% of all roads inside the City.
- Most of the hazardous materials storage tanks and potential exposure to hazardous materials come from military related issues. The Tijuana River Estuary may reconnect with San Diego Bay through Imperial Beach in the event of a 100-yr storm with 6.5 feet or more of sea level rise.¹⁶⁷

The study also provides detailed adaptation strategies tailored to Imperial Beach's specific vulnerabilities, including armoring, sand and beach nourishment, sand retention groins, and managed retreat, each of which are described in the next Section.¹⁶⁸

Eventually, all coastal communities will have to conduct vulnerability assessments, taking into consideration their specific locations, topographies, weather patterns, and

166 CCC SLR *Vulnerability Synthesis*, *supra* note 91, at 21–22.

167 See 2016 CITY OF IMPERIAL BEACH SEA LEVEL RISE ASSESSMENT, *supra* note 866, at 7-1–7-2.

168 *Id.* generally at 7-2, and more specifically in Chapter 6, “Analysis of Select Adaptation Strategies.”

other relevant data inputs, as well as a range of sea level rise scenarios. The results will help them develop tailored adaptation strategies. Inevitably, a city's vulnerabilities bleed into neighboring communities and overlap with state and federal agencies; thus, they must collaborate and plan together to address common hazards.

Local governments . . . face a challenge in that successful adaptation to sea level rise almost always requires coordination with entities outside their own jurisdiction and over whom they may have little influence. For example, many segments of highways and railroads are located in close proximity to the shoreline and in some cases act as lateral barriers to successful managed retreat. As sea level rises, coastal resources will be lost to inundation as they are caught between rising seas and lateral infrastructure or other development. Therefore, even if a local government intends to proactively plan to sustain their precious coastal resources over time, they may face challenges if they do not have a willing and active partnership established with . . . relevant agencies.¹⁶⁹

Private property owners also have a role to play. When they seek Coastal Development Permits ("CDPs"), if the property meets certain criteria, they must engage in an in-depth analysis of sea level rise impacts on the project.¹⁷⁰ For example, they must describe how the project is "planned, located, designed, and engineered for the changing water levels and associated impacts that might occur over the life of the development."¹⁷¹ Applications must also consider the future and "anticipate the migration and natural adaptation of coastal resources (beaches, access, wetlands, etc.) due to future sea level rise conditions in order to avoid future impacts to those resources from the new development."¹⁷² Applicants, accordingly, have to assess the impact of sea level rise on the project, *and* the impact of the project on sea level rise. With respect to the latter, if the project impacts coastal resources, or is expected to with sea level rise, the applicant must consider mitigation alternatives.¹⁷³ Decisionmakers can use the CDP process as a land use adaptation device that may restrain private property rights (albeit on a small scale vis-à-vis individual permits) to minimize present and future sea level rise harm to both property owners and the public.

Communities' analyses and assessments will assist decisionmakers in developing tailored adaptation strategy options designed to protect and preserve private and public property. This work also facilitates collaborative plans with adjacent communities, agencies, and utility providers. The next Section will describe the most common adaptation strategies, and the challenges and benefits of discrete strategies.

169 See CCC SLR *Vulnerability Synthesis*, *supra* note 91, at 22–23.

170 Criteria include whether the property is: "Currently in or adjacent to an identified floodplain; Currently or has been exposed to flooding or erosion from waves or tides; Currently in a location protected by constructed dikes, levees, bulkheads, or other flood-control or protective structures; On or close to a beach, estuary, lagoon, or wetland; On a coastal bluff with historic evidence of erosion; [or] Reliant upon shallow wells for water supply." See CCC SLR *Policy Guidance*, *supra* note 3, at 99.

171 *Id.*

172 *Id.*

173 *Id.* at 106 ("[A]pplicants should analyze how sea level rise will affect coastal resources now and in the future so that alternatives can be developed . . . to minimize the project's impacts to coastal resources throughout its lifetime.").

B. ADAPTATION STRATEGIES

Sea level rise adaptation strategies typically fall into one of three categories: protect, accommodate, and retreat.¹⁷⁴ The most effective plans combine all three strategies, with short-, middle-, and long-term components. In California, “[d]ecisions on which protection measure to implement are left in the hands of local coastal programs and the California Coastal Commission . . . where considerations are made for the profile of the beach, the nature of landward development, and the desired adaptation result.”¹⁷⁵ Updated LCPs provide guidance, recommendations, and requirements. Decisions about discrete CDPs also serve as implementation devices. Beyond the local level, state and federal laws and regulations can directly influence adaptation choices. Albeit more indirectly, property-related businesses like insurance and real estate finance also impact adaptation options. This Section describes the strengths and weaknesses of different adaptation strategies, some of which require more political will than most elected officials can muster.¹⁷⁶

1. PROTECT

In sea level rise parlance, “protect” means to safeguard existing development or infrastructure through some type of reinforcement.¹⁷⁷ The two most common protective devices are “hard armoring,” which involves non-native, constructed materials,¹⁷⁸ and “soft armoring,” which re-directs the natural environment.¹⁷⁹

a. HARD ARMORING

“Hard armoring” refers to engineered structures, such as seawalls, revetments, and bulkheads, that defend against coastal hazards like wave impacts, erosion, and flooding.¹⁸⁰ It is utilized mostly along coastal cliffs and bluffs, which make up most of California’s coastline.¹⁸¹ Blufftop property owners can obtain permits for hard armoring to protect *existing* structures,¹⁸² which includes those that pre-date the Coastal Act.¹⁸³ Hard

174 Jessica Grannis, *Adaptation Tool Kit: Sea-Level Rise and Coastal Land Use*, GEORGETOWN CLIMATE CTR. (Oct. 2011), https://www.georgetownclimate.org/files/report/Adaptation_Tool_Kit_SLR.pdf [hereinafter *Adaptation Tool Kit*] (providing an overview of adaptation tools, their strengths, weaknesses, and potential challenges).

175 See *Economic Costs of SLR*, *supra* note 766, at 42.

176 There is much literature on each discrete adaptation tool, and, given those resources, this Section merely provides an overview of each described tool.

177 See CCC SLR Policy Guidance, *supra* note 3, at 123.

178 *Id.*

179 *Id.*

180 *Id.*

181 See Meg Caldwell & Craig Holt Segall, *No Day at the Beach: Sea Level Rise, Ecosystem Loss, and Public Access Along the California Coast*, 34 *Ecology Law Quarterly* 533, 539 (2007) [hereinafter *No Day at the Beach*] (“Approximately 72% of California’s coastline consists of steep cliffs or bluffs.”).

182 See CAL. PUB. RES. CODE § 30235 (West 2020) (“Revetments, breakwaters, groins, harbor channels, seawalls, cliff retaining walls, and other such construction that alters natural shoreline processes shall be permitted when required to . . . protect existing structures . . . in danger from erosion and when designed to eliminate or mitigate adverse impacts on local shoreline sand supply.”).

armoring became a much more accessible adaptation tool for a while, as it was available to protect any structure in place when one applied for a permit, but that broad interpretation was widely criticized,¹⁸⁴ and the Coastal Commission obliquely admitted that its expansive interpretation of “existing” was in error. Although it has not legislatively renounced its broader interpretation, “going forward, the Commission recommends the rebuttable presumption that structures built after 1976 pursuant to a coastal development permit are not ‘existing’ as that term was originally intended relative to applications for shoreline protective devices”¹⁸⁵ Accordingly, seawalls are now only available to protect structures that pre-date the Coastal Act, with some exceptions.¹⁸⁶

In certain situations, property owners can get emergency permits (“EPs”) for hard armoring, so long as no permanent structures valued at more than \$25,000 are constructed.¹⁸⁷ Even though armoring built through EPs is supposed to be temporary, given property law’s dislike of waste, after seawalls are constructed, it is not likely they will be removed.¹⁸⁸

Once these emergency structures are in place, it is often difficult to remove them from a physical, financial, or political standpoint. Physically, these structures are in locations inherently exposed to high wave action and can often increase erosion to neighboring properties. Financially, the placement and removal can cost several hundred thousand dollars, depending on the size and style. Politically, the removal of structures intended to protect people and property from dangerous high-energy storm events can be extremely unpalatable.¹⁸⁹

The increased frequency of major weather events, the expectation those events will get worse with climate change, and landowners’ natural instinct to protect themselves and their property, will cause emergency requests for seawalls to proliferate.¹⁹⁰ Thus, it is

183 *Id.*; see also Todd Cardiff, *Conflict in the California Coastal Act: Sand and Seawalls*, 38 Cal. West. L. Rev. 255, 263 (2001). For many years, the Coastal Commission interpreted “existing” to include any existing structure at the time one applied for a hard-armoring permit. See, e.g., Molly Loughney Melius et al., *Managing Coastal Armoring and Climate Change Adaptation in the 21st Century*, STANFORD L. SCH. 16 (2015) [hereinafter *Managing Coastal Armoring*] (“[T]he Coastal Commission has . . . often interpreted “existing” to mean structures that existed at the time the application for shoreline armoring was made. Consequently, the universe of development subject to “grandfathering” under Section 30235 was substantially expanded to include any shoreline development that the Coastal Commission had approved.”).

184 See, e.g., *Managing Coastal Armoring*, *supra* note 183, at 16; Cardiff, *supra* note 183; Jesse Reiblich & Eric H. Hartge, *The Forty-Year-Old Statute: Unintended Consequences of the Coastal Act and How They Might Be Redressed*, 36 Stan. Env’t L. J. 63, 69 (2016) (“[T]he debate over the intended meaning of “existing” in Section 30235 is expected to continue short of legislative or judicial action on the subject.”).

185 CCC SLR Policy Guidance, *supra* note 3, at 166.

186 See, e.g., Reiblich & Hartge, *supra* note 184, at 81.

187 CAL PUB. RES. CODE § 30611 (West 2020).

188 See Reiblich & Hartge, *supra* note 184, at 82.

189 *Id.* at 84.

190 See *id.* at 65.

important to have viable alternatives with fewer downsides and a legally sound response for denying permits.

There is one more loophole that allows new seawalls and bypasses a California Environmental Quality Act (“CEQA”) review:¹⁹¹ geological hazard abatement districts (“GHADs”).¹⁹² GHADs can be formed for the “[p]revention, mitigation, abatement, or control of a geologic hazard”¹⁹³ and for “[m]itigation or abatement of structural hazards that are partly or wholly caused by geologic hazards.”¹⁹⁴ Savvy property owners can characterize cliff erosion and bluff destabilization as geologic hazards, thus necessitating seawalls to mitigate or abate structural hazards and opening the door to GHAD creation. Landowners with resources (which describes most coastal property owners) have both the incentive and the means to create GHADs for the purpose of building seawalls.¹⁹⁵ If successful, they can get around CEQA¹⁹⁶ and avoid an in-depth analysis of the impact of seawalls on the underlying and surrounding property and environment and less harmful alternatives.¹⁹⁷

Even with sea level rise dangers, people continue to build structures on blufftop properties, which will eventually be at risk from erosion or collapse.¹⁹⁸ Seawalls remain a go-to protective device, and property owners will continue to seek them to protect themselves and their expensive real estate.¹⁹⁹ “Coastal landowners in California are building seawalls at an alarming rate. Currently, shoreline armoring occupies between 130 and 150 miles of California’s 1,100-mile coastline.”²⁰⁰ For property owners with or seeking hard armoring, it probably seems like a necessity, and there are direct benefits as it temporarily protects those properties.²⁰¹ In fact, when the Coastal Commission approves hard armoring, it is typically because it is the only viable option which provides adequate protection.²⁰² Given the availability and precedent of hard armoring, property owners

191 Normally CEQA reviews are required in connection with any proposed projects, subject to various exemptions and exceptions. See generally CAL. PUB. RES. CODE § 21080 (West 2020); see also Reiblich & Hartge, *supra* note 184, at 85 (describing how GHADs circumvent CEQA review).

192 See CAL. PUB. RES. CODE § 26525 (West 2020).

193 *Id.*

194 *Id.*

195 See *Managing Coastal Armoring*, *supra* note 183, at 22; see also *California GHADs*, CAL. ASSOC. OF GHADs (Feb. 2020), <http://ghad.org/wp-content/uploads/2020/02/GHAD-CA-Map.jpg> (depicting a map of existing GHADs in California).

196 See CAL. PUB. RES. CODE § 21080(b)(4) (West 2020) (exempting “[s]pecific actions necessary to prevent or mitigate an emergency”).

197 See *Managing Coastal Armoring*, *supra* note 183, at 22 (describing how GHADs avoid CEQA review and the negative consequences of such an end run).

198 Cardiff, *supra* note 183, at 255.

199 *Id.*

200 *Id.* (footnotes omitted); see also *Managing Coastal Armoring*, *supra* note 183, at 3 (“Coastal armoring now occupies . . . 33 percent of the southern California coastline.”).

201 See Cardiff, *supra* note 183, at 255.

202 See, e.g., *Staff Report: CDP Hearing*, CAL. COASTAL COMM’N 31 (Mar. 29, 2019), <https://documents.coastal.ca.gov/reports/2019/4/W19a/W19a-4-2019-report.pdf> (“Thus, there do not appear to be feasible non-armoring (or ‘soft’) alternatives that could be applied in this

may believe they are entitled to it; thus, there may be increased demand as sea level rise (and its related storm and high tide impacts) creates ongoing coastal hazards.²⁰³

For all the benefits a few property owners receive through hard armoring, there are major downsides. While effective as short-term protection for existing development, hard armoring creates serious long-term problems, which are exacerbated by sea level rise, including beach diminishment, reduced beach access, damage to ecosystems, and proliferation of armoring necessitated by adjacent armoring.²⁰⁴ Shoreline armoring leads to the loss of one of California's greatest assets—beaches.²⁰⁵ “Put simply, when placed on an eroding or retreating beach, armoring structures will cause that beach to narrow and eventually disappear.”²⁰⁶ If California loses its beaches, it will lose a key part of its identity,²⁰⁷ and billions of dollars' worth of revenue. Gross state product for the California Coastal Tourism and Recreation Sector was \$22.4 billion in 2000 dollars.²⁰⁸ Those numbers would drop dramatically if California's beaches disappear, which would be disastrous for tourism and the coastal economy. Armoring also limits beach access,²⁰⁹ which is antithetical to the public trust doctrine and the Coastal Act mandate to provide coastal access to all.²¹⁰ Besides leading to sand diminishment and shrinking beaches, “armoring

case to protect the existing structures currently in danger from erosion, and therefore, hard armoring alternatives must be considered.”).

203 See *No Day at the Beach*, *supra* note 181, at 534 (“Battering winter storms and high tides have and will continue to cause bluff collapse and the loss of structures built upon bluffs. Property owners, if allowed to do so, will attempt to forestall the inevitable with seawalls, rock revetments, and other barriers to the sea. But these walls, through temporarily freezing the coast in place, will have significant social and ecological costs.”).

204 See generally *id.*

205 See *What is Shoreline Armoring?*, NAT'L OCEANIC & ATMOSPHERIC ADMIN. (Nov. 13, 2019), <https://oceanservice.noaa.gov/facts/shoreline-armoring.html> (“Armored shorelines can prevent sandy beaches, wetlands, and other intertidal areas from moving inland as the land erodes or sea levels rise, but they also have the potential to eliminate habitat for marine organisms and beach front for the public by restricting the natural movement of sediments.”); CCC SLR Policy Guidance, *supra* note 3, at 123 (“[H]ard structures form barriers that impede the ability of natural beaches and habitats to migrate inland over time. If they are unable to move inland, public recreational beaches, wetlands, and other habitats will be lost as sea level continues to rise.”).

206 *Managing Coastal Armoring*, *supra* note 183, at 3; see also *No Day at the Beach*, *supra* note 181, at 541.

207 See, e.g., Annie Sneed, *Sunken Pleasure California Will Need Mountains of Sand to Save Its Beaches*, *Sci. Am.* (Apr. 18, 2017), <https://www.scientificamerican.com/article/sunken-pleasure-california-will-need-mountains-of-sand-to-save-its-beaches/>. Besides, many of the Beach Boys' songs would be meaningless if there were no California beaches (i.e., Surfing USA and Surfing Safari).

208 Judith Kildow & Charles S. Colgan, *California's Ocean Economy*, NAT'L OCEAN ECON. PROGRAM 103 (July 2005), http://www.opc.ca.gov/webmaster/ftp/pdf/docs/Documents_Page/Reports/CA_Ocean_Econ_Report.pdf; see also Cardiff, *supra* note 183, at 2 (“Beaches are vital to California's economy, generating fourteen billion tourism dollar per year [as of 1999].”).

209 *No Day at the Beach*, *supra* note 181, at 540.

210 See *What is the Public Trust Doctrine?*, CAL. STATE LANDS COMM'N, <https://www.slc.ca.gov/public-engagement/> (last visited Nov. 27, 2020) (“The Public Trust provides that tide and submerged lands . . . are to be held in trust by the State for the benefit of the people of

structures are physical barriers that restrict the public's access to the beach (vertical access) or along the beach (lateral access).²¹¹ Thus, armoring that protects individual properties, does so at the cost of limiting coastal access for the larger public population.

Hard armoring also takes a toll on the natural environment, sometimes irreversibly. Shrinking beaches negatively influence neighboring eco-systems and will "reduce and eliminate intertidal . . . and supratidal . . . sandy beach habitats, thereby impacting shorebirds and coastal flora and fauna."²¹² In addition, like a disease, hard armoring is contagious—once seawalls are built to protect one property, they re-direct wave impacts to neighboring properties.²¹³ "[W]ave action diffracting around the edges of seawalls during storms or high tides increases the erosion at the margins of the seawalls. These 'end effects' increase the vulnerability of neighboring properties and lead to the need for more armoring."²¹⁴ This causes adjacent property owners to seek protection.²¹⁵ A slippery slope of more seawalls follows, creating the need for even more seawalls and resulting in a quicker loss of beaches and a greater toll on the environment.

Finally, hard armoring is expensive to build and maintain.²¹⁶ "California seawalls range from \$6,200 to \$10,000 per foot—up to \$56 million per mile—with significant annual maintenance costs."²¹⁷ While property owners foot much of the bill for their seawalls, the public also pays. The initial capital costs (in 2010) for coastal armoring at Torrey Pines and Zuma beaches were \$68.5 million and \$92.9 million dollars, respectively, with annual maintenance thereafter of \$2.1 million and \$2.3 million, respectively.²¹⁸ Armoring costs to protect transportation and infrastructure are likewise exorbitant.²¹⁹ According to one study, by 2040, climate change and sea level rise will cost the U.S. \$400 billion just for seawalls to protect infrastructure.²²⁰ California is looking at a price tag of \$22 billion, and is expected to have 1,785 miles of seawalls.²²¹ The public ultimately subsidizes the construction and maintenance of seawalls, which may provide short term protection, but eventually causes more harm than good.²²²

California."). Moreover, one of the Coastal Act goals is to "[m]aximize public access to and along the coast and maximize public recreational opportunities in the coastal zone consistent with sound resource conservation principles and constitutionally protected rights of private property owners." CAL. PUB. RES. CODE § 30001.5(c) (West 2020).

211 *Managing Coastal Armoring*, *supra* note 18383, at 9.

212 *Id.* at 10.

