

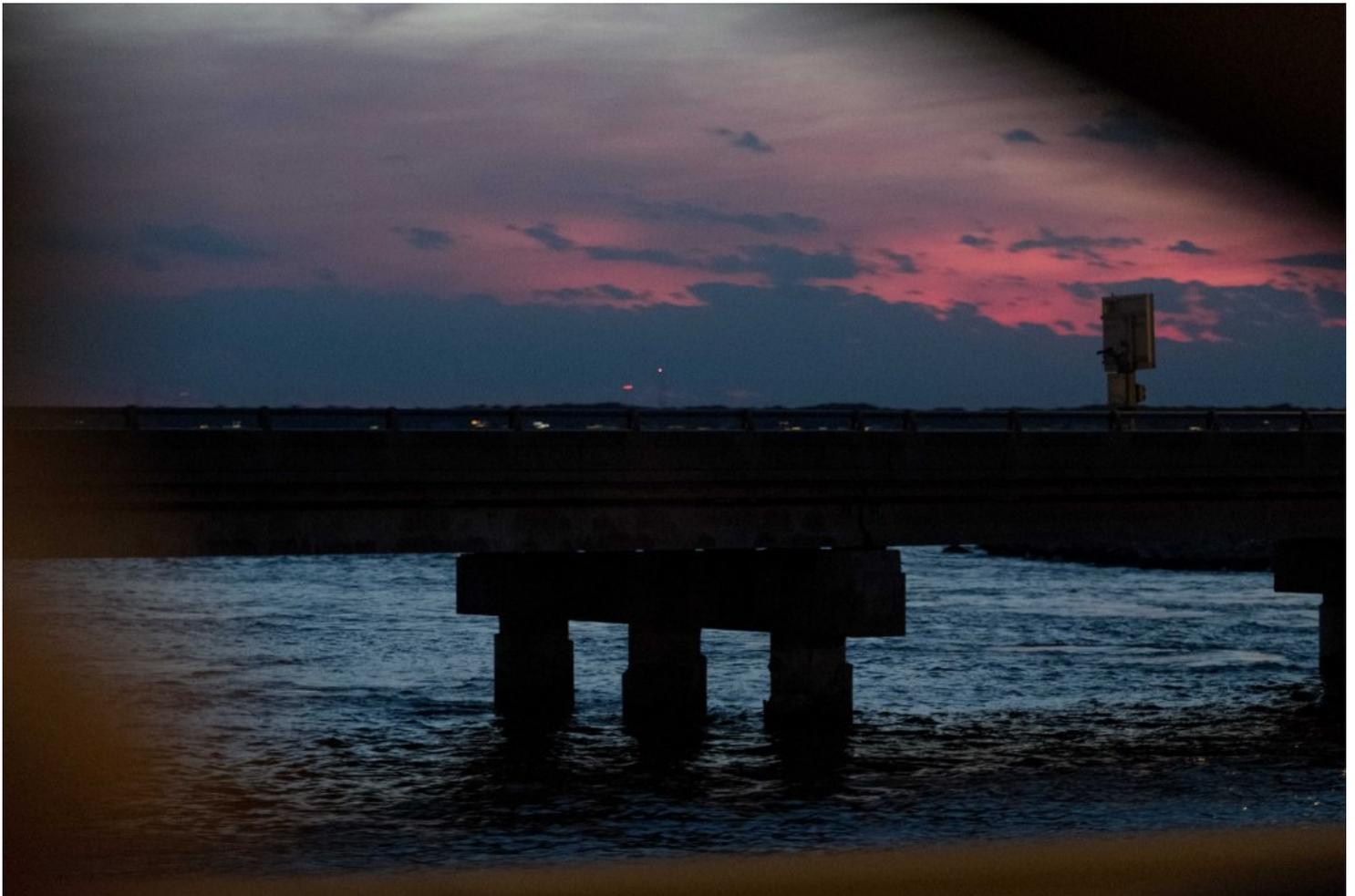


ENERGY + ENVIRONMENT

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For Virginia, adapting to sea level rise starts with choosing a curve

BY: SARAH VOGELSONG - JUNE 15, 2021 12:03 AM



The Hampton Roads Bridge Tunnel. (Ned Oliver/ Virginia Mercury)

In a warming world of rapidly rising waters, there are at least nine possibilities for what tomorrow will look like at Sewells Point in Norfolk.