213 See Cardiff, *supra* note 183, at 260.

214 *Managing Coastal Armoring*, *supra* note 183, at 9; see also Cardiff, *supra* note 183, at 260 ("Studies have shown that the rate of erosion to the shoreline adjacent to a seawall will actually increase due to wave reflection and increased wave energy surrounding a seawall.").

215 See, e.g., *Managing Coastal Armoring*, *supra* note 183, at 8 ("Because seawalls can cause increased erosion on neighboring properties, the construction of one seawall will often lead to the need for others.").

216 *Id.*

217 *Id.* at 29.

218 See *Economic Costs of SLR*, *supra* note 76, at 59.

219 *Id.* at 32.

220 Sverre LeRoy et al., *High Tide Tax: Sea-Level Rise Cost Study*, CTR. CLIMATE INTEGRITY (June 2019), https://climatecosts2040.org/files/ClimateCosts2040_Report.pdf

221 *Id.* at 11 tbl. 1.

222 See *Managing Coastal Armoring*, *supra* note 183, at 26.

Hard armoring admittedly provides some limited protection, but “[a] fortified coast comes with major financial, social and ecological costs.”²²³ However, for property owners and under certain circumstances, it seems like the only option:

There are situations . . . where armoring may be lawfully allowed and may represent a reasonable short- to mid-term adaptation strategy . . . This may be especially true in urbanized areas where existing residential development and/or critical infrastructure exist, where development is already protected by armoring, where the impacts of armoring on natural shoreline processes will be minimal due to the geology of the area and where the armoring is the least environmentally damaging alternative for adaptation.²²⁴

In those cases, hard armoring should be designed to minimize impacts. To the extent negative effects are inevitable, cities can impose mitigation steps or fees, which can be used to offset those effects “through options such as providing equivalent new public access or recreational facilities or undertaking restoration of nearby beach habitat. If such options are not feasible, proportional in-lieu fees that consider the full value of the beach—including with respect to impacts on shoreline sand supply, sandy beaches, public recreational access, public views, natural landforms, beach ecology, and water quality—may be used as a vehicle for impact mitigation”²²⁵ As sea level rises and is exacerbated by major storm events and high tides, there will undoubtedly be more hard armoring requests, and decisions should be guided by the concerns laid out in this Section. Alternatives, which concededly do not provide as much protection for property owners, have fewer drawbacks—including soft armoring, which will be discussed next.

b. SOFT ARMORING

“Soft’ armoring refers to the use of natural or ‘green’ infrastructure like beaches, dune systems, wetlands, and other systems to buffer coastal areas.”²²⁶ There are different ways to soft armor, including “preservation or restoration of dunes, wetlands and other coastal habitats [that] . . . leverage[] natural processes to reduce risk to human lives, property and infrastructure by providing a buffer against storm surge and increased wave action, thus reducing shoreline impacts and coastal erosion.”²²⁷ Soft armoring is attractive because it obviates the need for more extreme measures like hard armoring or managed retreat.²²⁸ In addition, it is, at least initially, cheaper than hard armoring,²²⁹ easier to maintain, more compatible with the environment, and does not create a domino

223 See *No Day at the Beach*, *supra* note 181, at 539.

224 See RESIDENTIAL ADAPTATION POLICY GUIDANCE, CAL. COASTAL COMM’N 34 (2018).

225 *Id.* at 71.

226 CCC SLR Policy Guidance, *supra* note 3, at 123; see also *Adaptation Tool Kit*, *supra* note 174.

227 See STATE OF CALIFORNIA SEA-LEVEL RISE GUIDANCE, CAL. NAT. RES. AGENCY 3 (2018).

228 See CCC SLR Vulnerability Synthesis, *supra* note 91, at 9 (“Some communities may have the opportunity to use regional sediment management and beach nourishment efforts to maintain beach area, possibly for many decades, without the need for allowing beaches to migrate inland through such adaptation strategies as managed retreat of development.”).

229 See James G. Titus et al., *Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*, U.S. CLIMATE CHANGE SCIENCE PROGRAM 94 (Jan. 2009), <https://www.globalchange.gov/sites/globalchange/files/sap4-1-final-report-all.pdf> [hereinafter *Coastal Sensitivity to SLR*] (“The initial cost for these projects is often significantly less than

effect of generating the need for more armoring of neighboring properties.²³⁰ Given that it has fewer overall downsides, it is a preferred strategy over hard armoring.

For all of its benefits, soft armoring is not problem-free.²³¹ First, it is temporary because imported sand will eventually meet the same fate as the sand it is replacing.²³² Second, imported sand will not have the exact same composition as native sand, which can disrupt the native environment.²³³ “While nourishment can create wider dry sand zones, the ecological value of nourished shorelines is not likely to scale with dry beach width. In addition, nourishment can cause disturbances and mortality of intertidal fauna associated with fill activities Recovery of ecological value of beaches may take years, even decades in some cases.”²³⁴ Third, there is a limited supply of sand to nourish depleted beaches.²³⁵ Fourth, while much cheaper than hard armoring, soft armoring is

for bulkheads or revetments; the long-run cost can be greater or less depending on how frequently the living shoreline must be rebuilt.”).

230 See STATE OF CALIFORNIA SEA-LEVEL RISE GUIDANCE, *supra* note 227, at 30. Soft armoring has “been shown in many cases to be low maintenance, cost-effective and adaptive to changing conditions. Additionally, natural infrastructure provides multiple benefits beyond flood protection including public access, habitat for wildlife and improved water quality, thereby building resilience while improving overall ecological function of coastal systems.” *Id.*

231 See generally *Beach Nourishment*, UNIV. OF CAL., <http://explorebeaches.msi.ucsb.edu/beach-health/beach-nourishment> (last visited Nov. 27, 2020) (“Nourishment is not a long-term solution to beach erosion. The erosive forces of waves, storms, and rising sea levels do not disappear after nourishment takes place. Waves will continue to ‘chew on’ the sand, and eventually it erodes away, moving down the coast and offshore. Therefore, nourishment can protect coastal structures for as long as the sand lasts, but after a certain period of time, the beach will have to be renourished. The associated price tag can be quite high.”).

232 See E. Research Grp., *What Will Adaptation Cost? An Economic Framework for Coastal Community Infrastructure*, NAT’L OCEANIC & ATMOSPHERIC ADMIN. A-8 (June 2013), <https://coast.noaa.gov/data/digitalcoast/pdf/adaptation-report.pdf> (“Beach nourishment is a short-term solution that protects people and property by decreasing the energy of waves and limiting how far inland storm surges travel. Beaches must be supplemented with additional quantities of sand every few years, however, for this measure to continue to be effective.”); see also *Economic Costs of SLR*, *supra* note 76, at 43 (“Beach nourishment projects are vulnerable to wave energy, primarily in winter months, that displaces sediment both offcoast and downshore.”).

233 See *Coastal Sensitivity to SLR*, *supra* note 229, at 98 (“Beach nourishment affects the environment of both the beach being filled and the nearby seafloor ‘borrow areas’ that are dredged to provide the sand. Adding large quantities of sand to a beach is potentially disruptive to [native species] that nest on dunes and to the burrowing species that inhabit the beach . . . though less disruptive in the long term than replacing the beach and dunes with a hard structure. The impact on the borrow areas is a greater concern . . .”).

234 *Economic Costs of SLR*, *supra* note 76, at 43.

235 See, e.g., *id.*; David Greene, *World Faces Global Sand Shortage*, NPR (July 1, 2017), <https://www.npr.org/2017/07/21/538472671/world-faces-global-sand-shortage>.

still costly.²³⁶ Fifth, soft armoring does not provide the same degree of protection to existing structures as hard armoring.

In sum, soft armoring is not always viable and does not always provide sufficient protection for existing structures and infrastructure. In addition, it is newer, so not many studies on its long-term effectiveness have been conducted.²³⁷ Thus, it cannot be solely relied upon as an adaptation strategy; it is simply one tool in the adaptation toolbox. Nonetheless, soft armoring is a viable adaptation tool, which allows ocean movement inland to coincide with sea level rise. In the event soft armoring alone does not provide sufficient protection, it can be combined with other adaptation tools as part of a suite of protective devices.

2. ACCOMMODATE

The first set of accommodation tools aim to mitigate sea level rise by attaching appropriate conditions, fees, or exactions (“Development Conditions”) to discrete projects. “[A]ccommodation strategies include actions such as elevating structures, retrofits and/or the use of materials meant to increase the strength of development, building structures that can easily be moved and relocated, or using extra setbacks.”²³⁸ A comprehensive discussion of Development Conditions is beyond this article’s scope, but the reader should be familiar with some common conditions. For high-hazard blufftop properties, a city can condition permit approval on designating the highest hazard land closest to the bluff as an undevelopable conservation easement,²³⁹ or, at a minimum, it can impose safe setbacks far enough back “to account for the amount of erosion anticipated over the life of the development, plus an additional setback to ensure structural stability under future conditions.”²⁴⁰ This type of Development Condition responds to sea level rise threats by removing land at the highest risk of bluff collapse or erosion from development, thus protecting people and structures. Another common Development Condition for blufftop properties is a no future armoring (“NFA”) clause, which the California Coastal Commission already routinely includes in CDPs.²⁴¹ This sends a clear message to property owners that they will not be allowed to build seawalls, and they assume the risk of developing in a high-hazard coastal area. It also provides constructive notice to others.

Cities can mandate that new construction and accompanying infrastructure be designed to be more resistant to sea level rise impacts like flooding and erosion. “For exam-

236 See *What Will Adaptation Cost?*, *supra* note 232, at A-8 (“Beach nourishment is a fairly expensive mitigation measure, generally costing between \$300 and \$1,000 per linear foot, including material, transportation, and construction costs.”).

237 See generally CCC SLR Policy Guidance, *supra* note 3, at 123.

238 *Id.* at 124.

239 See *infra* Section 3 (discussing managed retreat and describing conservation easements).

240 RESIDENTIAL ADAPTATION POLICY GUIDANCE, *supra* note 224, at 61.

241 *Id.* at 73 (“As a condition of approval . . . for new development or redevelopment on a beach, shoreline, bluff, or other area subject to coastal hazards, applicants shall be required to acknowledge and agree that no bluff or shoreline protective device(s) shall ever be constructed to protect the approved development, including if it is threatened with damage or destruction from coastal hazards in the future. . . . [A]pplicants shall also waive any rights to construct such devices that may exist under applicable law. Private property owners shall be required to record that acknowledgement, agreement, and waiver in a deed restriction.”).

ple, permits could require that roads be elevated and that sewer lines be flood protected.²⁴² Coastal communities routinely insert language about sea level rise in their permits and extra steps to mitigate against associated risks. One permit to build an oceanfront home in Seal Beach, California, included sea level rise related special conditions:

1. Assumption of Risk, Waiver of Liability and Indemnity. By acceptance of this permit, the applicant(s) acknowledges and agrees (i) that the site may be subject to hazards from . . . SEA LEVEL RISE; (ii) to assume the risks to the applicant(s) and the property that is the subject of this permit of injury and damage from such hazards in connection with this permitted development; (iii) to unconditionally waive any claim of damage or liability . . .; and (iv) to indemnify and hold harmless the Commission, its officers, agents, and employees with respect to the Commission's approval of the project against any and all liability, claims, demands, damages, costs (including costs and fees incurred in defense of such claims), expenses, and amounts paid in settlement arising from any injury or damage due to such hazards. . . .

2. No Future Shoreline Protective Device.

A. By acceptance of this permit, the applicant(s) agrees . . . that no shoreline protective device(s) shall ever be constructed to protect the development . . . including, but not limited to, the residence, garage, foundations, swimming pool and spa, patio, and any future improvements, in the event that the development is threatened with damage or destruction from . . . SEA LEVEL RISE, or other natural hazards in the future. By acceptance of this permit, the applicant(s) and landowner(s) hereby waives . . . any rights to construct such devices . . .

B. By acceptance of this permit, the applicant(s) further agrees . . . that the landowners shall remove the development authorized by this permit, including the residence, garage, foundations, and patio, if any government agency has ordered that the structure is not to be occupied due to any of the hazards identified above.²⁴³

Coastal cities everywhere can incorporate these types of clauses into high-hazard coastal areas' CDPs. They can also more efficiently address vulnerabilities by adding requirements of this nature to ordinances and building codes, rather than imposing them on a property-by-property basis. In fact, the second set of accommodation strategies does just that by modifying citywide planning tools in anticipation of sea level rise. Coastal communities can incorporate accommodation strategies when developing or updating their LCPs, building codes, and hazard mitigation plans, and when preparing vulnerability assessments.²⁴⁴ “[Z]oning can prevent or limit development in exposed areas, ensure that new development does not increase the severity of flooding, and require that new

242 See *Adaptation Tool Kit*, *supra* note 17474, at 30.

243 ADMINISTRATIVE PERMIT NO. 5-16-0123, CAL. COASTAL COMM'N 5-6 (2016) (emphasis added).

244 See CCC SLR *Vulnerability Synthesis*, *supra* note 91, at 20 (“Communities in Santa Cruz, Ventura and Los Angeles Counties . . . along with some communities in Orange County, are . . . considering revised standards for future shoreline protection.”).

and renovated structures incorporate flood-resilient features. Local ordinances must, at a minimum, comply with federal requirements for developing within floodplains, and many zoning ordinances already include measures related to flood-hazard areas.”²⁴⁵ Municipalities can downzone high-hazard coastal land to mitigate anticipated sea level rise as discussed in the next subsection on managed retreat, allowing owners to make some limited property uses, while reducing sea level threats to the extent practicable.²⁴⁶

Zoning designations are an effective way to limit new development in high-hazard coastal areas, but additional action is required to address existing uses. When cities update zoning ordinances to limit development, many current uses will become non-conforming uses (“NCUs”).²⁴⁷ Typically, NCUs are grandfathered in and allowed to remain in place.²⁴⁸ However, there are several exceptions, and NCUs may be terminated in many ways.²⁴⁹ Moreover, existing NCUs are subject to severe limitations on expansion, improvement, and modification.²⁵⁰ When cities rezone as an accommodation tool, they should explicitly legislate that existing uses that become NCUs as a result of rezoning cannot be expanded or improved, or rebuilt following damage or destruction.²⁵¹

“Accommodation” regulations include setbacks and other buffers, density rules, development or mitigation fees, elevation requirements, and use of resilient materials.²⁵² The Coastal Commission recommends ensuring “structures are set back far enough in-

245 See *What Will Adaptation Cost?*, *supra* note 232, at A-20.

246 Such downzoning might be challenged, but should be upheld under the police power because it would minimize future sea level rise related risks to people and property. See *infra* Part V.

247 See *Zoning and Nonconforming Uses*, PLANNING & ZONING RES. CO., <https://www.pzr.com/articles/zoning-non-conforming-use> (last visited Nov. 27, 2020).

248 See *generally id.* San Diego’s provisions are fairly typical: “A previously conforming structure can continue as it currently exists. No changes to the structure are required. The structure can be sold and continue as it currently exists.” *Previously Conforming Uses - Fact Sheet*, CITY OF SAN DIEGO 1, <https://www.sandiego.gov/sites/default/files/legacy/redevelopment-agency/pdf/grantvillepdf/pcusfactsheet.pdf> (last visited Nov. 27, 2020); see also SAN DIEGO MUNICIPAL CODE §§ 127.0101–127.0111 (2016).

249 See *Elimination of Nonconforming Uses*, AM. PLANNING ASS’N (May 1949), <https://www.planning.org/pas/reports/report2.htm> (describing NCU termination). For example, cities can order NCUs terminated following a reasonable amortization period sufficient to allow owners to recoup their investments. See *generally Non-Conforming Users*, ELISABETH HAUB SCH. OF L., <https://law.pace.edu/non-conforming-users> (last visited Nov. 27, 2020).

250 See *Elimination of Nonconforming Uses*, *supra* note 249 (“The most commonly accepted restriction is that no non-conforming use may be extended. . . . Other restrictions include those of limiting the alterations or repairs that may be made in a non-conforming building; prohibiting rebuilding or reconstruction of buildings damaged to a specified extent in cases of fire, flood, or similar cause; refusing to allow a non-conforming use to be reestablished once a more highly restricted use has been substituted, and refusing to permit a re-establishment of a use if the use or building has been discontinued or abandoned for a specified period of time.”).

251 Additionally, updated zoning and ordinances should specifically establish more narrow rules for NCUs in high-hazard coastal zones to minimize property owners’ ability to change their use.

252 See, e.g., Herzog & Hecht, *supra* note 8, at 475–76; CCC SLR Policy Guidance, *supra* note 3, at 124.

land from the beach or bluff edge such that they will not be endangered by erosion (including sea level rise induced erosion) over the life of the structure, *without the use of a shoreline protective device*.²⁵³ Coastal communities can establish “super setback” regulations for properties in high hazard zones, which can be justified as a way to protect persons and property.²⁵⁴ Newport Beach adopted waterfront development resiliency standards, which can be a model for similarly situated coastal cities.²⁵⁵ In addition to super setbacks, they may require a higher floor elevation in new construction, and “additional standards for waterfront development to promote sea level rise resiliency, including: to minimize, and where feasible, avoid shoreline hazards identified in, for example, coastal hazards and/or geologic stability reports.”²⁵⁶ In addition to fortifying construction standards, Newport Beach shifts responsibility and risk acknowledgment to the property owner.²⁵⁷ Its suite of adaptation regulations is effective because it protects against the risks of sea level rise, yet still allows for productive use of the property with suitable restrictions.

Some accommodation strategies are implemented through Development Conditions on a case-by-case basis in response to specific CDPs, while others are incorporated into codes, ordinances, policies, and guidance documents with city-wide application. Regardless of the accommodation tool or how it is implemented, accommodation options prepare for sea level rise through Development Conditions promoting resilience, thoughtful zoning, and updated building standards to minimize threats and enhance strength while respecting property rights.

3. RETREAT

Managed retreat, the most controversial of the adaptation strategies, involves prohibiting development in high hazard coastal zones, or requiring removal or relocation of buildings upon defined benchmarks, thus allowing oceans to naturally move inland with sea level rise.²⁵⁸ Coastal property owners have been very vocal in their opposition to managed retreat, urging their elected officials to exclude it from their communities’

253 See CCC SLR Policy Guidance, *supra* note 3, at 129 (emphasis in the original).

254 See James G. Titus, *Rolling Easements*, ENV’T PROT. AGENCY 4 (June 2011), <https://www.epa.gov/sites/production/files/documents/rollingeasementsprimer.pdf> [hereinafter *Rolling Easements*] (“Landowners tolerate setbacks as long as they can build somewhere on their property. Thus, setbacks can be practical where parcels are large or the land is steep enough so that each lot can have a building site high enough to be safe for the next few centuries.”).

255 See *Consideration of Sea Level Rise in Recent LCP Updates: Newport Beach Case Study*, CAL. COASTAL COMM’N 139 (Feb. 24, 2017), https://documents.coastal.ca.gov/assets/climate/slr/vulnerability/FINALCaseStudy_Newport.pdf.

256 *Id.*

257 See *id.* The code requires “the property owner/applicant to acknowledge any hazards present at the site, assume the risk of injury and damage from such hazards, and unconditionally waive any claim of damage or liability against the decision authority from such hazards; to remove nonconforming structures particularly when located on State tidelands or beaches available to the public; and to bring new development and/or replacement structures into conformity with current standards for setbacks from the shoreline, bluff and/or bulkhead.”

Id.

258 *Id.*

LCPs,²⁵⁹ and even going so far as to say it should not be in their vocabulary.²⁶⁰ Although managed retreat is considered one of the key adaptation strategies that should be part of every LCP, given its provocative nature, it has not been universally adopted. One impediment is it involves a long-term view where sea level rise will eventually inundate coastal communities, but not today or tomorrow, making it difficult to convince many of the urgency to plan now. However, with the inevitability of sea level rise, it should be included in all LCPs.

There are numerous ways to implement managed retreat, from prohibiting new development and remodeling that expands current footprints on high hazard coastal land to limiting future hard armoring and seawall repair, and even requiring structure removal upon a triggering event.²⁶¹ The strongest managed retreat mechanism is to prohibit or severely limit new development and expansion in high hazard areas, which municipalities can do through their LCPs. If they do not have the political will or support to designate land as high hazard, states could designate vulnerable coastal areas as high hazard, or federal floodplain definitions can be expanded to include sea level rise components. Although land use is typically a local matter,²⁶² given the pervasiveness of sea level rise impacts on coastal communities everywhere, it is logical to have uniform high hazard coastal zone definitions within national floodplain designations. FEMA could establish these zones as they already do with special flood hazard areas.²⁶³ While flooding

259 See, e.g., *supra* text accompanying notes 163–65 (describing how this experience transpired in Del Mar, California); see also ESA, *City of Del Mar Sea-Level Rise Adaptation Plan*, CITY OF DEL MAR 24 (May 21, 2018), <http://www.delmar.ca.us/DocumentCenter/View/3580/Revised-Adaptation-Plan-per-Council-May-21>; *Economic Costs of SLR*, *supra* note 76, at 44 (“Given the high value of coastal land, coastal property owners are generally affluent and politically organized. In the event that a coastal area is identified for managed retreat, mobilized property owners can exert significant amounts of influence on politicians responsible for approving coastal policy measures.”).

260 “Commissioners suggested they should change the name [“managed retreat”] to make it more palatable, but by any name, retreat means homes are removed so beaches can migrate inland. And that rarely goes down smoothly with homeowners.” Shelia Pell, *Don’t Say Retreat When Talking About Sea Rise In California*, *The San Diego Reader* (July 16, 2019), <https://www.sandiegoreader.com/news/2019/jul/16/stringers-dont-say-retreat-when-talking/>.

261 A triggering event could be landward movement of the mean high tide to a certain point, cliff or bluff collapse or dangerous erosion, or repeated serious flooding. See CCC *SLR Policy Guidance*, *supra* note 3, at 131 (“Triggers for relocation or removal of the structure would be determined by changing site conditions such as when erosion is within a certain distance of the foundation; when monthly high tides are within a certain distance of the finished floor elevation; when building officials prohibit occupancy; or when the wetland buffer area decreases to a certain width.”). The Coastal Commission lists retreat methods as “gradually removing and relocating existing development. Acquisition and buyout programs, transfer of development rights programs, and removal of structures where the right to protection was waived (i.e., via permit condition).” *Id.* at 125.

262 See Richard Grosso, *Planning and Permitting to Reduce and Respond to Global Warming and Sea Level Rise*, 6 *J. Animal & Env’t L.* 41, 45 (2015) (“[W]hile federal funding, permitting and facility and infrastructure siting decisions do influence land use patterns, local and state governments play the dominant role in determining what gets built where.”).

263 See *Flood Zones*, FED. EMERGENCY MGMT. AGENCY, <https://www.fema.gov/flood-zones> (last updated July 7, 2020) (“Flood hazard areas identified on the Flood Insurance Rate Map are

would remain a sea level rise hazard, other hazards could include cliff and bluff collapse and erosion, which undermine structural stability. Once coastal property is designated high hazard, LCPs can limit what can be built in those zones, prohibit future armoring, incorporate appropriate accommodation tools like setbacks, condition permit approval on structure relocation or removal on triggering events, and include waiver and release of liability agreements. While these recommendations would not apply retroactively to existing structures,²⁶⁴ they are part of a powerful suite of tools to prevent future sea level threats against people and property from materializing.

FEMA can also provide guidance on rebuilding policies and limitations for structures damaged in connection with sea level rise. FEMA's national flood insurance program ("NFIP") classifies frequently damaged properties as "repetitive loss properties,"²⁶⁵ which are subject to premium increases if they do not mitigate risks.²⁶⁶ In fact, a disproportionate percentage of NFIP claims are paid out on repetitive loss properties, which "make up less than 1% of all properties insured under the NFIP, but account for 25-30% of all claims, and the number of repetitive loss properties has increased by 50% over the past 10 years."²⁶⁷ Similar statistics may well emerge for sea level rise-related damage to coastal properties if owners are allowed to rebuild after each damaging event. While NFIP only addresses insurability of property and premiums, its model can be modified for sea level rise to provide that if a threshold is met, property would first be subject to premium increases, then eventually could be deemed "uninsurable," and ultimately designated as too hazardous a location for rebuilding.²⁶⁸ A repetitive-loss property program in the sea level rise context could limit property owners' ability to both obtain assistance and insurance, and rebuild following sea level rise-related property damage, after which point no future development is allowed.²⁶⁹

identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood.").

264 See Grosso, *supra* note 262, at 55.

265 See *National Flood Insurance Program: Frequently Asked Questions Repetitive Loss*, FED. EMERGENCY MGMT. AGENCY (Oct. 2005), https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt (defining a repetitive loss property as "any insurable building for which two or more claims of more than \$1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978").

266 *Id.* ("Under the severe repetitive loss pilot program authorized by Flood Insurance Reform Act of 2004, if an offer to mitigate is made and the owner refuses the offer, the premium will increase in the manner authorized in the Act.").

267 See Grosso, *supra* note 262, at 57.

268 The Coastal Commission recommends a repetitive loss program, which would "require properties with Repetitive Loss Structures to be rezoned to less intensive uses that limit reconstruction and to accommodate shoreline migration, increased coastal flooding, inundation, and related sea level rise impacts." See RESIDENTIAL ADAPTATION POLICY GUIDANCE, *supra* note 224, at 80.

269 See *id.*

Rolling easements also provide an effective way to implement managed retreat.²⁷⁰ The Texas Open Beaches Act inspired James Titus to popularize the term “rolling easement” to “describe a broad collection of arrangements under which human activities are required to yield the right of way to naturally migrating shores.”²⁷¹ Rolling easements “are regulatory mechanisms or interests in land that allow wetlands or beaches to migrate inland as sea level rises and thus transfer of the risk of sea level rise from the environment or the public to the property owner.”²⁷² They take different forms, each of which attempts to balance private property rights against public health and safety by allowing continued private property use until specified events occur.²⁷³

Once created, “[a] rolling easement would generally prohibit shore protection [such as hard armoring] and require removal of pre-existing structures seaward of a specific migrating shoreline such as the dune vegetation line, mean high water, or the upper boundary of tidal wetlands.”²⁷⁴ Rolling easements allow property use in the present, thus respecting private property rights, while also protecting against future damage by requiring structure removal upon triggering events.²⁷⁵ This balance reduces initial resistance and is therefore less threatening to property owners. Rolling easements “have the potential to provide effective environmental and social protections, to minimize harm to property owners, to preserve the public fisc, and to shape legal expectations appropriately.”²⁷⁶ Unlike total prohibitions on development, rolling easements allow land use,²⁷⁷ albeit with temporal limits, and once created, they put the world on constructive record notice of the restraint. Accordingly, “[a] rolling easement helps to align a property owner’s expectations with the migrating nature of the shore and if sea level rise is expected, property owners can efficiently prepare for that eventuality.”²⁷⁸ Rolling easements are

270 See Erica Novack, *Resurrecting the Public Trust Doctrine: How Rolling Easements Can Adapt to Sea Level Rise and Preserve the United States Coastline*, 43 B.C. Env’t Aff. L. Rev. 575 (2016) (discussing rolling easements as a tool for sea level rise adaptation).

271 See James G. Titus, *Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches Without Hurting Property Owners*, 57 Md. L. Rev. 1279, 1313 (1998) [hereinafter *Rising Seas, Coastal Erosion, and the Takings Clause*].

272 See LOCAL LAND USE RESPONSE TO SEA LEVEL RISE, NAT’L OCEANIC & ATMOSPHERIC ADMIN. 48 (2020) (citations omitted).

273 See *Rolling Easements*, *supra* note 254, at 41 (“A rolling easement can be either (a) a government regulation that prohibits shore protection or (b) a property right to ensure that wetlands, beaches, barrier islands, or access along the shore moves inland with the natural retreat of the shore.”); see also *Local Land Use Response to Sea Level Rise*, *supra* note 272, at 48 (“When implemented as an interest in land, a rolling easement offers an alternative to the purchase of the property by the government or the negotiation of a conservation easement.”).

274 See *Rolling Easements*, *supra* note 254, at 5.

275 *Id.*

276 J. Peter Byrne, *The Cathedral Engulfed: Sea-Level Rise, Property Rights, and Time*, 73 La. L. Rev. 69, 72 (2012).

277 See LOCAL LAND USE RESPONSE TO SEA LEVEL RISE, *supra* note 272, at 48 (“When rolling easements are implemented as a regulation, they provide an alternative to prohibiting all development in coastal area, which may be politically infeasible, inequitable, or even unconstitutional.”).

278 *Id.*

one of the many land use tools that limit the right to use property; but, because they still allow present property uses, they are not as repugnant as total prohibitions on development and thus may be more palatable.

Another managed retreat tool involves purchasing either high hazard coastal properties or development rights.²⁷⁹ Buyers can then prohibit development altogether or move existing structures.²⁸⁰ Purchase tools are expensive, and even if funds are available, many coastal property owners love the ocean and their homes,²⁸¹ which makes sale of their property or development rights challenging. The first set of acquisition tools entails buying properties in high-hazard zones.²⁸² To facilitate cohesive retreat management, governments, agencies, land trusts,²⁸³ or other non-profit entities can buy high-hazard properties or obtain sea level rise purchase options.²⁸⁴ These can be pricey solutions, because oceanfront property is not cheap. For example, as of November 15, 2020, the median listing price for a beachfront home in San Diego County was \$3,295,000.²⁸⁵ The highest priced home was listed at \$11,999,000.²⁸⁶ While oceanfront homes remain among the most expensive real estate, there is growing recognition that sea level rise has started to impact coastal property prices, with declining values expected to accelerate in the future.²⁸⁷ Even with some coastal values dropping, beachfront real estate remains

279 See Anne Siders, *Managed Coastal Retreat: A Legal Handbook on Shifting Development Away from Vulnerable Areas*, COLUMBIA L. SCH. 109 (2013).

280 *Id.*

281 See Daniel J. DePasquale, *A Pragmatic Proposition: Regionally Planned Coastal TDRs in Light of Rising Seas*, 48 *The Urban Lawyer* 179, 184 (2016) (“Many residents of these communities will likely fight any policy that will force them to move away from not just their homes, but communities with school systems that their children attend, neighbors they have created close bonds with, and numerous other sentimental feelings and memories from the area that they call home.”).

282 *What Will Adaptation Cost?*, *supra* note 232, at A-5 (“Fee-simple acquisition involves the outright purchase of property and all associated development rights. [It] . . . is often used when local governments purchase waterfront properties that are vulnerable to erosion and flooding. In the context of coastal flooding, the purpose of the acquisition is to remove or prevent future development in vulnerable areas and to reduce future damage from coastal flooding.”).

283 See *What Is a Land Trust?*, PENN. LAND TRUST ASS’N, <https://conservationtools.org/guides/150-what-is-a-land-trust> (last visited Nov. 27, 2020) (“A land trust is a charitable organization that acquires land or conservation easements, or that stewards land or easements, to achieve one or more conservation purposes.”); see generally *What We Do*, LAND TRUST ALLIANCE, <https://www.landtrustalliance.org/what-we-do> (last visited Nov. 27, 2020).

284 See generally Richard Turner Henderson, *Sink or Sell: Using Real Estate Purchase Options to Facilitate Coastal Retreat*, 71 *VAND. L. REV.* 641 (2018).

285 See *Beachfront Homes For Sale San Diego*, LUXURY SO CAL REALTY, <https://www.luxurysocalrealty.com/beachfront/> (last visited Nov. 27, 2020).

286 *Id.* The home was in San Diego.

287 Coastal values are already seeing a decline in some areas. See Allison Rebecca Penn, *What Climate Change Means for Coastal Real Estate Values and Property Investors*, ALL PROPERTY MGMT. (June 24, 2019), <https://www.allpropertymanagement.com/blog/post/what-climate-change-means-for-coastal-real-estate-values/> (“As a result of this frequent tidal flooding, sea level rise, and proximity to waterways, many coastal communities have seen real estate values significantly decline.”).

expensive. However, funds for disaster prevention might be available to buy high-hazard coastal properties. FEMA, for example, offers pre-disaster mitigation grants,²⁸⁸ and acquiring land to enable managed retreat and avoid serious property damage and loss of life would fit its criteria. FEMA also has a grant program designed to help state and local governments “rebuild in a way that reduces, or mitigates, future disaster losses in their communities.”²⁸⁹ There have been over 1,485 disaster declarations since 1989, resulting in grants of over \$13.8 billion,²⁹⁰ demonstrating that such declarations are fairly common, and these grants are well-funded. Grants could be used to purchase high-hazard coastal property and relocate structures and occupants.²⁹¹ Land trusts also have resources to purchase high-hazard coastal real estate.²⁹² Because their mission is to acquire land for coastal habitat conservation and preservation,²⁹³ buying land for managed retreat would be appropriate. In California alone, through 2015, land trusts protected almost five million acres of land.²⁹⁴ Coastal property remains expensive, but funds are available to buy high-hazard land.²⁹⁵

Once land is purchased for managed retreat, some acquisition costs can be recouped. Undeveloped property can be rented for ecotourism, weddings, receptions, camping, or other uses compatible with a scenic, oceanfront, largely-undeveloped site. Although it is unlikely income would offset purchase costs or losses to local coffers from declining property tax revenues, it would defray expenses and ease the path towards responsible managed retreat. Moreover, taking a long-term view, any expenses are less than those

288 See *Pre-Disaster Mitigation Grant*, FED. EMERGENCY MGMT. AGENCY, <https://www.fema.gov/pre-disaster-mitigation-grant-program> (last updated Sept. 4, 2020).

289 See *Hazard Mitigation Grant Program (HMGP)*, FED. EMERGENCY MGMT. AGENCY, <https://www.fema.gov/grants/mitigation/hazard-mitigation> (last updated Aug. 6, 2020) (requiring a presidential disaster declaration, which could be forthcoming considering the threat of sea level rise and its disastrous consequences for coastal communities); see generally *Hazard Mitigation Assistance Guidance*, FED. EMERGENCY MGMT. AGENCY (Feb. 27, 2015), https://www.fema.gov/media-library-data/1424983165449-38f5dfc69c0bd4ea8a161e8bb7b79553/HMA_Guidance_022715_508.pdf.

290 *Flood Mitigation*, FLOOD RISK ON THE BEND, <https://floodriskonthebend.com/flood-mitigation/> (last visited Nov. 27, 2020).

291 See *Coastal Sensitivity to Sea Level Rise*, *supra* note 229, at 166 (“From 1985 to 1995 . . . the National Flood Insurance Act helped fund the relocation of homes in imminent danger from erosion FEMA’s Severe Repetitive Loss Program is authorized to spend \$80 million to purchase or elevate homes that have made either four separate claims or at least two claims totaling more than the value of the structure Several other FEMA programs provide grants for reducing flood damages, which states and communities can use for relocating residents out of the flood plain”).

292 See LAND TRUST ALLIANCE, NATIONAL LAND TRUST CENSUS REPORT 3 (2015) (stating that land trusts acquired over 56 million acres of land and managed over \$2.18 billion worth of “endowments and dedicated funding”).

293 See generally *Rising Sea Levels*, LAND TRUST ALLIANCE, <https://climatechange.lta.org/climate-impacts/changing-ocean-systems/rising-sea-levels/> (last visited Nov. 27, 2020).

294 See *National Land Trust Census*, LAND TRUST ALLIANCE (2016), <https://www.landtrustalliance.org/census-map/> (hover over California on the map). California happens to have more land trusts than any other state, making it a good managed retreat partner. See *id.*

295 *Id.*

associated with loss of life and property through sea level rise and major damage events. For developed property, costs can be recovered by creating a stock of rental properties. Vacation rentals are nothing new, but the Airbnb model revolutionized short-term vacation rentals by creating a large inventory, together with a simple protocol for both owners to list their properties, and renters to find a property.²⁹⁶ Take Mission Beach, California, as an example, which “is known for its incredibly long, wide beach”²⁹⁷ and has approximately 3,539 mostly-sea level housing units,²⁹⁸ including many that are beachfront. Mission Beach oceanfront units are regularly available for rent on Airbnb,²⁹⁹ with prices dependent on the size, number of bedrooms, general condition, and location.³⁰⁰ In addition, oceanfront units are available for long term rental, with prices dependent on the same variables.³⁰¹ The City of San Diego, land trusts, or other agencies could offer to buy high-hazard coastal homes in Mission Beach, easing the way for a comprehensive managed retreat strategy for this stretch of sea-level homes that will be inundated with very little sea level rise.³⁰² It is not clear how many homeowners would participate in a voluntary program,³⁰³ but it could be designed to give homeowners the first option to lease their property back. This may be attractive because the homeowner gets fair market value, the city can better control its managed retreat program, and the homeowner is not displaced. Others might see the sea level rise writing on the wall—their sea level properties are at higher risk than higher elevated oceanfront properties—and gladly accept fair market value for homes whose value will gradually decline in the coming years.

296 See generally AIRBNB, <https://www.airbnb.com>; see also Keycafe Team, *The History of Airbnb*, Medium (May 22, 2019), <https://medium.com/keycafe/the-history-of-airbnb-397c3d539f27> (giving background on Airbnb).

297 See *Mission Beach San Diego*, GO SAN DIEGO, <https://www.gosandiego.com/neighborhoods/mission-beach/> (last visited Nov. 27, 2020); *Community Profiles: Mission Beach*, CITY OF SAN DIEGO, <https://www.sandiego.gov/planning/community/profiles/missionbeach> (last visited Nov. 27, 2020) (The Mission Beach community planning area is located on a sand bar peninsula two miles long and up to 1/4 of a mile wide along the western edge of the mid-coastal region of the City of San Diego.).

298 See *Community Profiles: Mission Beach*, *supra* note 297.

299 AIRBNB, *supra* note 296. On June 15, 2020, in the middle of the COVID-19 pandemic, when most of California was still under shelter in place orders, there were approximately 269 stays available in a variety of sizes, many with ocean views, for August 1–8, 2020 (beach properties are typically booked months in advance). *Id.*

300 *Id.* Prices averaged \$491 per night and ranged from a low of \$91 per night to \$1,100 per night. *Id.*

301 ZILLOW, <https://www.zillow.com/>. On June 15, 2020, rent for Mission Beach properties ranged from \$1,325 to \$15,000 per month. *Id.*

302 This same strategy could be used in other sea-level cities like Coronado, California.

303 People with a deep attachment to their property might not opt into a voluntary program. Prof. Radin explored the idea of property and personhood, positing that “an object is closely related to one’s personhood if its loss causes pain that cannot be relieved by the object’s replacement,” in which case, we should give more weight to property rights. Margaret Jane Radin, *Property and Personhood*, 34 Stan. L. Rev. 957, 959 (1982).