All agree that by 2050 the sea will have overtaken more of the land than today. But by how much – half a foot, more than three feet or somewhere in between?

When it comes to projections, “you’ve got this Tower of Babel,” said Skip Stiles, executive director of Norfolk-based nonprofit Wetlands Watch.

“Curve of Babel” might be more appropriate. Over the past decade, state and federal scientists have been devising curves that show the trajectory sea level rise could take through the end of the century. The Army Corps has issued three, the National Oceanic and Atmospheric Administration five, and the Virginia Institute of Marine Science, which acts as the commonwealth’s advisor on coastal management and change, one.

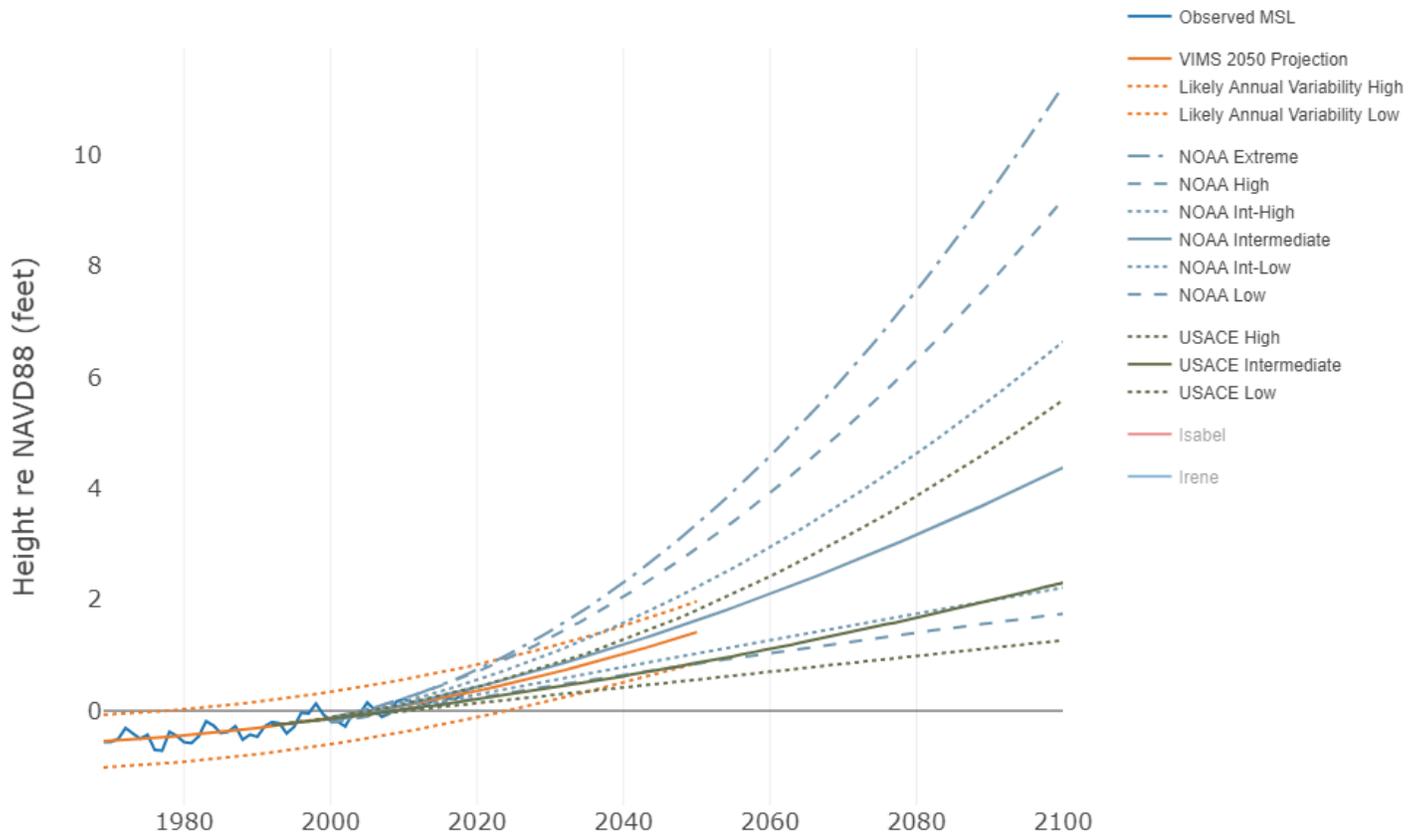
No one knows which, if any, will prove correct. Nevertheless, Gov. Ralph Northam in 2019 quietly threw his weight behind the NOAA “intermediate-high” curve, tucking a provision into an executive order declaring Virginia would use that projection as “the state standard for predicting sea level rise.”