If San Diego started acquiring high risk properties just in Mission Beach,³⁰⁴ its gross rental income, after expenses,³⁰⁵ could eventually pay for acquisition costs and create a pool to buy more properties. Although the wide beach currently provides a modicum of protection, only a slight sea level rise would submerge Mission Beach homes.³⁰⁶ A strategic campaign that highlights sea level risks, and gradual but consistent declining values could warm owners up to the idea of selling. Any campaign should include a fair market value offer at the outset, with built in price drops over time to reflect increased sea level risks over that same period.³⁰⁷ The goal of an acquisition and rental program is not to become a for-profit commercial real estate entity, but rather to protect a community's safety by acquiring an inventory of high-hazard coastal properties for the purpose of controlling managed retreat in a fiscally responsible manner.

Managed retreat can also be carried out by offering a transfer of development rights ("TDR") option to property owners in high-hazard areas ("sending area"), that removes their right to develop there in exchange for the right to develop at a higher density than otherwise allowed in a safer area ("receiving area").³⁰⁸

[Z]oning [in the receiving area] is changed to permit more units to be built. This generates the opportunity to earn more money from development than landowners would have received in the absence of the TDR program. Because the money from this change in zoning is a windfall to current landowners in the development zone, the state is justified in laying claim to this money and turning it over to people whose development rights were taken away as a result of the environmental regulation.³⁰⁹

304 This is admittedly an expensive proposition, with the median home value at \$976,684 in the 2010 census and 48% of homes valued at \$1 million or more. See DEMOGRAPHIC INFORMATION, CITY OF SAN DIEGO PLANNING DEPARTMENT (2018).

305 Expenses would include commissions, cleaning, advertising, maintenance, repairs, utilities, and like costs.

306 Bob Guza et al., *Scenarios for Coastal Flooding Caused by Sea Level Rise*, COASTAL DATA INFO. PROGRAM, https://cdip.ucsd.edu/themes/media/docs/publications/posters/Sea_Level_Rise_SD_2100sm.pdf (last visited Nov. 27, 2020).

307 The price formula should be determined by the average expected amount of sea level rise for a set period (like ten years), and the impact that would have on values for each like period.

308 See generally DePasquale, *supra* note 281 (describing TDRs and their use as a sea level rise adaptation tool and explaining that the high hazard or "sending area would be a specified area close to the shoreline, in anticipation of inundation by the ocean in coming year."); see also LOCAL LAND USE RESPONSE TO SEA LEVEL RISE, *supra* note 272, at 68 ("Localities can provide for the transfer of the right to develop property under current zoning provisions from one part of the community to another. Voluntary, market-based transfer of development rights (TDR) programs offer protection for sensitive coastal resources by directing needed development away from the resource, designated the 'sending' area, and siting it in an appropriate 'receiving' area, where increased density of development can be accommodated.").

309 *What is a Transfer of Development Rights (TDR) Program*, RUTGERS, <https://njaes.rutgers.edu/highlands/transfer-development-rights.php> (last visited Nov. 27, 2020).

TDRs are cost-effective, as local governments do not have to pay for TDRs, other than administrative costs and arranging for deed restrictions in the sending land.³¹⁰ While conceptually rational, TDRs may be difficult to carry out: even though it is theoretically possible to transfer development rights to receiving land, practically, it will be challenging both to determine what increased density level on the receiving end is equivalent to foregone development rights on the oceanfront sending end, and to establish a high enough value to be appealing to coastal property owners.³¹¹ In addition, property owners are restricted in property use as soon as deed restrictions are created, but are not paid for the TDR until buyers materialize.³¹² One model creates a TDR bank to administer the program, which can sometimes be used by a state “to purchase all of the available TDRs in the market, holding them until investors in the receiving area are found.”³¹³ This is appealing, as it is administratively efficient, creates a robust and centralized marketplace that is more attractive to senders and receivers, and allows for immediate purchase of TDRs. While TDRs arose to preserve natural resources by prohibiting development in sensitive areas,³¹⁴ the concept can readily be applied to prohibit development in high-hazard zones as a sea level rise mitigation measure. If municipalities use TDR programs to prevent development in high-hazard coastal zones, they must be carefully constructed to incentivize sending landowners to participate in the program, provide enough value to receiving parties to buy TDRs, and fairly allocate the costs and benefits.³¹⁵

Cities can also prevent development in high hazard zones through purchase of development rights agreements (“PDRs”) or conservation easements,³¹⁶ each of which allows managed retreat to progress naturally.

310 *See id.*

311 *See, e.g.,* DePasquale, *supra* note 281, at 193. A program in Florida “hit a standstill because the oceanfront property owners value their land much more than TDRs would sell for on the market.” *Id.* at 194. While that program was not created in response to sea level rise and did not completely prohibit development on sending land, it is analogous insofar as it downzoned coastal property. *Id.* A program in Oxnard, California, which is more akin to a sea level rise-inspired program, likewise “has not garnered any transfers due to the shoreline land being too valuable in comparison to sending areas.” *Id.*

312 *Id.* at 186.

313 *Id.*

314 *Id.* at 193 (“To date, TDR programs have not been used for the purpose of mitigation of sea level rise, erosion, and damage to land.”).

315 The Coastal Commission suggested that “LCPs can establish policies to implement a TDR program to restrict development in areas vulnerable to sea level rise and allow for transfer of development rights to parcels with less vulnerability to hazards.” CCC SLR Policy Guidance, *supra* note 3, at 129.

316 A conservation easement is “a nonpossessory interest of a holder in real property imposing limitations or affirmative obligations the purposes of which include retaining or protecting natural, scenic, or open-space values of real property, assuring its availability for . . . recreational, or open-space use, protecting natural resources, maintaining or enhancing air or water quality, or preserving the historical, architectural, archaeological, or cultural aspects of real property.” UNIFORM CONSERVATION EASEMENT ACT § 1 (NAT’L CONFERENCE OF COMM’RS ON UNIFORM STATE LAWS 2007).

[PDR] is an incentive based, voluntary program with the intent of permanently protecting productive, sensitive, or aesthetic landscapes, yet retaining private ownership and management. . . . [A] landowner sells the development rights . . . to a public agency, land trust or unit of government. A conservation easement is recorded on the title of the property that limits development permanently. . . . While the right to develop . . . is permanently restricted, the land owner retains all other rights and responsibilities associated with that land and can use or sell it for purposes allowed in the easement.³¹⁷

PDRs with conservation easements provide significant tax benefits.³¹⁸ While important, the tax benefits do not fully compensate a landowner for the loss of development rights—hence, the purchase component of PDRs.³¹⁹ The combination of tax benefits, an attractive purchase price, and, possibly, the moral value of supporting important environmental causes, can motivate coastal property owners to forfeit development rights. PDRs are cheaper than fee simple purchases, and simpler than TDRs insofar as there is no receiving property that must be rezoned to accommodate higher density development.³²⁰ Conservation easements can also stand on their own as they do not necessarily involve a purchase of development rights.³²¹ Landowners may choose to provide conservation easements for a combination of their associated tax and environmental benefits.³²² With PDRs and conservation easements, coastal property owners still own their land, but give up development rights, enabling managed retreat.

If TDRs, PDRs, and conservation easements are not available to prevent development and owners are not willing to voluntarily sell property, governments might be able

317 Douglas Miskowiak & Linda Stoll, *Planning Implementation Tools: Purchase of Development Rights*, CTR. LAND USE EDUC. (Aug. 2006), https://www.uwsp.edu/cnr-ap/clue/Documents/PlanImplementation/Purchase_of_Development_Rights.pdf; see also *Purchase of Development Rights*, WETLANDS WATCH, <http://wetlandswatch.org/purchase-of-development-rights> (last visited Nov. 27, 2020) (“Common sources to fund PDR programs include general appropriations, real estate transfer taxes, bonds (most popular) and donated lands.”).

318 See *Rolling Easements*, *supra* note 254, at 107 (“There are two primary sources of tax savings for most property owners. First, an easement is a charitable contribution equal to its fair market value, which is generally the diminution in land value resulting from the restrictions. . . . Second, the diminution in value lowers the assessment for property taxes. These . . . refund about half the value of a donated easement to the property owner. In addition, property subject to a conservation easement may be partly excluded from the inheritance tax”); see also Timothy C. Lindstrom, *Recent Developments in the Law Affecting Conservation Easements: Renewed Tax Benefits, Substantiation, Valuation, Stewardship Gifts, Subordination, Trusts, and Sham Transactions*, 11 Wyo. L. Rev. 433 (2011) (discussing how conservation easements are treated for tax purposes).

319 See *Purchase of Development Rights*, *supra* note 249 (“Common sources to fund PDR programs include general appropriations, real estate transfer taxes, bonds (most popular) and donated lands.”).

320 See CCC SLR Policy Guidance, *supra* note 3, at 189.

321 See UNIFORM CONSERVATION EASEMENT ACT § 1 (NAT’L CONFERENCE OF COMM’RS ON UNIFORM STATE LAWS 2007).

322 See *Rolling Easements*, *supra* note 254, at 107.

to exercise eminent domain to take private property in harm's way.³²³ Using eminent domain to mitigate sea level rise would probably be considered an appropriate public use.³²⁴ Although it does not serve the public in the same way as a highway, post office, or other public use, managed retreat provides protection by removing people and structures from sea level rise-related damage and destruction.³²⁵ Eminent domain is a last resort option that should only be undertaken in extreme circumstances.³²⁶ While possible in some cases, there are less heavy-handed alternatives to acquire land voluntarily or to purchase or transfer development rights, so eminent domain should be utilized only when no better options exist.

Sea levels are rising and not even the best protect and accommodate strategies will keep the sea at bay. Thus, careful managed retreat strategies designed for the long arc of time between today and when seas start to permanently inundate coastal properties, not just during storm surges and high tide events, are essential. Thoughtful leaders must overcome strong resistance and craft comprehensive retreat plans that can be layered and rolled out at appropriate times. When considering adaptation strategies, planners and decisionmakers must use a carefully considered blend of protect, accommodate, and retreat. The impetus of sea level rise planning begins with municipalities, but requires cooperation of coastal property owners, who must understand the risks³²⁷ and their role in property and life preservation.³²⁸ In sum, adaptation tools must balance property rights with health and safety concerns by taking into consideration specific properties' hazard threat and location, allowing safe uses but removing development rights altogether on some properties, and eventually requiring structure removal and potential relocation before they are underwater.

323 See U.S. CONST. amend. V (“[N]or shall private property be taken for public use, without just compensation.”). An 1875 case states that “[t]he right of eminent domain was one of those means well known when the Constitution was adopted, and employed to obtain lands for public uses. . . . The fifth amendment contains a provision that private property shall not be taken for public use without just compensation. What is that but an implied assertion that, on making just compensation, it may be taken?” *Kohl v. United States*, 91 U.S. 367, 372–73 (1875). The California Constitution likewise requires payment of just compensation when taking private property. See CAL. CONST. art. I, §19(a) (“Private property may be taken or damaged for a public use and only when just compensation . . . has first been paid . . .”).

324 See Herzog & Hecht, *supra* note 8, at 61 (“Re-siting infrastructure in response to sea-level rise almost certainly would constitute a proper public use for exercise of eminent domain.”)

325 See *id.* at 534.

326 See *id.* at 482 (“[A] takings challenge can be expensive, time-consuming, and politically damaging.”).

327 California, for example, requires residential property sellers to disclose if property is in a natural hazard area. See CAL. CIV. CODE § 1103.2 (West 2020).

328 Cities can “[e]stablish standards, permit conditions, and deed restrictions that ensure that current and future risks are assumed by the property owner,” and should “[c]onsider policies that would encourage or require property owners to set aside money, such as in the form of a bond, as a contingency if it becomes necessary to modify, relocate, or remove development that becomes threatened in the future.” CCC SLR Policy Guidance, *supra* note 3, at 132.

4. EXTERNAL FORCES THAT INFLUENCE ADAPTATION

Decisionmakers primarily prepare for sea level rise through the tools described in the previous subsection. External forces can also indirectly promote adaptation by making coastal property less valuable and managed retreat more feasible, thus limiting or influencing landowners' choices. For example, insurance availability, or lack thereof, may sway someone not to buy or build on a particular parcel. All real property owners who financed their purchases through traditional loans have property insurance.³²⁹ Most private insurance companies decline to insure risky properties or require higher premiums to offset the higher risk.³³⁰ Yet, many still routinely insure high-hazard coastal homes.³³¹ However, insurance companies typically do not provide flood insurance for those properties, requiring owners to procure it from specialized providers.³³² If insurance companies did not provide property insurance for land in high-hazard coastal zones, it would probably change buyer behavior, eventually leading to a decline in property values and diminished marketability. This, in turn, would make it easier to pursue managed retreat for such properties.

A related, and perhaps more pressing, problem is the continued availability of subsidized flood insurance in high-risk areas. When private insurance companies decline coverage for coastal property at higher risk from sea level rise damage or calamity strikes, the government often steps in with insurance coverage or disaster relief to fill the gap.³³³

The existence of federally subsidized insurance means that homeowners do not bear the full cost of owning a property in an area at high risk of flooding. In theory, if people faced the more expensive premiums that reflect the full flooding risk they might choose not to build or to buy properties in high-risk areas.³³⁴

329 Lenders require buyers to obtain property insurance effective at the close of escrow, and buyers typically must provide proof of insurance through escrow before a lender will fund the loan. See Edward P. Richards, *Applying Life Insurance Principles to Coastal Property Insurance to Incentivize Adaptation to Climate Change*, 43 Boston Coll. Env't Affs. L. Rev. 427, 444–45 (2016) (“[T]he federal mortgage insurance system requires property-casualty insurance on all mortgaged homes and flood insurance on those that are in the Federal Emergency Management Agency (‘FEMA’) designated floodplains.”).

330 Tying premiums for a given property to the actual risk for that property is an actuarial approach. See, e.g., John O’Neill & Martin O’Neill, *Social Justice and the Future of Flood Insurance*, JOSEPH ROWNTREE FOUND. 8 (Mar. 7, 2012), <https://www.jrf.org.uk/report/social-justice-and-future-flood-insurance> (“[O]ne treats some individual fairly with regard to making them bear the costs of their own risks when you align the costs that they face with their associated level of risk.”); see also Jennifer Wriggins, *Flood Money: The Challenge of U.S. Flood Insurance Reform in a Warming World*, 119 Penn State L. Rev. 361, 371 (2014).

331 San Diego, for example, has hundreds of oceanfront homes, which presumably are covered by homeowners’ insurance policies.

332 Erwann O. Michel-Kerian, *Catastrophe Economics: The National Flood Insurance Program*, 24 J. ECON. PERSP. 165, 168 (2010).

333 Craig E. Landry & Mohammad R. Jahan-Parvar, *Flood Insurance Coverage in the Coastal Zone*, 78 J. RISK & INFLUENCE 267, 361 (2011).

334 See Agustin Indaco, Francesc Ortega & Suleyman Taspinar, *Flood Insurance in a World with Rising Seas*, ECONOFACT (Oct. 15, 2018), <https://econofact.org/flood-insurance-in-a-world-with-rising-seas>.

While insurance reform has shifted some of the burden to property owners through higher premiums,³³⁵ significant subsidies for properties in high-hazard areas still exist, which is problematic.

[S]tates permitting extensive coastal development are increasingly financially stressed by their involvement in both primary and secondary insurance markets to protect coastal assets. As coastal development has intensified, hurricane damages have increased significantly, and . . . states have increasingly become involved in underwriting reinsurance policies to bear some of the risk of loss that the private sector will not assume.³³⁶

States have no business serving as the primary underwriters for flood damage. Engaging in the reinsurance game is costly and will get more expensive with increased sea level rise-related threats.³³⁷ If we shifted to an actuarial approach, with premiums priced to reflect actual risks rather than subsidizing flood insurance, it would appropriately channel behavior.³³⁸ Huge premiums should disincentivize purchase or maintenance of high-risk coastal property. One proposal to raise premiums to match sea level risks, provides:

[T]he cost of insurance would increase as the risk . . . increases with time. The predictable increasing cost of insurance would reduce the value of the property over time. Without an assurance of long-term value, there would be less political resistance to governmental programs that buy and tear down endangered properties to allow the coast to retreat inland. This would reduce catastrophic losses and deaths, and better preserve coastal ecology.³³⁹

By shifting insurance costs to the insured rather than heavily subsidizing insurance costs, governments can use their limited resources for more comprehensive sea level rise damage prevention, like purchasing high-hazard property for managed retreat.³⁴⁰ This approach better allocates risks to those who enjoy the benefits, shifting funds from property owners who can afford oceanfront property to broader public purposes.

335 See generally Wriggins, *supra* note 330 (providing a detailed history and critique of U.S. flood insurance policy and a call for reform).

336 Margaret E. Peloso & Margaret R. Caldwell, *Dynamic Property Rights: The Public Trust Doctrine and Takings in a Changing Climate*, 30 *Stan. Env't L. J.* 51, 55–56 (2011) (citations omitted).

337 See Richards, *supra* note 329, at 428.

338 On the other hand, while many coastal property owners are wealthy, not all are—so it makes sense to subsidize property insurance in limited circumstances. For a thoughtful proposal, see Wriggins, *supra* note 330, at 432–37. “[P]art of a government’s role is to assist low-income people, in flood insurance as in other arenas like food and health care. Therefore a means-tested plan should accompany the elimination of subsidies, as the GAO and experts have said for years.” *Id.* at 436.

339 See Richards, *supra* note 329, at 428.

340 See DePasquale, *supra* note 281, at 199–200 (“[T]he government could . . . utilize publically [sic] funded buyouts of these flood prone regions. Such a plan would encompass government purchase of willing residents’ lands, with demolition of all existing structures on the land, while maintaining the land for use by the public. Research shows that this is not only safer, but also a much more cost-effective measure for the government. Such a plan would generate a savings for the government within ten years, as the government would not have to deal with subsidizing insurance or recovery costs of eventual future floods.”).

Given the sea level rise-related risks of high-hazard coastal properties, there is no reason for insurance companies or governments to subsidize, or even insure, such properties. Prudence suggests that no one should offer insurance coverage for high-hazard coastal property; if insurance is not available, it would discourage construction and habitation in those locations. If it is offered at all, it should be at high enough initial premiums, increasing as the risk grows, so that potential buyers would think twice before proceeding with purchases.³⁴¹ Allowing costs to align with risks would appropriately alter buyer behavior, better enabling orderly managed retreat to proceed with fewer obstacles.

Real estate finance can also impact adaptation decisions. If buyers cannot pay all cash for property,³⁴² and lenders will not finance high-hazard coastal property purchases, or will only do so at a premium, then potential buyers are less likely to proceed with such purchases. To the extent those properties are undeveloped, they are more likely to remain that way. If developed, their marketability will decline, as will any incentive to make future improvements. As described above, lenders require that buyers obtain property insurance. Therefore, if property is not insurable, traditional lenders will not provide loans, which will cause a decline in the property's marketability.³⁴³ If property is insurable but high risk, in addition to requiring risk appropriate insurance (which is more expensive), lenders will likely offset the risk by charging higher interest rates, making the property even more costly. While these are not direct adaptation tools, higher insurance premiums coupled with higher interest rates make high-hazard coastal property less attractive and, hence, less marketable. Managed retreat is clearly easier to pursue with these properties because government agencies, land trusts, or non-profits can more readily acquire them. As the market for such properties dries up, owners will be more likely to participate in TDR or PDR programs, or participate in voluntary property transfers, easing the way to managed retreat.

Sea level rise continues, and no planning will stop that. However, adaptation strategies have emerged to mitigate harm to people and property alike. Municipalities and agencies design and implement many of the strategies, but property owners and ancillary service providers, like insurance companies and mortgage lenders, also play a role. Although cities can typically adopt and carry out adaptation strategies under the police

341 For example, a buyer could "be told that the policy would be significantly more expensive at renewal, and that it might not be renewable at all, depending on the rate of sea level rise. Rather than providing steady state earth insurance stability, it would force the property owner to internalize the risk of sea level rise. This could be offset by selling the property and moving inland, or by elevating or hardening the property, if feasible." Richards, *supra* note 329, at 457.

342 Most home buyers finance their purchases. See *Highlights from the Profiles of Home Buyers and Sellers*, NAT'L ASS'N OF REALTORS (2020), <https://www.nar.realtor/research-and-statistics/research-reports/highlights-from-the-profile-of-home-buyers-and-sellers#financing> ("86% of recent buyers financed their home purchase. Those who financed their home purchase typically financed 88%.").

343 Uninsurable properties are not truly unmarketable as buyers can pay all cash, but the market is limited because the pool of all cash buyers is relatively small. Also, even those buyers care about the eventual sale of their property and the small pool of all cash buyers willing to buy uninsurable property severely hampers marketability.

power because they promote health and safety,³⁴⁴ those strategies restrict private property owners' ability to use their property. Americans highly value private property and do not take well to restrictions. Part V discusses the delicate balancing act between sea level rise adaptation tools and property rights.

V. LEGAL CHALLENGES

Sea level rise is a looming threat, requiring collaborative and Herculean efforts to mitigate potentially catastrophic damage to people and property alike. Part IV described adaptation strategies and hinted at some potential challenges. This Part addresses them directly, looking at potential legal objections, as well as likely outcomes that fairly balance health and safety with private property rights. Legal challenges could arise in response to each of the “protect, accommodate, and retreat” strategies, with some potential overlap. First, “protect” adaptation tools—especially seawalls—have already faced legal challenges and will likely face more. If property owners' requests to build new protective devices or repair existing seawalls are denied, or they are required to remove seawalls, they may challenge such actions, arguing they are entitled to protect their property. Second, “accommodate” adaptation tools have also faced legal challenges, which will continue. Owners might object to specific Development Conditions, claiming they are takings or otherwise not sufficiently related to their projects to be upheld. In addition, owners or property rights advocates could oppose new or revised regulations, ordinances, or codes that mandate owner action or limit property use. Third, “managed retreat” adaptation tools, particularly those that rezone land as high-hazard coastal property or otherwise limit property use, may invite legal challenges. Owners of downzoned property may claim such zoning deprives them of all economically viable use of their land, thus they have suffered a taking. Property owners may also object to rolling easements, which may eventually transfer their private property to the state. Finally, TDRs and PDRs may also be subject to challenges because they eliminate development rights. Regardless of the category of legal challenge, most of them would be analyzed within the regulatory takings' framework, incorporating nuisance and public trust principles. Section A provides an overview of regulatory takings. The remaining Sections analyze potential legal challenges to “protect,” “accommodate,” and “managed retreat” adaptation tools.

A. REGULATORY TAKINGS FRAMEWORK

Regulatory takings' law is well established, and much scholarship has been devoted to climate change and sea level rise regulations.³⁴⁵ This Section does not provide the same depth as articles devoted to takings. Instead, it describes the legal framework used to assess legal challenges to sea level rise adaptation tools, focusing on three sets of cases

344 See, e.g., CAL. CONST. art. XI, § 7 (“A county or city may make and enforce within its limits all local police, sanitary and other ordinances and regulations not in conflict with general laws.”).

345 See generally *Rising Seas, Coastal Erosion, and the Takings Clause*, *supra* note 271; Michael A. Hiatt, *Come Hell or High Water: Reexamining the Takings Clause in a Climate Changed Future*, 18 *Duke Env't L. & Pol'y F.* 371 (2008); Peloso & Caldwell, *supra* note 336; Byrne, *supra* note 276.

involving land use, regulations, and property rights. The first includes early decisions recognizing regulatory takings as a distinct “takings” category, and land use regulation generally as a valid exercise of the police power (*Hadacheck* and *Euclid*).³⁴⁶ The second addresses regulations that limit property use or development (“Development Prohibitions”) (*Pennsylvania Coal, Penn Central*, and *Lucas*).³⁴⁷ The third involves Development Conditions (*Nollan* and *Dolan*).³⁴⁸

In 1915, the Supreme Court decided *Hadacheck v. Sebastian*,³⁴⁹ one of the earliest cases that expanded takings beyond the traditional realm of physical takings. Because Hadacheck’s property contained valuable clay uniquely suited for brickmaking, he operated a brickyard—which required considerable investment.³⁵⁰ A city ordinance prohibited brickyard operations within city limits, thus Hadacheck’s brickmaking operation was illegal.³⁵¹ Hadacheck argued that if the ordinance was upheld, he would “be compelled to entirely abandon his business and will be deprived of the use of his property.”³⁵² The lower court upheld the ordinance partly because brickyards were out of place in residential neighborhoods.³⁵³ The Supreme Court found the landowner did not suffer a total economic loss, as “there is no prohibition of the removal of the brick clay; only a prohibition within the designated locality of its manufacture into bricks.”³⁵⁴ The Court also rejected Hadacheck’s argument that he had a vested right to continue the business in which he had invested heavily, because such argument “would preclude development, and fix a city forever in its primitive conditions. *There must be progress, and if, in its march, private interests are in the way, they must yield to the good of the community.*”³⁵⁵ *Hadacheck* confirmed that cities can exercise the police power to regulate land use so long as it serves legitimate public purposes and does not cause a total economic loss, even if it causes a diminution in property value.

In 1926, the Supreme Court decided *Village of Euclid, Ohio, v. Ambler Realty Co.*,³⁵⁶ the seminal case recognizing zoning as a valid exercise of the police power. The Village

346 See generally *Hadacheck v. Sebastian*, 239 U.S. 394 (1915); *Vill. of Euclid, Oh., v. Ambler Realty Co.*, 272 U.S. 365 (1926).

347 See generally *Pa. Coal Co. v. Mahon*, 260 U.S. 394 (1922); *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104 (1978); *Lucas v. S.C. Coastal Council*, 505 U.S. 1003 (1992).

348 See generally *Nollan v. Cal. Coastal Comm’n*, 483 U.S. 825 (1987); *Dolan v. City of Tigard*, 512 U.S. 374 (1994).

349 *Hadacheck*, 239 U.S. at 394.

350 *Id.* at 405.

351 See *id.* at 404–05. Hadacheck was convicted of a misdemeanor for violating such ordinance, taken into custody, and filed for a writ of habeas corpus. *Id.*

352 See *id.* at 405. Hadacheck claimed the value of his property was \$800,000 when brickmaking was allowed, but only \$60,000 when limited to residential purposes.

353 *Id.* at 409. This outcome was not surprising as there was a movement in the United States at that time to zone so incompatible uses would not be adjacent to each other. See Amanda Erickson, *The Birth of Zoning Codes, a History*, BLOOMBERG (June 19, 2012), <https://www.bloomberg.com/news/articles/2012-06-19/the-birth-of-zoning-codes-a-history> (detailing the history of city zoning laws).

354 *Hadacheck*, 239 U.S. at 412.

355 *Id.* at 410 (emphasis added).

356 *Euclid*, 272 U.S. at 365.

Council of Euclid, Ohio, enacted its first zoning ordinance in 1922,³⁵⁷ which Ambler claimed reduced the value of its 68 acres from \$10,000 per acre to \$2,500 per acre.³⁵⁸ Ambler challenged the ordinance as a taking because it restricted its land use, causing its property value to decline.³⁵⁹ The Court famously said:

Regulations the wisdom, necessity and validity of which, as applied to existing conditions, are so apparent that they are now uniformly sustained a century ago, or even half a century ago, probably would have been rejected as arbitrary and oppressive. Such regulations are sustained, *under the complex conditions of our day*, for reasons analogous to those which justify traffic regulations, which, before the advent of automobiles and rapid transit street railways, would have been condemned as fatally arbitrary and unreasonable. And in this there is no inconsistency, for, while the meaning of constitutional guaranties never varies, the scope of their application must expand or contract to meet the new and different conditions which are constantly coming within the field of their operation.³⁶⁰

Euclid arose when industrialization had already swept the country, and separating incompatible uses was a matter of public health, safety, and welfare.³⁶¹ The Court stressed that even if a regulation inconveniences a particular property owner, it will be upheld unless it is “clearly arbitrary and unreasonable, having no substantial relation to the public health, safety, morals, or general welfare.”³⁶² Though *Euclid* generally validated zoning, it did so with some caveats. First, a regulation’s validity cannot be adjudicated in the abstract, and instead must be in the context of specific facts.³⁶³ Second, there is a presumption of validity for legislative action like zoning unless clearly arbitrary and unreasonable—meaning the bar is high for someone challenging a regulation, and proponents merely need to show legitimate health and safety grounds to defeat such a challenge.³⁶⁴ Third, while *Euclid* was grounded in police power principles and a locality’s responsibility to protect health and safety, it also relied on nuisance principles and expert opinions and reports.³⁶⁵

357 *Id.* at 379–82.

358 *Id.* at 379, 384.

359 *Id.* at 384.

360 *Id.* at 387 (emphasis added).

361 *See id.* at 391.

362 *Euclid*, 272 U.S. at 395.

363 *Id.* at 387 (“The line which in this field separates the legitimate from the illegitimate assumption of power is not capable of precise delimitation. It varies with circumstances and conditions. A regulatory zoning ordinance, which would be clearly valid as applied to the great cities, might be clearly invalid as applied to rural communities.”).

364 *See id.* at 395.

365 *See id.* at 388, 394. Discussing nuisance law, the Court stated that “[a] nuisance may be merely a right thing in the wrong place; like a pig in the parlor instead of the barnyard. If the validity of the legislative classification for zoning purposes be fairly debatable, the legislative judgment must be allowed to control.” *Id.* at 388. And in discussing the evidence before it, the Court stated “[t]hese reports which bear every evidence of painstaking consideration, concur in the view that the segregation of residential, business and industrial buildings will make it easier to provide fire apparatus suitable for the character and intensity of

In 1922, the Court decided *Pennsylvania Coal Co. v. Mahon*, which explored the question of when regulations go so far that they result in a taking.³⁶⁶ Mahon acquired the property's surface rights, but Pennsylvania Coal owned the right to remove coal under the property.³⁶⁷ Mahon sued Pennsylvania Coal under a 1921 Pennsylvania statute that forbade mining that caused homes to subside.³⁶⁸ Pennsylvania Coal claimed the statute destroyed its property and contract rights.³⁶⁹ The Court summarized the balance between the police power on the one hand and private property rights on the other hand as follows:

Government hardly could go on if to some extent values incident to property could not be diminished without paying for every such change in the general law. As long recognized some values are enjoyed under an implied limitation and must yield to the police power. But obviously the implied limitation must have its limits or the contract and due process clauses are gone. One fact for consideration in determining such limits is the extent of the diminution. When it reaches a certain magnitude, in most if not in all cases there must be an exercise of eminent domain and compensation to sustain the act. So the question depends upon the particular facts. The greatest weight is given to the judgment of the legislature but it always is open to interested parties to contend that the legislature has gone beyond its constitutional power.³⁷⁰

The Court affirmatively answered the question of whether the police power went too far under these facts by destroying property and contract rights without compensation, because "the extent of the taking is great. It purports to abolish what is recognized in Pennsylvania as an estate in land—a very valuable estate—and what is declared by the Court below to be a contract hitherto binding the plaintiffs."³⁷¹ While not invalidating the act, the Court said it could not "be sustained as an exercise of the police power, so far as it affects the mining of coal . . . where the right to mine such coal has been reserved"; thus, Pennsylvania Coal should get the benefit of the bargain it struck, and Mahon should not get a better deal than what he paid for.³⁷² *Pennsylvania Coal* did not provide a litmus test about how much regulation was too much, but made it clear there was such a point when bargained for property and contract rights were nullified by regulation.³⁷³

Several decades later, the Supreme Court decided *Penn Central Transportation Co. v. City of New York*.³⁷⁴ The City adopted a Landmarks Preservation Law (the "Law") which limited uses on designated sites or buildings,³⁷⁵ and listed Grand Central Terminal as a

the development in each section; that it will increase the safety and security of home life" *Id.* at 394.

366 *Pa. Coal Co.*, 260 U.S. at 415.

367 *Id.* at 412. Mahon's title provided that the grantee explicitly assumed any risks and waived any claims for damages. *Id.*

368 *Id.* at 412–13.

369 *Id.*

370 *Id.*

371 *Pa. Coal Co.*, 260 U.S. at 413–14.

372 *Id.*

373 *Id.* at 420.

374 *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 104 (1978).

375 *Id.* at 109–11.

landmark building and the entire block where it is located as a landmark site.³⁷⁶ Penn Central's plan to build an office tower atop the Terminal was rejected because it involved tearing down, rather than preserving, a landmark and blocking a "majestic view from the south."³⁷⁷ Although Penn Central acquired TDRs allowing it to pursue projects of significant value, it sued, claiming the Law took its property without payment "and arbitrarily deprived them of their property without due process of law."³⁷⁸ However, Penn Central did not dispute the Law's general validity, that it could earn a reasonable return as allowed to operate under the Law, or that the TDRs provided some value.³⁷⁹ Recognizing the fluidity of regulatory takings cases and their fact-specific nature, the Court noted some important factors to consider, including "[t]he economic impact of the regulation on the claimant and, particularly, the extent to which the regulation has interfered with distinct investment-backed expectations" and "the character of the governmental action."³⁸⁰ Applying those factors, the Court disagreed with Penn Central's claim that the loss of airspace use was a taking, because it considered the entire parcel, rather than just a discrete component (like the airspace), to assess whether there was a deprivation of all property use.³⁸¹ Penn Central conceded that regulations might result in declining property values, but still argued that the Law effectuated a taking, stressing that it arbitrarily singled out historic or landmark property owners, causing them to bear more of the burdens of preservation.³⁸² The Court again disagreed, partly because the Law had a comprehensive scheme establishing approximately 400 landmarks and 31 historic districts.³⁸³ The Court decided that the Law did not go too far because it did not prevent Penn Central from using the property as it did before the Law was adopted and obtaining a reasonable return from such use.³⁸⁴ Moreover, construction was not prohibited in the airspace above the Terminal—only Penn Central's particular plan was rejected.³⁸⁵ Finally, any lost construction rights were compensated for, in part, through the TDRs, which Penn Central could use in nearby buildings that it owned.³⁸⁶ In sum, the

376 *Id.* at 115–16.

377 *Id.* at 117.

378 *Id.* at 119.

379 *Id.* at 129.

380 *Id.* at 124. With respect to the character of the governmental action, a physical taking is more problematic "than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good." *Id.*

381 *Id.* at 130–31.

382 *Id.* at 131.

383 *Id.* at 132. The Court added that "the New York City law is not rendered invalid by its failure to provide 'just compensation' whenever a landmark owner is restricted in the exploitation of property interests, such as air rights, to a greater extent than provided for under applicable zoning laws." *Id.* at 136.

384 *Id.* at 136.

385 *Id.* at 137. In fact, the Commission said, "[We have] no fixed rule against making additions to designated buildings—it all depends on how they are done But to balance a 55-story office tower above flamboyant Beau-Arts facade seems nothing more than an aesthetic joke. Quite simply, the tower would overwhelm the Terminal by its sheer mass. The 'addition' would be four times as high as the existing structure and would reduce the Landmark itself to the status of a curiosity." *Id.* at 117–18 (alterations in original).

386 *Id.* at 137.

Court held there was no taking, reasoning that “[t]he restrictions imposed are substantially related to the promotion of the general welfare and not only permit reasonable beneficial use of the landmark site but also afford appellants opportunities further to enhance not only the Terminal site proper but also other properties.”³⁸⁷ The Court fine-tuned the analysis when regulations limit property use and lower property value by considering the character of the regulation and its economic impact on the entire parcel, as well as the owner’s investment-backed expectations.³⁸⁸

In 1992, the Supreme Court decided *Lucas v. South Carolina Coastal Council*.³⁸⁹ Lucas bought two residential beach lots and planned to build homes on each, but after the Beachfront Management Act (the “Act”) was passed, Lucas was prohibited from building permanent homes on the land.³⁹⁰ The Supreme Court said “there are good reasons for our frequently expressed belief that when the owner of real property has been called upon to sacrifice *all* economically beneficial uses in the name of the common good, that is, to leave his property economically idle, he has suffered a taking.”³⁹¹ But the Court also acknowledged prior jurisprudence, where regulation that caused a total economic loss was not a taking if the government produced compelling nuisance or state law principles that accomplished the same ends as the challenged regulation.³⁹²

In 1987, the Supreme Court heard *Nollan v. California Coastal Commission*.³⁹³ Nollan sought a permit to replace a dilapidated beach home with a three-bedroom house, which the Coastal Commission recommended subject to a public beach access easement.³⁹⁴ The Coastal Commission justified the condition because the new home would block ocean views, thus harming the public as it might not know there was a public beach below, and increase private beach use; thus, the “effects of construction of the house, along with other area development, would cumulatively ‘burden the public’s ability to traverse to and along the shorefront.’”³⁹⁵ Nollan claimed the dedication “could not be imposed absent evidence that their proposed development would have a direct adverse impact on public access to the beach.”³⁹⁶ Although municipalities can impose Develop-

387 *Id.* at 138.

388 *See id.*

389 *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1003 (1992).

390 *Id.* at 1006–07.

391 *Id.* at 1019 (emphasis in original).

392 *Id.* at 1029 (“Any limitation so severe cannot be newly legislated or decreed (without compensation), but must inhere in the title itself, in the restrictions that background principles of the State’s law of property and nuisance already place upon land ownership. A law or decree with such an effect must, in other words, do no more than duplicate the result that could have been achieved in the courts—by adjacent landowners (or other uniquely affected persons) under the State’s law of private nuisance, or by the State under its complementary power to abate nuisances that affect the public generally, or otherwise.”).

393 *Nollan v. Cal. Coastal Comm’n*, 483 U.S. 825, 825 (1987).

394 *Id.* at 828. The easement was to be placed between a seawall on the property and the boundary between the property and the mean high tide line. *Id.*

395 *Id.* at 828–29.