The decision largely flew below the radar. “Is the average homeowner or property owner aware of it? Probably not,” said Ann Phillips, a retired U.S. Navy rear admiral and Virginia’s special assistant to the governor for coastal adaptation and protection, a position created in 2018 specifically to deal with the effects of sea level rise.

But while the selection of a state standard may have attracted little public notice, its effects will quite literally shape Virginia’s future landscape. Sea level rise adaptation will require an almost unparalleled bureaucratic response as state, local and federal planners are forced to revise building, bridge, road, dam, land use and other infrastructure standards to accommodate not only the encroachment of waters but also increased precipitation.

Building codes have traditionally been “historical looking,” said Carol Considine, an engineering professor at Old Dominion University and director of applied projects for the Commonwealth Center for Recurrent Flooding Resiliency. “They look backwards to what was climate before, and they don’t look forward to what climate is going to be. Having a forward-looking code is going to be important as climate changes.”

Norfolk (Sewells Point), Virginia



📷 A range of projections exists for what sea level rise will look like at Sewells Point in Norfolk through 2050 and then the end of the century. (AdaptVa, http://adaptva.com/info/virginia_sea_level.html)

What the new state codes and standards will look forward to is the vision of the future sketched by NOAA’s intermediate-high scenario: 2.2 feet of sea level rise at Sewells Point by 2050.

The projection is a little more conservative than the trajectory currently revealed by VIMS tide-gauge data: NOAA’s “intermediate curve is the one most similar to the historic record,” wrote VIMS scientist Molly Mitchell in an email. “Whether or not it is the most likely curve depends on future conditions (particularly rates of atmospheric warming), which at this point is unknown. The further out into the future we are looking, the more likely that things could vary from the historic trend (but how much is hard to say).”

By going a little higher than the projection based on historical tide-gauge data, Virginia sought to chart a course that was “risk averse but not ridiculous,” said Phillips – “something that’s a little higher, that would force us to consider a future that might require a little more consideration for sea level rise than we’re currently seeing.”

“We know that we may need to change the curve in the future. We said that in (the) executive order,” she said. But, she added, “you’ve got to start somewhere.”

It was a sentiment shared by many other state and local policymakers. “For planning purposes, yes, you kind of have to pick a point and move from there,” said Virginia Beach stormwater engineer Toni Utterback. “The important thing to note for localities and the state is the science will change and the data will get better and we need to make adjustments accordingly.” Ben McFarlane, a senior regional planner with the Hampton Roads Planning District Commission, said that “while the one curve may not be the right curve – I don’t think there is one right curve – it’s a useful curve.” Stiles described the choice as a way of Virginia getting “everybody moving pretty much in the same direction.”