396 *Id.*

ment Conditions to mitigate projects' impacts, there must be a nexus between the Conditions and specific impacts,³⁹⁷ which was not present under these facts.³⁹⁸

In 1994, the Supreme Court heard *Dolan v. City of Tigard*.³⁹⁹ Dolan sought a permit to nearly double her commercial property's size and pave over a gravel parking lot, which was granted subject to several Development Conditions—two of which Dolan challenged. The first Development Condition required Dolan to dedicate a public greenway along an adjacent creek to absorb increased stormwater, mitigate drainage issues, and minimize flooding resulting from the proposed building and paved lot.⁴⁰⁰ The second Condition required Dolan to dedicate land for a pedestrian and bicycle path to relieve traffic congestion.⁴⁰¹ Dolan challenged the Conditions, claiming they constituted a taking without just compensation, and the Supreme Court agreed.⁴⁰² While *Nollan* established the nexus requirement, it left open the question of “the required degree of connection between the exactions imposed by the city and the projected impacts of the proposed development.”⁴⁰³ *Dolan* answered that by proposing rough proportionality,⁴⁰⁴ which “best encapsulates what [the Court] hold[s] to be the requirement of the Fifth Amendment. No precise mathematical calculation is required, but the city must make some sort of individualized determination that the required dedication is related both in nature and extent to the impact of the proposed development.”⁴⁰⁵ The Court decided both Development Conditions met the nexus test but were not roughly proportional.⁴⁰⁶

397 The Court later said, “it must be determined whether an ‘essential nexus’ exists between a legitimate state interest and the permit condition.” See *Dolan v. City of Tigard*, 512 U.S. 374, 386 (1994).

398 *Nollan*, 483 U.S. at 838–39 (“It is quite impossible to understand how a requirement that people already on the public beaches be able to walk across the Nollans’ property reduces any obstacles to viewing the beach created by the new house. It is also impossible to understand how it lowers any ‘psychological barrier’ to using the public beaches, or how it helps to remedy any additional congestion on them caused by construction of the Nollans’ new house.”).

399 *Dolan*, 512 U.S. at 374.

400 *Id.*

401 *Id.*

402 *Id.*

403 *Id.* at 377.

404 *Id.* at 386.

405 *Id.* at 391.

406 There was a sufficient nexus for the public greenway dedication because the new construction would create more impermeable surfaces adjacent to a 100-year floodplain, leading to more flooding problems. But the dedication was not roughly proportional because “the city . . . not only wanted petitioner not to build in the floodplain, but it also wanted petitioner’s property along Fanno Creek for its greenway system. The city has never said why a public greenway, as opposed to a private one, was required in the interest of flood control.” *Id.* at 391–93. There was also a sufficient nexus for the pathway dedication because doubling the size of the store would increase traffic. *Id.* However, the dedication of the pathway was not roughly proportional because “[d]edications for streets, sidewalks, and other public ways are generally reasonable exactions to avoid excessive congestion from a proposed property use. But on the record before us, the city has not met its burden of demonstrating that the additional number of vehicle and bicycle trips generated by petitioner’s development rea-

To summarize, two situations give rise to a taking: first, when the government physically takes property, even if only a small portion,⁴⁰⁷ and second, when regulation deprives someone of all economic or productive use of property.⁴⁰⁸ In the vast grey area, local governments can regulate to promote health, safety, and welfare, but when regulations do not legitimately advance public interests, they will not be upheld. And even if regulations do advance legitimate interests, if they go too far, there may be a regulatory taking. As a threshold matter, any challenged Development Condition or Prohibition requires a legitimate state purpose. *Penn Central* also assesses Development Prohibitions' with respect to the economic impact on the entire tract subject to regulation—not just a portion of it—and the property owners' distinct investment-backed expectations.⁴⁰⁹ *Lucas* likewise assesses economic impact, but even when Development Prohibitions would otherwise constitute a taking because they wipe out most economic value, they can be upheld if other state principles like nuisance, custom, or the public trust doctrine would allow the same ends as the Prohibition.⁴¹⁰ In cases involving Development Conditions, *Nollan* established the nexus requirement, and *Dolan* added rough proportionality to define the scope of the nexus.⁴¹¹ Accordingly, the fact specific inquiry should analyze Development Conditions and the harm they are designed to prevent, ensuring there is rough proportionality between the two.⁴¹² An important lesson for sea level rise planners, policymakers, and decisionmakers, is to document an appropriate nexus between Development Conditions and how a given project's impacts create the need for those Conditions.

B. PROTECT: SEAWALLS

As sea level rises, the impact of king tides and major storms will be exaggerated, causing more blufftop property owners to seek permits to build, repair, or extend the life of seawalls. If localities deny permits or require burdensome Development Conditions, there may be an increase in legal challenges. Cities may also order seawalls removed when permits expire, or earlier if damaged, which could also invite legal challenges.

In California, even though the Coastal Act allows armoring to protect existing structures,⁴¹³ it otherwise prohibits new armoring.⁴¹⁴ The Coastal Commission has included NFA clauses in permits for many years, and San Luis Obispo's LCP provides that con-

sonably relate to the city's requirement for a dedication of the pedestrian/bicycle pathway easement." *Id.* at 395.

407 See, e.g., *Loretto v. Teleprompter Manhattan CATV Corp.*, 458 U.S. 419 (1982) (holding that permanent, even if minor, physical intrusion by a cable company's cable equipment required compensation).

408 See, e.g., *Agins v. Tiburon*, 447 U.S. 255, 260 (1980); *Nollan v. Cal. Coastal Comm'n*, 483 U.S. 825 (1987); *Keystone Bituminous Coal Ass'n v. DeBenedictis*, 480 U.S. 470 (1987); *Hodel v. Virginia Surface Mining & Reclamation Ass'n, Inc.*, 452 U.S. 264 (1981).

409 *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 137 (1978).

410 *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1029 (1992).

411 *Nollan*, 483 U.S. at 837; *Dolan*, 512 U.S. at 387.

412 *Dolan*, 512 U.S. at 387–388.

413 See CCC SLR Policy Guidance, *supra* note 3, at 165 (“[E]xisting development is only entitled to shoreline protection if it is in fact in danger, and the proposed shoreline protection is the least environmentally-damaging alternative to abate such danger.”); see also *supra* text accompanying notes 184–186.

struction permits for oceanfront properties must include NFA clauses.⁴¹⁵ This type of provision could be challenged upon adoption, but they already exist and individual property owners are unlikely to invest the time or resources to invalidate them.⁴¹⁶ However, a consortium of property owners or a well-funded entity might fight new regulations of this nature. If they mounted a challenge, it would be an uphill battle, as ordinances are typically upheld if there is any rational relationship between them and the community's health and safety.⁴¹⁷ LCPs that require NFA clauses in new permits serve many public purposes: they preserve public beaches by allowing the natural landward migration of the ocean, ensure broader public beach access, enhance safety (because seawalls tend to endanger neighboring properties by directing wave energy to them), and prevent negative seawall aesthetics. Furthermore, the public trust doctrine supports prohibiting seawalls.⁴¹⁸

If, instead of being challenged in the abstract, an NFA clause was challenged as a Development Condition in connection with a CDP, then the legal analysis changes. Property owners could argue that one of the essential sticks-in-the-bundle of property ownership is the right to use your property as you please,⁴¹⁹ including establishing security and safety measures. But that right is limited as property owners cannot engage in nuisance-like behavior,⁴²⁰ or use their property in ways that endanger or damage adjacent properties.⁴²¹ Seawalls damage underlying beaches⁴²² and endanger neighboring

414 See CAL. PUB. RES. CODE § 30235 (West 2020). The Coastal Act allows exceptions for emergencies and for seawalls built through GHADs as discussed in Part IV. Section B.

415 See, e.g., *The Land Use and Circulation Elements of the San Luis Obispo County General Plan: North Coast*, CTY. OF SAN LUIS OBISPO, CALIF. 7-34–35 (Oct. 5, 2018), <https://www.slocounty.ca.gov/getattachment/d8c5ebea-b556-4774-9d2d-53af23bc09c8/North-Coast-Area-Plan.aspx> (“Shoreline and bluff protection structures shall not be permitted to protect new development. All permits for development on blufftop or shoreline lots that do not have a legally established shoreline protection structure shall be conditioned to require that prior to issuance of any grading or construction permits, the property owner record a deed restriction against the property that ensures that no shoreline protection structure shall be proposed or constructed to protect the development, and which expressly waives any future right to construct such devices . . .”).

416 But see Herzog & Hecht, *supra* note 8, at 512–13.

417 See generally *Euclid*, 272 U.S. at 365.

418 This type of ordinance “merely codifies the public trust doctrine’s background limits on private development in tidelands.” Herzog & Hecht, *supra* note 8, at 514. Moreover, “[b]uilding . . . a seawall for an existing structure will . . . encroach on public tidelands as the sea rises and migrates toward and around the bases of buildings that once stood on dry land. Building a seawall does not eliminate the problem: a seawall that prevents the mean high tide line from migrating landward of the seawall artificially prevents the movement of the mean high tide line and denies the public its reversionary trust interest. It also destroys the public’s trust interests in the beach itself: with the beach damaged or entirely absent, the trust interests in access, navigation, fisheries, and ecosystem functions, among others, have been entirely lost. Seawalls violate the public trust in a time of rising seas.” *No Day at the Beach*, *supra* note 181, at 554 (internal citations omitted).

419 See, e.g., SPANKLING & COLETTA, *supra* note 18, at 68–82.

420 *Id.*

421 Because armoring can damage adjacent property, it could be proscribed on that basis. See *Adaptation Tool Kit*, *supra* note 174, at 38 (“Governments, in some instances, can also be

properties by re-directing wave action to them.⁴²³ “[T]he Commission’s practice of including ‘no further armoring’ conditions in CDPs is widespread, and furthers the policies of the Coastal Act, which prevent the Commission from approving development that: contributes to erosion, requires armoring devices, or interferes with the public’s right to access the coast.”⁴²⁴ Cities have the right to regulate for a community’s well-being, even if some private property owners bear more of the regulation’s burden than others,⁴²⁵ and NFAs are justified on nuisance grounds. Moreover, there is a strong argument that when someone buys blufftop property, they assume the risk of bluff erosion and instability.⁴²⁶ If unhappy property owners object to the inclusion of NFA clauses in their CDPs, they can either accept such clauses or forego construction. They can pursue administrative relief or legal action, but, because there is significant precedent for upholding NFA clauses, they are not likely to prevail.

Even if property owners have a right to build a seawall,⁴²⁷ any permit will have Development Conditions attached to it. “For example, landowners could be required to pay impact fees to mitigate damages to natural resources (such as the loss of the ecological services provided by wetlands and beaches).”⁴²⁸ If a property owner objects to Development Conditions, a court’s analysis would use the *Nollan-Dolan* two-part nexus and rough proportionality test. The first part would assess whether there is a rational relationship between the project and harms the Development Conditions are designed to mitigate. The second part would assess whether the Conditions are roughly proportional to the harm they are designed to avoid or mitigate. By way of illustration, a common seawall permit condition is payment of a mitigation fee like the following:

The beach area itself and degradation of public access to and along the beach that would be impacted due to encroachment and the area impacted by estimated passive erosion over the 20 year mitigation period will be mitigated through the City’s Public Recreation Fee program. Thus, the applicants are required to pay a fee of \$127,786, in-lieu of providing new beach area to replace

sued for permitting armoring where the armoring causes flooding to neighboring property.”).

422 See *supra* text accompanying notes 204–206.

423 See *id.*

424 Herzog & Hecht, *supra* note 8, at 526 (internal citations omitted).

425 See, e.g., *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 124 (1978) (“A ‘taking’ may more readily be found when the interference with property can be characterized as a physical invasion by government . . . than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good.”).

426 See, e.g., Madeline Reed, *Seawalls and the Public Trust: Navigating the Tension between Private Property and Public Beach Use in the Face of Shoreline Erosion*, 20 *Fordham Env’t L. Rev.* 305, 336–37 (2017).

427 Seawalls are permissible to protect existing structures, in emergency situations, or through a GHAD. CAL. PUB. RES. CODE §§ 30235, 30611 (West 2020); see *supra* text accompanying notes 191–197 (discussing GHADs).

428 See *Adaptation Tool Kit*, *supra* note 174, at 37.

the beach area that will be lost due to the impacts of the seawall for the initial 20 year period.⁴²⁹

A permit should explain how seawall encroachment will negatively impact the beach, thus providing the nexus between the Development Condition and how the proposed project creates the need for it. The permit or underlying reports should explain how the mitigation fee was derived,⁴³⁰ thus providing evidence for the rough proportionality prong. If the permit contains such information, the Development Condition would likely be upheld.⁴³¹

A hard-armoring challenge could also arise in the unlikely event a locality orders a property owner to take down a seawall. For example, a city might order armoring removed if the seawall was intended to be temporary, its permit has expired, or it “has been damaged by storms or . . . comes to encroach on public lands as the foreshore erodes.”⁴³² While at least one state has an ordinance requiring seawall removal,⁴³³ and a California court affirmed a city’s order to remove a seawall that encroached on a public beach on nuisance grounds,⁴³⁴ municipalities might be reluctant to order seawall removal. Aside from being politically unpopular and likely to elicit negative press, property law typically abhors waste, so it may frown on a city order to destroy something that is still functional. Nonetheless, there is legal justification—in the form of ordinances and caselaw—supporting seawall removal under appropriate circumstances.

C. ACCOMMODATE: DEVELOPMENT CONDITIONS

Accommodate-based adaptation tools include both narrower Development Conditions tailored to specific CDPs and regulations of broader application. Development Conditions can range from building requirements, like setbacks and other conditions designed to enhance resilience, to exactions or dedications designed to mitigate against a given project’s impacts. Regulatory tools include zoning changes, such as newly-created, high-hazard coastal zones, which will be discussed in the next Section, and code changes designed to strengthen structures to mitigate sea level rise impacts. Applicants can chal-

429 See STAFF REPORT: REGULAR CALENDAR, APPLICATION NO. 6-18-0288, CAL. COASTAL COMM’N 3 (2019).

430 *Id.*

431 See Herzog & Hecht, *supra* note 8, at 526 (providing examples of typical seawall permit conditions, and arguments for why they should be upheld).

432 See *Adaptation Tool Kit*, *supra* note 174, at 37.

433 See ME. ADMIN CODE 06-096 Ch. 355, §10 (2010).

434 See *Scott v. City of Del Mar*, 58 Cal. App. 4th 1296, 1305 (Cal. Ct. App. 1997) (“[T]he evidence introduced at trial proved that the seawalls, riprap and patios were abatable nuisances per se.”).

lenge Development Conditions at the outset,⁴³⁵ or accept Development Conditions to acquire a permit, and challenge them along the way or after completing construction.⁴³⁶

Beach cities routinely include Development Conditions in CDPs to protect the sensitive habitat and unique environment often connected to coastal development. Cities can impose Development Conditions specifically designed to mitigate against sea level rise risks, including common ones like increased setbacks, higher elevation requirements, and assumption of risk and waiver of liability agreements. Property owners could challenge Development Conditions as insufficiently related to their projects under the *Nollan-Dolan* test. Absent specific conditions attached to an actual CDP, it is impossible to engage in a fact-specific inquiry. Nonetheless, any challenge requires a legitimate purpose underlying the Development Conditions and a nexus between the Conditions and the project. If no such nexus exists, the inquiry ends. If a valid nexus exists, it must be roughly proportional to the harm the condition is designed to avoid. For example, a CDP may include a condition that all structures be sufficiently elevated to avoid increased flood risk due to sea level rise projections. To meet the nexus prong, the permitting agency must convincingly articulate that the elevation requirements are necessary to protect people and property in the face of anticipated sea level rise. Rough proportionality can be met with vulnerability assessments or studies that document the expected impacts of sea level rise and anticipated flooding levels. Development Conditions should reference such impacts and be tailored with elevation requirements sufficient to protect against anticipated flooding in that specific location. So long as the municipality can establish a nexus and rough proportionality, these types of Development Conditions are likely to be upheld.

Localities can also impose common development costs, such as exactions or land dedications,⁴³⁷ but *Nollan* and *Dolan* made clear that there are limits to these costs.⁴³⁸ If a property owner wants to build on an oceanfront lot where the sea level is expected to rise over the coming years, a permitting entity could condition approval on land dedication to preserve public beaches that will disappear as the mean high tide line moves

435 See, e.g., *Pfeiffer v. City of La Mesa*, 69 Cal. App. 3d 74, 78 (Cal. Ct. App. 1977) (noting that instead of complying with the conditions first and suing later, the applicants should have challenged the conditions by a petition for writ of mandate). It is probably less likely that property owners will sue for a writ of mandate, since many applicants want to proceed with construction—after all, time is money.

436 See, e.g., *Bowman v. Cal. Coastal Comm'n*, 230 Cal. App. 4th 114 (Cal. Ct. App. 2014) (relying on *County of Imperial v. McDougal*, 19 Cal. 3d 505, 511 (Cal. Ct. App. 1977) (“A party who fails to challenge the validity of a permit condition and accept its benefits has acquiesced in the permit and is bound by the conditions.”)); *Lynch v. Cal. Coastal Comm'n*, 3 Cal. 5th 470 (Cal. Ct. App. 2017) (“The Commission granted the permit [to build a new seawall after the old one suffered storm damage] subject to several mitigation conditions. The owners filed an administrative mandate petition objecting to two conditions but then proceeded with construction. We hold that the owners forfeited their challenge because they accepted the benefits the permit conferred.”).

437 Exactions are a routine part of the permit process. See Hayley Raetz et al., *Residential Impact Fees in California*, TERNER CTR. 16 (Aug. 5, 2019), http://turnercenter.berkeley.edu/uploads/Residential_Impact_Fees_in_California_August_2019.pdf (reporting fees charged in California for residential development).

438 See *supra* Part V. Section A.

landward.⁴³⁹ Property owners could challenge such dedications as takings, which are, again, subject to a *Nollan-Dolan* analysis, but a land transfer is more onerous than mitigation fees or construction requirements, so a closer nexus may be required.⁴⁴⁰ To establish a sufficient nexus, beyond showing that inevitable sea rise will consume existing beaches, a city would have to show that the proposed dedication somehow contributes to the need for the beach. Then it would have to show rough proportionality. Under this example, when the sea migrates landward, the public beach will shrink and possibly vanish. If the city relies on vulnerability studies that predict the amount of sea level rise during the expected life of the structures that are the subject of the permit, it can design a dedication matching the level of beach expected to be lost during that same time period. This allows both continued beach access, as required by the public trust doctrine, and property owners' use of their remaining land. Cities must carefully design Development Conditions based on reliable data as applied to the actual property subject to the permit to mitigate sea level rise impacts. The better cities do this, the likelier the Development Conditions can meet the *Nollan-Dolan* test and appropriately balance land-use regulations and private-property rights.

Although seawalls were discussed in the previous Section, they are relevant here if there is a Development Condition *not* to build seawalls. For example, a permit for an oceanfront property may include an NFA clause like that in the Seal Beach permit discussed earlier.⁴⁴¹ If property owners challenge this type of Development Condition, under *Nollan-Dolan*, a locality must establish a nexus between the condition and the project's impacts. It could argue the Development Condition preserves beaches, beach access, and the ecosystem's environmental health,⁴⁴² while enhancing the safety of neighboring properties by preventing increased wave action. It could establish rough proportionality by arguing the Condition is precipitated by development on blufftop property.