“We could sit here and argue over which curve is right,” he said. “And the next thing you know, it’s 2040 and you’ve got a foot of water on the road.”

How sea level rise curves are created

Sea level rise curves are the product of a host of information, from local changes in land levels and tide-gauge readings to global sea level data, predictions of future greenhouse gas emissions scenarios and knowledge about ice sheet dynamics. All show a consistent trend: Sea level rise is accelerating.

The idea of releasing official curves that could be used broadly is a recent phenomenon. NOAA came out with its first set in 2012, and updated its projections in 2017. The U.S. Army Corps of Engineers released its own curves in 2013. Other, less popular curves have also been devised, including by the U.S. Department of Defense.

The intent was to provide “a plausible range of futures,” said William Sweet, an oceanographer with NOAA’s National Ocean Service. “Let’s bound the plausible space for a global scenario. Let’s bring that down locally, because decisions are made locally. ... And then let’s try to get some bounding of what’s more likely over the next several decades or not.”

Adaptation

Virginia’s choice of a sea level rise standard wasn’t unprecedented. When Northam signed a November 2018 executive order declaring Virginia “must have a standard approach for predicting sea level rise when scoping, designing, siting and constructing state-owned buildings,” Hampton Roads had already been grappling with the question of a standard for several years.

Just a month prior, the region’s planning district commission – representing 17 cities and counties in Virginia’s southeastern corner – had adopted a resolution recommending local governments assume 1.5 feet of sea level rise in planning projects over the 2018-2050 span, three feet for the 2050-2080 horizon and 4.5 feet for even longer-term decisions. Virginia Beach and the Port of Virginia would later adopt closely comparable projections.

It was not surprising that Hampton Roads was ahead of the curve. There, rising seas and land subsidence have combined to give the region the fastest rate of sea level rise on the East Coast. Sewells Point has seen sea level rise more than 18 inches over the past century, according to

tide-gauge data. Phillips testified to U.S. House members in November 2019 that state officials “expect an additional 18 inches of relative sea level rise by mid-century.”

Retreat is largely not on the planning table: Only recently did Gov. Ralph Northam’s administration acknowledge that “protecting every component of the built environment exactly where it stands today is not realistic.”

What that leaves is adaptation.

“We want Virginia Beach to remain a viable coastal destination for people to come to,” said city stormwater engineer C. J. Bodnar. Utterback said “the discussion in Virginia Beach is learning to live with water.”

The Virginia Institute of Marine Science, in recommending projections for the state, took a similar tack: “Selecting an appropriate sea level projection for planning purposes is a critical step towards promoting resilience,” [the institute wrote](#) in February 2019.



📷 A statue of Neptune on Virginia Beach's oceanfront. (Ned Oliver/Virginia Mercury)

Different standards for different needs

While Hampton Roads has embraced a 1.5 feet by 2050 standard and the state the 2.2 feet projected by the NOAA intermediate-high curve, the two aren't as incompatible as they might appear, said state and local officials.

McFarlane described the new state standard as “pretty consistent with what we’re doing” in the region. And Virginia’s Coastal Resilience Master Planning Framework, a precursor to [a state master plan the Northam administration is hurrying to release](#) before a new governor takes office in January, said the Hampton Roads projections “closely align with the NOAA Intermediate-High curve.”

Why the two standards differ at all comes down to two things: evolving understanding of how sea level rise is occurring and the kind of infrastructure state and local governments are trying to build.

Hampton Roads was the first region in Virginia to set a sea level rise standard, at a time when “there really wasn’t anything coming out from the state,” according to McFarlane.

“We started our study back in 2014. We used the most relevant information at the time to move forward. Now the state is just beginning theirs, and rightfully so they’re going to use the best information” now available, said Utterback. “We know the science is going to change. We know there’s an acceleration occurring.”

Perhaps more consequentially, the variation reflects the degree to which buildings and roads, dams and drainage systems are built with a lifespan. Few projects are intended to last for centuries. Some, like telecommunications facilities or stormwater systems, tend to be replaced every 20 to 30 years due to technology changing or wearing out. Others, like many bridges and other major state-owned infrastructure, are built to last much longer.

“When we look at buildings, we want to project what is the anticipated life of the structure,” said Considine.

Both Old Dominion University and VIMS have highlighted the link between project lifespan and official standards in recommendations on sea level rise projections and standards.

“Considering that new construction building life would extend beyond” the projection put forward by VIMS for sea level rise through 2050, “it is necessary to consider NOAA climate scenarios,” [Old Dominion University researchers wrote](#). VIMS concluded that “the Intermediate curve is (a) potential target for infrastructure that can tolerate moderate flooding,” but “flood intolerant infrastructure should incorporate higher curves.”

Without unlimited public funds, much of sea level rise planning comes down to a question of how much risk people are willing to swallow – and, in a nation where large swathes of the electorate still do not accept climate change is occurring, how much they will acknowledge.

NOAA’s “extreme” and “high” sea level scenarios, Bodnar pointed out, project between nine and 11 feet of sea level rise at Sewells Point by 2100, while Virginia Beach has an average elevation of about 10 feet.

“How do you plan for something like that?” asked Utterback. “It’s hard enough to get buy-in from citizens to understand this is happening, let alone happening that much.”

McFarlane said most planning comes down to “balancing costs and benefits.”

“For some projects the benefits of being conservative will be bigger; for some the costs will be bigger,” he said.

Reconciling local, state and federal standards

Already, Virginia’s choice to embrace NOAA’s intermediate-high curve has had ripple effects.

On Valentine’s Day 2020, the Virginia Department of Transportation began using the intermediate-high curve as part of its bridge design standards for replacing coastal or near coastal bridges. A study conducted with VIMS to identify “projected impacts from sea level rise, subsidence and recurrent flooding on existing and planned road infrastructure” will base its analyses on the state curve, wrote VDOT spokesperson Marshall Herman in an email.

New regulations from the Department of Environmental Quality that attempt to incorporate sea level rise into land use decisions in the Chesapeake Bay watershed also rely on the intermediate-high curve, as does new guidance for living shorelines. And state floodplain managers are mapping “sea level rise inundation areas” based on the chosen NOAA curve.

“What we’re trying to do in the commonwealth is get ahead of (sea level rise) and start to deal with it now instead of getting caught,” said Phillips.

Setting a state standard means that “now it’s real,” said Stiles of Wetlands Watch. “It’s not just, ‘Hey guys, you guys need to think about intermediate-high. These are actual design standards.’”



📷 Flooded low-lying land near a park bench in Alexandria, Va., in December 2020. (Sarah Vogelsong/Virginia Mercury)

Still, Stiles cautioned that major gaps remain. State standards apply only to agency decisions and state-owned property, whereas in the absence of a county or city ordinance, local infrastructure like schools or fire stations aren't required to be built according to any particular sea rise projection.

“There's no mandate that schools need to be built to this curve,” he said. “That's not state infrastructure, so it's not covered by the executive order. But it is critical public infrastructure.”

And even as Virginia has moved to standardize its projections, one outlier persists: the Army Corps of Engineers, whose 2013 curves – and particularly its default intermediate curve – chart a much more conservative path for sea level rise than any other projections. Corps work is designed based on these curves, and while local governments can negotiate for projects to be built to higher sea level rise standards, they must pay for the difference.

It's a situation Phillips has complained about on the federal level.