[T]he Coastal Act . . . provides that new development 'shall assure stability and structural integrity, and neither create nor contribute significantly to erosion,

439 Cities could also require dedication of rolling easements—discussed in the next Section on managed retreat.

440 “[T]he constitutionally required nexus may be tighter where exactions include the actual conveyance of property as opposed to the imposition of fees. For example, this approach has been followed by California courts since *Nollan*.” See Daniel J. Curtin, *Planning and Zoning Exactions, Dedications and Development Agreements Nationally and in California: When and How Do the Dolan/Nollan Rules Apply?*, *CTR. FOR AM. & INT’L L.* 4 (Apr. 10, 2003), http://www.ca-ilg.org/sites/main/files/file-attachments/resources__exactions.pdf.

441 See *supra* text accompanying note 2433. Property owners could also be subject to this clause not through a CDP, but rather through an LCP that applies to all coastal properties. See, e.g., *The Land Use and Circulation Elements of the San Luis Obispo County General Plan: North*, *supra* note 41508, at 7-34–35 (“All permits . . . shall be conditioned to require that prior to issuance of any grading or construction permits, the property owner record a deed restriction against the property that ensures that no shoreline protection structure shall be proposed or constructed to protect the development, and which expressly waives any future right to construct such devices that may exist.”).

442 See *No Day at the Beach*, *supra* note 181, at 578 (“[T]he conditions serve a fundamental purpose of preserving the state’s ability to steward public trust lands as they physically shift from natural and climate change forces by preserving the trust lands themselves.”).

geologic instability, or destruction of the site or surrounding area or in any way require the construction of protective devices that would substantially alter natural landforms along bluffs and cliffs.’ The ‘no future armoring’ conditions effectuate this statutory prohibition and make explicit the state’s intention to protect public trust lands and resources.⁴⁴³

Building on high-hazard coastal property is risky, and if property owners proceed with construction, they should assume the risk of damage. But for construction, armoring, which is dangerous to neighboring tracts and causes environmental harm and beach degradation, would be unnecessary. Thus, a Development Condition obligating the property owner to accept an NFA clause is fair—it strikes an appropriate balance between property rights by allowing owners to continue using their property, while protecting public beaches, access, and adjacent properties.

The second set of accommodation tools are regulatory, and, thus, of broader application than Development Conditions (though they often involve the same types of provisions). Routine regulations designed to improve safety or enhance resilience include setbacks, building reinforcements, or design standards to enable easier relocation when seas rise.⁴⁴⁴ Such regulations can better withstand legal challenges if they are part of an updated LCP intended to improve safety and prepare for sea level rise based on detailed vulnerability studies and adaptation plans designed to mitigate those vulnerabilities.⁴⁴⁵ Underlying studies that inform LCP updates are akin to the studies that influenced the *Euclid* Court to generally validate zoning and to give LCPs more legitimacy.⁴⁴⁶

Property owners could challenge sea level rise mitigation regulations upon adoption, but there is probably not enough self-interest for individuals to put in the time or money for such a challenge.⁴⁴⁷ However, real estate consortia or property rights advocates could oppose new regulations that limit property rights in coastal areas.⁴⁴⁸ Even if challenged, opponents would face a difficult battle because cities can regulate under the police power

443 *Id.*; see also CAL. PUB. RES. CODE § 30253(2) (West 2020).

444 See CCC SLR Policy Guidance, *supra* note 3, at 89 (“The options available to minimize risks from sea level rise are dependent upon the specifics of the local community, and will vary widely depending on whether the area is an urban, fully developed waterfront, or a rural, undeveloped coastline. In undeveloped areas, the options may be clear: strictly limit new development in sea level rise hazard zones.”).

445 In fact, regulations to mitigate impacts from natural disasters have been around for decades, such as those designed to enhance flood resilience, withstand earthquakes, and reduce fire hazards. “Where it is appropriate to encourage or allow development, coastal construction setbacks for new developments and redevelopment should be based upon the best available projections of the location of the shoreline during the lifetime of the building to be constructed, based on a “no regrets” approach that grants the benefit of the doubt to the most restrictive line supported by the science.” Grosso, *supra* note 262 at 59.

446 See *Euclid*, 272 U.S. at 394.

447 Property owners are likelier to challenge regulations as applied to their specific CDPs, as discussed above.

448 For example, the Institute for Justice fights “is dedicated to protecting the right of every American to own and use his or her property freely. Respecting the right of private property is essential to a just and prosperous society. But government at all levels—local, state and federal—routinely infringe on these rights.” *Private Property*, INST. FOR JUSTICE, <https://ij.org/issues/private-property/> (last visited Nov. 28, 2020).

and, so long as there is a rational link between regulations and safety, the regulations will be upheld.⁴⁴⁹ Almost 100 years ago, the Supreme Court upheld setback requirements and land use regulations, reasoning that localities “who deal with the situation from a practical standpoint, are better qualified than the courts to determine the necessity, character, and degree of regulation these *new and perplexing conditions* require; and their conclusions should not be disturbed by the courts, unless clearly arbitrary and unreasonable.”⁴⁵⁰ Each era will have its own “new and perplexing conditions” necessitating regulations to abate danger and enhance a community’s well-being. The current “new and perplexing conditions” of climate change and sea level rise call for regulatory action designed to protect the coast, private property, and human safety. Given the strong relationship between regulations designed to mitigate sea level rise and enhanced safety, there is sufficient justification for challenged regulations to be upheld.

Regulations could also emerge if developed coastal property is destroyed or damaged due to sea level rise, storm surge, flooding, or erosion. If such property is in high-hazard coastal zones, like FEMA’s high-risk Special Flood Hazard Areas,⁴⁵¹ redevelopment after sea level rise-related damage could be banned or severely curtailed. Property owners might argue such prohibitions amount to a taking—and they would be sympathetic plaintiffs, having already suffered property loss; however, there are compelling reasons both to protect them and the community and to minimize expenditure of government dollars to subsidize rebuilding or insurance, which counsel against rebuilding. Further, mother nature does not respect the property rights of those in high-hazard areas.

[L]andowners in this situation, unlike with a *Lucas*-like building prohibition, would be resting their cases on the violation of some kind of ‘fundamental right to maintain structures despite the effects of the forces of nature,’ which is a stick not found in any of the familiar bundles of property rights. Indeed, the existence of government restrictions on rebuilding after structures are significantly damaged by natural hazards such as coastal flooding and extremely high winds . . . indicate strongly that placing even significant burdens on any such proffered right would be much less likely to result in a favorable takings ruling than cases involving the much more recognizable and respected (though certainly not absolute) rights to exclude and alienate.⁴⁵²

There are persuasive safety-based arguments to prevent rebuilding structures destroyed by natural disasters in high-hazard zones. Nonetheless, property owners who suffer loss due to sea level rise and related events, could argue that regulations that prevent them from rebuilding cause a total economic loss. The argument may fail because there

449 See *Gorrie v. Fox*, 274 U.S. 603, 608 (1927) (“[C]omprehensive zoning laws and ordinances, prescribing, among other things, the height of buildings to be erected and the extent of the area to be left open . . . etc., are, in their general scope, valid under the federal Constitution.”) (citing *Euclid*, 272 U.S. at 386).

450 *Id.* (emphasis added).

451 See *Flood Maps*, FED. EMERGENCY MGMT. AGENCY, <https://www.fema.gov/disaster/updates/fema-flood-maps-and-zones-explained> (last updated Sept. 7, 2020).

452 See Michael Allan Wolf, *Strategies for Making Sea-Level Rise Adaptation Tools “Takings Proof,”* 28 J. Land Use & Env’t L., 157, 190–91 (2013) (citations omitted).

is precedent for these restrictions,⁴⁵³ and they will not truly have suffered a total loss as they still own their land and are likely to receive insurance proceeds from damage claims.

Many Development Conditions and regulations are designed to prevent or mitigate sea level rise vulnerabilities, some of which could generate takings challenges. However, “accommodate” tools can be thoughtfully designed to establish an appropriate nexus that is roughly proportional to a project’s impacts. If so designed, they should be upheld, while also allowing property owners continued use of their land.

D. MANAGED RETREAT: DOWNZONING, ROLLING EASEMENTS, AND TDRs/PDRs

Managed retreat tools are the most controversial in the adaptation toolbox. The chief managed retreat strategies are Development Prohibitions in high-risk zones, rolling easements that move property lines landward as sea levels rise and facilitate eventual structure relocation from high-risk areas, and TDR/PDR programs. While some protect and accommodate tools promote managed retreat goals, managed retreat is still typically considered a separate adaptation category. Property owners may object to the managed retreat tools, arguing they limit property use and decrease property value, amounting to a regulatory taking.

1. DOWNZONING

One of the most important and charged managed retreat tools is a ban on development or expansion of existing development (downzoning),⁴⁵⁴ through the creation of high-hazard coastal zones that limit property use and likely reduce values.⁴⁵⁵ All cities were downzoned the moment they enacted their first zoning ordinances,⁴⁵⁶ and, in spite of early opposition, the Supreme Court upheld the validity of zoning in *Euclid*.⁴⁵⁷ However, specific zoning amendments that change a tract’s zoning and severely limit property use, could be problematic. For example, if property were rezoned as high-hazard coastal

453 See James Schwab et al., *Planning for Post-Disaster Recovery and Reconstruction*, AM. PLANNING ASS’N 63–64, 70, 72 (Sept. 2005), https://www.fema.gov/pdf/rebuild/ltrc/fema_apc_ch3.pdf.

454 See Justin Gundlach & P. Dane Warren, *Local Law Provisions for Climate Change Adaptation*, COLUMBIA L. SCH. 11 (2016) (“Downzoning is a strategy by which local governments limit development and redevelopment to low-density or low-intensity uses. Downzoning can be useful for limiting development in areas where managed retreat from a coastline or waterway is appropriate. Downzoning could theoretically prohibit coastal development altogether, though such an approach could invite legal challenge on the grounds that it imposed a regulatory taking.”).

455 See DWIGHT H. MERRIAM & SARA C. BRONIN, RATHKOPF’S THE LAW OF ZONING AND PLANNING § 38:30 (4th ed. 2020) (“Since downzoning generally results in a loss of property value, part of a downzoned property owner’s case will almost certainly be a claim of confiscation.”).

456 Not surprisingly, many opposed zoning ordinances early on because pre-zoning, they could use their property as they pleased, subject to some limitations such as those tied to nuisance and other state and common law constraints. See, e.g., *Euclid*, 272 U.S. at 365; *Hadacheck v. Sebastian*, 239 U.S. 394, (1915).

457 *Euclid*, 272 U.S. at 397.

that allows only minimal use, owners could easily mount a takings challenge, alleging their property has been zoned out of utility and drastically decreased in value.

Under *Penn Central*, a court assessing the validity of newly-created, high-hazard coastal zones would: analyze the regulation's character (whether it supports legitimate health and safety concerns); its economic impact on the parcel as a whole (whether there is any remaining value in the entire parcel); and the landowner's distinct investment-backed expectations.⁴⁵⁸ Downzoning promotes health and safety both by protecting property owners from sea level rise hazards and by safeguarding beaches and beach access.⁴⁵⁹ Newly-created, high-hazard coastal zones would remove most property value, but some low impact uses would remain.⁴⁶⁰ It is not possible to analyze distinct investment-backed expectations for a specific owner, but there are some common generalizations. As a starting point, if land is still undeveloped when regulations creating high-hazard coastal zones are enacted, there is no expectation of an economic return, at least through the time of the zoning amendment. In addition, climate change has been in the global consciousness for decades, and "sea level rise" is now a common phrase.⁴⁶¹ Coastal property has always been subject to more intense impacts from storm events.⁴⁶² Thus, coastal landowners' investment-backed expectations are shaped, at least in part, by knowledge of heightened flood and erosion risks for coastal properties, as well as the likelihood that such properties might be subject to greater regulation because of those risks. On balance, under *Penn Central*, there is a strong case that the character of regulations creating high-hazard coastal zones and investment-backed expectations of coastal property purchasers will favor upholding the creation of such zones.⁴⁶³ While the economic impact will disfavor these zones, owners can continue to use their property, even if development is limited, and the strength of the other two factors could cause a court to balance land use regulation and property rights in favor of the former.⁴⁶⁴

Lucas directly addressed Development Prohibitions that restrict construction on coastal lots,⁴⁶⁵ thus it would be on point for a downsizing challenge that likewise limits coastal lots' development. When engaging in a fact-specific inquiry that focuses on a regulation's economic impact, if little value remains, there is a taking unless "restrictions that background principles of the State's law of property and nuisance already place upon land ownership" would allow such a Development Prohibition.⁴⁶⁶ Accordingly, if owners challenged their property's rezoning to high-hazard coastal, a court would assess

458 *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 124 (1978)

459 *See id.* at 125.

460 *See* MERRIAM & BRONIN, *supra* note 455, § 38:30.

461 *See, e.g.*, Peter Jackson, *From Stockholm to Kyoto: A Brief History of Climate Change*, UNITED NATIONS, <https://www.un.org/en/chronicle/article/stockholm-kyoto-brief-history-climate-change> (last visited Nov. 27, 2020); Joshua K. Willis et al., *Sea Level Rise*, SMITHSONIAN INST. OCEAN (Apr. 2018), <https://ocean.si.edu/through-time/ancient-seas/sea-level-rise#:~:text=Florida%20is%20the%20U.S.%20state,humans%20have%20caused%20so%20far>.

462 *See generally* EVALUATION OF EROSION HAZARDS SUMMARY, FED. EMERGENCY MGMT. AGENCY (2000).

463 *See Penn Cent. Transp. Co.*, 438 U.S. at 124.

464 *See id.*

465 *See Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1003 (1992).

466 *See id.* at 1029.

how much economic value remained following the change.⁴⁶⁷ If most value disappeared, there would be a taking unless a similar loss would occur under state law background principles.⁴⁶⁸ Even after being rezoned, there is still some value for camping, picnics, education, and other low-impact activities.⁴⁶⁹ Nonetheless, the value would significantly decline if the land could not be developed, which is enough to find a taking.⁴⁷⁰ However, the Development Prohibition might be upheld if its goals could otherwise be achieved under state law background principles. Since *Lucas*, courts have been willing to view such principles more expansively.⁴⁷¹ While the *Lucas* Court focused on nuisance law,⁴⁷² the public trust doctrine and custom have emerged to provide broader justification of managed retreat tools.⁴⁷³

The world has changed since *Lucas* was decided—with sea level rise now a pressing problem in coastal communities—and the story is still being written. The *Euclid* Court said that regulations develop in response to complex current conditions,⁴⁷⁴ and sea level rise is certainly a current complex crisis that requires new regulations to address previously non-existent problems. There is a persuasive argument that both the police power and public trust doctrine support limiting development in high-hazard coastal zones. Local governments are charged with protecting their communities under the police power, which allows them to regulate to that end. Public health and safety concerns demand a far-reaching response to mitigate potential sea level rise damage compounded by storm or tide events—even as drastic as preventing development in areas that are in the bullseye of sea level rise destruction. Beyond the police power, background principles of state law such as nuisance, as well as the public trust doctrine and custom, may provide support for Development Prohibitions through high-hazard coastal zones where building is curtailed or prohibited.

First, while property owners generally can use their property as they wish, nuisance principles militate against uses that harm others or prevent them from using their property as they wish.⁴⁷⁵ While building certain coastal property structures, like seawalls, can harm adjacent properties, building on one's own land does not in and of itself constitute a nuisance. However, if natural landward migration of the ocean resulting from sea level rise inundates structures, eventually submerging them, there could be valid nuisance concerns: the structures themselves, plus their infrastructure and contents, could pollute

467 See *id.*

468 See *id.*

469 See, e.g., Grosso, *supra* note 262, at 54 (“[T]he allowance of uses such as picnics, parking, and recreation —while not highly profitable—were economically beneficial and thus precluded a takings claim . . .”).

470 See *Lucas*, 505 U.S. at 1029.

471 See Byrne, *supra* note 276, at 99 (“Subsequent decisions more sympathetic to environmental regulation have focused both on . . . expanding the scope of its exception for limitations that inhere in the owner’s title.”).

472 See *Lucas*, 505 U.S. at 1003.

473 See *Sea Level Rise Adaptation Strategies*, *supra* note 161.

474 *Euclid*, 272 U.S. at 397.

475 See generally DONAL NOLAN & ANDREW ROBERTSON, ‘A TORT AGAINST LAND’: PRIVATE NUISANCE AS A PROPERTY TORT, RIGHTS & PRIVATE L. 459–90 (Hart Publishing 2011).

the ocean, release toxins, and leave debris and waste.⁴⁷⁶ Thus, regulations that prohibit building in high-hazard coastal zones might be justified on nuisance grounds based on sea level rise projections, but this claim is tenuous.

Second, the public trust doctrine obligates governing bodies to protect beaches and beach access.⁴⁷⁷ While oceans have always risen and fallen, sea level is currently rising at unprecedented rates, creating extraordinary challenges, including a potential public trust crisis. Development restraints are essential to preserve beaches, their unique habitats, and beach access. With rising sea levels, the mean high tideline will move landward, and unless private property lines likewise adjust, beaches will disappear.⁴⁷⁸ Such adjustments are easier to make if land is unfettered by structures. One academic convincingly argues the public trust

defeats private owners' regulatory takings claims against the application of development regulations to projects within public trust areas. Moreover, it will move landward with the tideline. Thus, as the seas rise and the public trust areas move upland, the use rights of owners will either be extinguished or subjected to public property interests that will permit strict regulation without regard to *Lucas*. Note that when the public trust applies, the private owner . . . has no takings claim at all because the public enjoys a superior property interest.⁴⁷⁹

Another writer agrees, arguing “[i]t should not be considered a taking under the Fifth Amendment when the public trust doctrine compels a state to take title or assert control on behalf of the public over private lands that have been permanently submerged by the rise in sea level caused by climate change.”⁴⁸⁰ While these are credible public trust arguments, they are untested as of now. Landowners still have a strong claim that these regulations, which presently prohibit development even if the sea does not rise until the future, comprise a taking.⁴⁸¹ However, rolling easements can accomplish some of the same goals and provide a better compromise between sea level rise adaptation and private property rights, as described in the next subsection.

2. ROLLING EASEMENTS

Rolling easements are another controversial managed retreat tool, but they are tame compared to downzoning because they do not limit property use until sea level rise actually materializes.⁴⁸² An increasingly common managed retreat tool,⁴⁸³ rolling easements adjust private property lines landward to preserve public beaches and access when sea levels rise to defined benchmark levels, and may require structure and infrastructure

476 See generally Frank L. Seamans, *Tort Liability for Pollution of Air and Water*, 3 NAT. RES. LAWYER 1, 146 (1970).

477 See, e.g., *supra* text accompanying notes 112, 209.

478 See Byrne, *supra* note 276, at 99–100.

479 *Id.*

480 Hiatt, *supra* note 34545, at 385.

481 See Peloso & Caldwell, *supra* note 336, at 61.

482 See, e.g., *id.* (“The rolling easements concept assumes that as sea levels rise and the mean high tide line moves inland, public trust title will follow this line.”).