Any Army Corps analysis is “underestimating the rate of change, depth and future impacts, which results in under engineered and underestimated solutions,” she told the U.S. House Subcommittee on Water Resources and the Environment in November 2019. “In essence, by using these very conservative sea level rise scenario-planning curves, and not considering local analysis and rates of change, (the Army Corps) is ‘shooting behind the duck’ – wasting federal

dollars in a tail chase to address an ever-expanding problem and delivering underdesigned and underengineered outcomes.”

McFarlane said the Hampton Roads Planning District Commission largely hadn’t factored the Army Corps projections into its regional policy.

“The corps’ ones are a little old now, so we don’t use them much anymore,” he said. “They’re based on some older science.”

Army Corps of Engineers spokesperson Gene Pawlik said in an email that the corps plans to review its sea level rise scenarios ahead of NOAA’s next release of official mean sea levels in 2025 but the corps “feels its scenarios are still actionable for its purposes at this time.”

“Different federal agencies, state governments and other entities each have their own preferred sea level scenarios because they have their own purposes, preferences and risk tolerances,” he wrote. For the Army Corps, which focuses on engineering and construction, “these scenarios include sea levels that are considered plausible for project planning and design purposes, but not all sea levels that are theoretically or physically possible. Other scenarios might be more useful for other state, federal or other entities with different mandates.”

As climate change research continues to alter scientists’ understanding of how sea level rise will occur over the next decades, policies too will have to adapt to the changing circumstances, said state officials.

“It’s a long road ahead,” said Phillips, “but we start with setting standards.”

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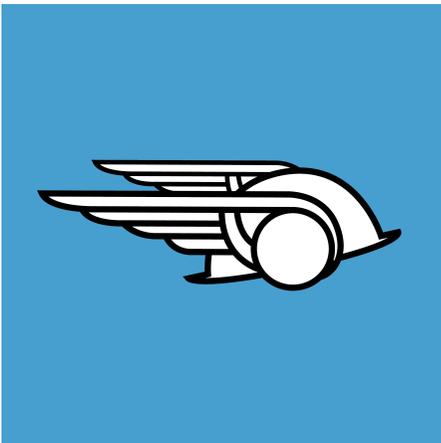
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On Virginia's rural coast, resiliency and Chesapeake Bay conservation goals collide amid sea level rise

BY: SARAH VOGELSONG - MARCH 31, 2021 12:04 AM



📷 An abandoned house in the salt marshes of the Eastern Shore in November 2020. (Sarah Vogelsong/Virginia Mercury)

The geography of Mathews County was carved by catastrophe.

Thirty-five million years ago, a meteorite or comet tore through the Earth's atmosphere and slammed into its surface somewhere between the county and what is now called Cape Charles. In the ruin it left behind, the Chesapeake Bay would form. Mathews, at the very tip of Virginia's Middle Peninsula, remains one of the state's lowest-lying areas, surrounded on three sides by the Chesapeake Bay and the waters that flow into it.

“We’re flat as a pancake,” said Thomas Jenkins, the county’s planning, zoning and wetlands director. “Much of the county is close to sea level.”

Today a far slower but perhaps no less catastrophic force is reshaping Mathews. As climate change drives seas upward, the county is struggling to keep its waterfront properties above the tides.

“I’d say we are ground zero for it because of how much we are exposed,” said Jenkins. “We’re getting hit from all sides.”

In 2020, with Democrats newly at the helm, the General Assembly passed two bills requiring that sea level rise and coastal resilience be incorporated into longstanding laws designed to protect the Chesapeake Bay and state wetlands. Earlier this year state agencies released their first attempts at translating the legislative mandate into the nuts and bolts of state regulations that for several decades have guided virtually every decision made along the state’s coast.

“All of the laws and the regulatory programs, they only dealt with water flowing downhill,” said Del. Keith Hodges, R-Urbanna. “We’ve never addressed water coming up.”