483 See *No Day at the Beach*, *supra* note 181, at 570 (“Whether rooted in public trust doctrine, custom, nuisance doctrine, permitting requirements, or statute, rolling easements have been deployed across the country.”).

removal. They are more palatable than other managed retreat tools because they allow property owners to freely use their property until triggering events occur; they “are an efficient means of adapting to rising sea levels because they impose no costs until sea levels actually rise, they have plenty of time to be incorporated into reasonable investment-backed expectations, and they may foster consensus on coastal development policies. . . .”⁴⁸⁴ If sea levels rise to predefined points, property lines change and structures might require removal.

Landowners might challenge rolling easements as takings, but they would probably pass constitutional muster since they do not deny all potential productive uses:

Although productive use would eventually end if and when the sea level rises to a particular elevation, the regulation itself does not prevent productive use when instituted. Moreover, because the contingency would generally be decades—perhaps centuries—away, the impact on property values would be very small. If included as a condition for a . . . building permit, rolling easements should pass the *Nollan-Dolan* test⁴⁸⁵

Further, nature is actually behind rising sea levels, so arguably there is no state action and hence no taking of private land for public purposes.⁴⁸⁶

Even with convincing justifications, rolling easements will still be challenged. If created through Development Conditions, the *Nollan-Dolan* test would apply⁴⁸⁷; but if created through Development Prohibitions, the *Penn Central* and *Lucas* tests would apply.⁴⁸⁸ Regardless of how created, if challenged, a local government would have to establish the legitimacy of the rolling easement and that it is not arbitrary.⁴⁸⁹ Broadly speaking, rolling easements promote health and safety by keeping structures and people out of sea level rise dangers. They benefit public welfare by preserving beaches and beach access, and they are not arbitrary because they attach to all high-hazard coastal properties to achieve important safety, environmental, and municipal goals.

Rolling easements created as a Development Condition require a nexus between the easement and proposed development, which could be established because any high-hazard coastal land will be subject to flooding and inundation when sea levels rise.⁴⁹⁰ Accordingly, rolling easements designed to mitigate harm and preserve person and property, by adjusting property lines and moving private property inland, are reasonably related to the harms they are designed to avoid.⁴⁹¹ It would be a stretch for a city to argue that development of any sort would create the need for a rolling easement. But, conceptually, if vulnerability assessments reveal sea level rise risks for coastal property, including time frame estimates for increased flooding and eventual inundation, then rolling easements

484 See Peloso & Caldwell, *supra* note 33636, at 61.

485 See *Rising Seas, Coastal Erosion, and the Takings Clause*, *supra* note 271, at 1357–58.

486 See *Penn Cent. Transp. Co.*, 438 U.S. at 124. (“A ‘taking’ may more readily be found when the interference with property can be characterized as a physical invasion by government . . . than when interference arises from some public program adjusting the benefits and burdens of economic life to promote the common good.”).

487 See *Rising Seas, Coastal Erosion, and the Takings Clause*, *supra* note 271, at 1357–58.

488 See Byrne, *supra* note 276, at 99.

489 See, e.g., Novack, *supra* note 27070, at 601–02.

490 See, e.g., *No Day at the Beach*, *supra* note 181, at 567–68.

491 See *id.*; Novack, *supra* note 270, at 601–02.

tied to those same time frames could establish the nexus and provide support for rough proportionality. To further demonstrate rough proportionality, rolling easement benchmarks should be based on sea level rise predictions as established by the most recently available science. So long as appropriate studies are used to create benchmarks, they should be sufficient to form a roughly proportional nexus to the harm they are designed to mitigate. Until the benchmark is met, property owners can freely use their property. Property lines only change when sea levels hit predetermined benchmarks, thus fairly balancing sea level rise mitigation steps with private property rights.

If rolling easements are created by Development Prohibitions, many of the same arguments supporting Development Conditions validate them.⁴⁹² In fact:

Rolling easements . . . do not impair the property's use today, and by the time they must be enforced, many decades may have passed. As a result, the rolling easement will have plenty of time to become part of the investment-backed expectations in areas that are developed in the future, and perhaps even in areas that have already been developed.⁴⁹³

Penn Central requires looking at the entire property, including temporal aspects, rather than just a discrete component.⁴⁹⁴ Given that rolling easements allow landowners full use of their property until some future date when predetermined benchmarks are met, there is no viable argument that owners have suffered a complete economic loss when regulations are put in place. In sum, there are compelling arguments supporting rolling easements under the tests for both Development Conditions and Prohibitions. They fairly balance sea level rise mitigation and property rights and should survive a legal challenge.

Beyond the traditional tests, other legal doctrines support rolling easements. For example, the public trust doctrine requires states to protect public beaches and access.⁴⁹⁵ When the mean high tide migrates landward due to sea level rise, property lines should likewise migrate, preserving beaches and access under the public trust mandate and protecting people and property.

[T]he full scope of a state's public trust duty under the radically different environmental circumstances of significant sea level rise may require not only that the state proactively assert the advance of the public trust title with rising seas, but also that the state deny permits to hold back the natural advance of mean high tide.⁴⁹⁶

Relying on *Titus*, others argue:

[T]he common law of erosion and the public trust jointly act to 'diminish the rights of coastal lowland owners, compared with the rights of noncoastal dryland owners.' The public trust doctrine is a background principle of the common law

492 There are legitimate health and safety reasons for rolling easements, they are not arbitrary or unreasonable, and they do not take away all economic use of the property.

493 See *Rising Seas, Coastal Erosion, and the Takings Clause*, *supra* note 271, at 1355.

494 See *Byrne*, *supra* note 276, at 109–10 (“A court reviewing a rolling development restriction must consider its effect on the whole property for its full duration.”).

495 See *Peloso & Caldwell*, *supra* note 33636, at 61.

496 *Id.* at 59.

and so would obviate a *Lucas* taking as applied in this case. The easement, simply put, has always been there: it is not an imposition on the property owner but part of the nature of his or her property.⁴⁹⁷

Public trust arguments therefore bolster the validity of rolling easements as Development Conditions and Prohibitions.

Custom also supports rolling easements:

Like the public trust doctrine, custom may constitute a background principle of law whose application could defeat a takings claim. In general, customary use can grant an easement over beach property. . . . In short, a rolling easement can be based on customary beach use, although the degree to which custom applies will vary based on the history of a particular stretch of beach.⁴⁹⁸

The custom rationale relies on the same basis justifying prescriptive public easements—long established use by the public can create an expectation that one has a right to use property, even if only as an access way.⁴⁹⁹ If the public has customarily used the beach in front of private property, when sea level rise erases the public beach, the public can make customary use of what had formerly been private beach property. If it does so long enough, it could establish a prescriptive easement over private land or justify the use under custom.

Texas was an early proponent of public rolling easements. However, it pivoted in 2012 when a divided Court decided *Severance v. Patterson*.⁵⁰⁰ The narrow ruling looked specifically at “whether private beachfront properties on Galveston Island’s West Beach are impressed with a right of public use under Texas law without proof of an easement.”⁵⁰¹ Underlying the certified question was whether Texas recognized:

[A] “rolling” public beachfront access easement, *i.e.*, an easement in favor of the public that allows access to and use of the beaches on the Gulf of Mexico, the boundary of which easement migrates solely according to naturally caused changes in the location of the vegetation line, without proof of prescription, dedication or customary rights in the property so occupied[.]⁵⁰²

While the Court acknowledged that “[b]eachfront property lines retract or extend as previously dry lands become submerged or submerged lands become dry,”⁵⁰³ it also said that there was no automatically-arising rolling easement that follows such movement:

497 *No Day at the Beach*, *supra* note 181, at 568.

498 *Id.* at 555.

499 *See, e.g.*, CAL. COASTAL COMM’N, SOME FACTS ABOUT PUBLIC PRESCRIPTIVE RIGHTS 1 (2001), (“Prescriptive Rights refer to public rights that are acquired over private lands through use. Along the California coast the general public has historically used numerous coastal areas. Trails to the beach, informal parking areas, beaches, and bluffs have provided recreational opportunities for hiking, picnicking, fishing, swimming, surfing, diving, viewing and nature study. The public may . . . acquire the right through use of the property without permission.”).

500 *Severance v. Patterson*, 370 S.W.3d 705, 705 (Tex. 2012).

501 *Id.* at 708.

502 *Id.*

503 *Id.*

[W]hen a beachfront vegetation line is suddenly and dramatically pushed landward by acts of nature, an existing public easement on the public beach does not “roll” inland to other parts of the parcel or onto a new parcel of land. Instead, when land and the attached easement are swallowed . . . in an avulsive event, a new easement must be established by sufficient proof to encumber the newly created dry beach bordering the ocean.⁵⁰⁴

Even with this decision, *Severance* is not a death knell for rolling easements for several reasons. First, it is limited to Texas.⁵⁰⁵ Second, it involves an automatically arising easement rather than an easement created explicitly by regulation like Development Prohibitions, by permit like Development Conditions, or by implication through prescription.⁵⁰⁶ Third, *Severance*’s fact-specific context involved a rapid change in the tide line due to an avulsive event—not a gradual sea level rise scenario.⁵⁰⁷ Rolling easements as conceptualized for sea level rise adaptation are distinct enough from the rolling easement found invalid in *Severance* that the case should not invalidate rolling easements as a managed retreat tool. However, whether arising as a Development Prohibition or Condition, rolling easements should be designed based on vulnerability assessments and sea level rise predictions. Further, rolling easements should be carefully tailored to allow landowners full use of their land until benchmark levels are met. If so structured, they are more likely to be upheld.

Between the police power, common law, the public trust doctrine, and custom,⁵⁰⁸ important justifications for rolling easements exist. They preserve public beaches and access by adjusting property lines with rising sea levels, and more importantly, protect people and private property by moving structures inland as seas rise.

3. TDRs AND PDRs

TDR and PDR programs are the least controversial managed retreat tool because they primarily involve voluntary participation and provide economic value. Under these programs, landowners transfer development rights in exchange for more intensive development rights elsewhere,⁵⁰⁹ or sell them. While most programs are voluntary, some are

504 *Id.*

505 *See Severance*, 370 S.W.3d at 708.

506 *See id.* at 705.

507 *See, e.g.,* Byrne, *supra* note 276, at 110 (stating that the *Severance* Court’s “takings analysis applies only to avulsion and to public access easements and not to rolling use restrictions tied to sea-level rise”).

508 *See No Day at the Beach*, *supra* note 181, at 551–52 (“Expressly grounding rolling easements in the longstanding background principles of the common law and within the principles of property law helps to immunize the state from potential constitutional takings challenges because articulating such background principles does not change the existence of fundamental property rights enjoyed by a private owner but merely clarifies that owner’s existing rights.”). *But see Severance*, 370 S.W.3d at 708 (“[A] new easement must be established by sufficient proof to encumber the newly created dry beach bordering the ocean.”).

509 *See* Nicholas R. Williams, *Coastal TDRs and Takings in A Changing Climate*, 46 Urb. Law. 139, 149–50 (2014) (“Where a state or local government identifies a coastal area where retreat is the optimal adaptation strategy, a [TDR] program can restrict coastal development while simultaneously allowing landowners to profit from the development potential of their parcels.”).

mandatory.⁵¹⁰ Voluntary programs do not typically pose legal problems;⁵¹¹ however, mandatory programs could precipitate legal challenges. The easiest way to avoid this is to structure programs as voluntary and model them on the most successful existing programs.⁵¹² Even if mandatory, challenges are not insurmountable. Both TDR and PDR programs clearly advance legitimate state purposes because they “preserve public resources [like beaches, wetlands, and their animal and plant denizens] and minimize future costs to public and private property.”⁵¹³ Like the TDRs in *Penn Central*, TDRs give property owners enhanced development rights elsewhere.⁵¹⁴ Like *Lucas*, which limited coastal development, TDRs and PDRs involve Development Prohibitions.⁵¹⁵ Under both programs, owners get payment or denser development rights elsewhere and some continued land use, so neither program denies property owners of all their land’s economically viable use. However, that does not guarantee no taking will be found—one must still engage in *Penn Central* and *Lucas* analyses.

Penn Central looks at economic impact and “the extent to which the regulation has interfered with distinct investment-backed expectations”⁵¹⁶ Mandatory TDR or PDR programs clearly reduce property values because they remove development rights. This is offset partially, but not much, by the continued ability to make some land uses, like camping, picnicking, or providing education programs, that can still take place without further property development.⁵¹⁷ Reduced property values are also partially offset by a reduction in costs that are tied to real estate value—like property taxes in California.⁵¹⁸ The more significant offset occurs through the sale of development rights or the right to develop more densely elsewhere. TDRs and PDRs accordingly reduce property value by removing development rights, but owners still get property use and significant economic value. Turning to investment-backed expectations, it is impossible to engage in a fact-specific inquiry without considering an actual tract and its owner. However, one factor that will influence the analysis is when the property was acquired; if purchased after concerns about climate change and sea level rise emerged, such knowledge

510 *Id.* at 155 (“[T]he vast majority of TDR programs are entirely voluntary programs. TDRs are introduced, not on top of a development restriction, but as a way to incentivize developers to locate their development elsewhere.”); see also *Transfer of Development Rights (TDRs) Model and Commentary*, PLANNING FOR HAZARDS, <https://planningforhazards.com/transfer-development-rights-tdrs-model-and-commentary> (last visited Nov. 28, 2020).

511 *But see* Herzog & Hecht, *supra* note 8, at 527 (stating that TDRs are still vulnerable to takings claims if there is no viable market for TDR credits).

512 There are hundreds of TDRs that can be studied for best practice ideas. See DePasquale, *supra* note 281, at 191 (“As of 2010 there were nearly 250 TDR programs across the country, with active TDRs ‘in thirty-four states as well as the District of Columbia.’”).

513 See Williams, *supra* note 50902, at 172.

514 *Penn Cent. Transp. Co. v. City of New York*, 438 U.S. 104, 124 (1978);

515 *Lucas v. S.C. Coastal Council*, 505 U.S. 1003, 1030 (1992).

516 See *Penn Cent. Transp. Co.*, 438 U.S. at 124.

517 See *supra* text accompanying note 469.

518 California voters passed Proposition 13 in 1978, which returned property taxes to 1976 levels, freezing them there subject to modest annual increases until the sale of the property, at which time the property was reassessed. See *Understanding Proposition 13*, SANTA CLARA CNTY. ASSESSOR’S OFF., <https://www.sccassessor.org/index.php/faq/understanding-proposition-13> (last visited Nov. 28, 2020).

would shape investment-backed expectations as buyers would be on constructive notice of potential development limitations, as well as property loss.⁵¹⁹ “In an era of sea level rise . . . coastal landowners’ expectations should be shaped by increased risks that they will, over the course of time, lose their land to advancing seas, as well as experience damaging coastal storms that destroy structures at an earlier date.”⁵²⁰ Even if one bought coastal property before sea level rise concerns became widespread, such properties have always been subject to a greater risk of flood damage from large storms and high tides, which would inform investment-backed expectations. In summary, using a *Penn Central* analysis, while TDR and PDR programs would have a negative economic impact on property value, owners retain property use and obtain economic benefits.⁵²¹ Thus, in the abstract such programs would likely withstand a takings challenge.

Under *Lucas*, if a TDR or PDR program removed all economically viable use from property, there would be a taking unless background principles of law could produce the same result as the program.⁵²² Even without specific facts, the value of any tract would almost certainly decline if development were limited or prohibited. However, a property owner could still use and enjoy coastal property, and any remaining value would be enhanced by the sale or transfer value of development rights. Depending on a challenging owner’s particular facts, enough remaining value should exist between allowed uses, plus TDR or PDR value, to find no taking.⁵²³ On the slim chance facts exist to support a taking under *Lucas*, state or common law doctrines could still achieve the same results as a TDR or PDR program. As previously discussed, nuisance law could prohibit construction on high-hazard land.⁵²⁴ Likewise, the public trust doctrine limits private uses that inhibit public beach access or lead to the loss of public beaches or wetlands.⁵²⁵ Thus, TDRs and PDRs should survive a takings challenge under *Lucas* as they would not lead to a total economic loss, and state and common law doctrines provide support for these programs.

Managed retreat tools are both the most politically-charged adaptation tools and the most likely to produce legal challenges. Balancing regulation and property rights is difficult when it comes to long term responses to extreme natural hazards like sea level rise. Downzoning, which prohibits new development by its nature, compromises property rights the most in favor of regulation and faces the highest hurdles. Nonetheless, downzoning regulations could still survive legal challenges if properly developed. Rolling easements could achieve many of the downsizing benefits but would allow landowners their property’s full use until set sea levels are reached. Rolling easements better balance land use and regulation with property rights and can be designed to sustain legal challenges. Voluntary TDR and PDR programs should not produce legal challenges because

519 See Hiatt, *supra* note 345, at 394.

520 Williams, *supra* note 50902, at 171–72.

521 See *Penn Cent. Transp. Co.*, 438 U.S. at 124.

522 See *Lucas*, 505 U.S. at 1015.

523 See, e.g., Williams, *supra* note 509, at 159 (“As a private-market mechanism that enables landowners to realize economic gain from the sale of their parcel’s development potential, TDRs would seem to provide the economic benefit necessary to defeat any *per se* takings claim under *Lucas*”).

524 See *supra* text accompanying note 466.

525 See *supra* text accompanying notes 477–481.

property owners choose to participate in the programs. Even mandatory programs could overcome legal challenges, so long as they are appropriately tailored to meet legitimate state interests, because payments for development rights prevent a total economic loss and owners can still otherwise use their property.

VI. CONCLUSION

This Article considered sea level rise, land use, and property rights. It explored sea level rise, a current problem that will get significantly worse with devastating impacts, and a multi-pronged regulatory approach that simultaneously respects property rights and promotes health and safety. It described adaptation tools, like Development Prohibitions and Conditions, and their strengths and shortcomings. These tools are standard land use devices that can mitigate sea level rise impacts, prevent harm, and save property and resources. One managed retreat tool utilizes traditional purchase programs, and this Article added the innovative concept of creating a rental pool for prime oceanfront real estate as part of a purchase program. This could be attractive to oceanfront property owners as they receive fair market value for their property while it is still at its peak. It also allows property owners to rent the property back if they are attached to the location and creates a rental pool to recoup costs and acquire more high-hazard coastal properties. Accordingly, this innovative approach introduces a way to enable managed retreat through voluntary transfers, which is critical for high-risk coastal properties.

Adaptation tools are essential to mitigate harm and preserve person and property. However, they can significantly constrain venerated property rights. While tools can be designed to prevent damaging impacts and preserve some property rights, for any property rights lost, legal challenges will likely follow. This Article noted that, in the abstract, it is impossible to determine legal outcomes. But using a regulatory takings framework buttressed by nuisance principles, the public trust doctrine, and custom, this Article demonstrated that most adaptation tools, if carefully tailored, should survive legal challenge.

In sum, coastal communities everywhere should proceed with vulnerability assessments and adaptation strategies. Auxiliary businesses like insurance companies and mortgage lenders should modify their policies and practices to channel behavior that mitigates harm. Finally, individual property owners should build responsibly and assume sea level rise risks. Provided all the parties in a position to reduce risks work together, sea level rise damages can be minimized and, in some cases, prevented altogether.

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