Now Virginia is. The draft regulations issued this year would incorporate coastal resilience linked to climate change and sea level rise into not only existing Chesapeake Bay Preservation Act rules governing local land use decisions, but also [new guidelines for protecting tidal wetlands](#). But particularly when it comes to [the Bay regulation changes](#), the state’s proposal has left many officials and environmental groups worried that in its effort to help landowners make their threatened properties more “resilient,” Virginia is instead creating what Skip Stiles, executive director of environmental nonprofit Wetlands Watch, has called a “doughnut hole” in the law.

“Whose resilience?” Stiles asked this March during a virtual discussion of the new proposed regulations. “Because resilience of the natural ecosystem is different from and often opposed to the resilience of built systems. Are you going to protect the house, or are you going to protect the ecosystem and its water quality and habitat benefits?”

A moving buffer

Perhaps nowhere is the dilemma more pressing than in Virginia’s rural coastal areas – the Middle Peninsula, Northern Neck and Eastern Shore. As in Hampton Roads, seas here are rising rapidly, but the rural counties’ smaller populations, lack of major military installations and less robust economies have meant they’ve often flown under the radar for state officials.

For locals, though, the changes are impossible to ignore. The Middle Peninsula alone has some 1,000 miles of shoreline, most of it privately owned, and water is encroaching on all of it.

“We know what Mother Nature’s going to do. She is going to win in the end,” said Lewie Lawrence, executive director of the Middle Peninsula Planning District Commission. Sea level rise “is eating our shorelines up, literally and figuratively, grain by grain.”

That pressure is bringing to a head an unexpected clash between landowners' desire to preserve their property and laws that aim to protect the Chesapeake Bay and its tidal wetlands. Where that battle is most vividly playing out is in strips of land known as the resource protection area.

In the Chesapeake Bay watershed, coastal landowners don't have free rein over their property. For nearly two decades, the state has required property owners to maintain a 100-foot buffer stretching back from the shoreline, tidal wetlands and other water bodies. This "resource protection area" is sacrosanct: Unless owners get a special exception from local planners, no new development can take place there. Less restrictive but still regulated is a "resource management area" that stretches behind the RPA before giving way to unfettered land where the owner can freely build and alter the terrain.

Scientists see vegetated buffers as one of the best ways to decrease erosion and maintain water quality by providing a big natural sponge for runoff to filter through. Fewer nutrients and pollutants flowing into the waterways means less algae, more water clarity and, in turn, more wetlands and underwater grasses where fish and crabs can flourish.

"The idea is you treat the land right ... and the nitrogen and sediments will stay in the soil and not in the waterways," said Peggy Sanner, Virginia director for the Chesapeake Bay Foundation. "That is the purpose of the act: it's to protect water quality."

Others, like Hodges, are more skeptical of the deference that has been given to the RPA over the years, particularly as seas rise.

Preserving water quality is critical, he said, but the RPA is "not necessarily a place that's pristine and wonderful. It's people's backyards, it's where septic systems are, you have sheds, you have all kinds of things in there. It's not this kind of magical place with gnomes and elves that people in Richmond believe. It's who we are and where we live."

It's also, inconveniently, moving. When the Bay Act and the related 1972 Wetlands Act were written, they set down clear boundaries of where waters flowed, wetlands grew, buffers lay and development was allowed. Different agencies were granted jurisdiction over these zones: the Department of Environmental Quality over Bay Act areas, the Virginia Marine Resources Commission over wetlands.

Climate change is erasing those clear lines. Today's grassy lawn is tomorrow's tidal flats; today's tidal flats are tomorrow's open water. John Bateman, a regional planner with the Northern Neck Planning District Commission, summed up the confusion in a comment during Wetlands Watch's March virtual discussion: "Delineation is impossible to keep up with now."

To fill or not to fill

For both landowners and state and local governments, though, delineation is critical to grappling with sea level rise because what zone a property lies in determines whether the

owner can use an effective but potentially destructive tool to keep waters at bay: fill.

“I think that’s the big question we’re all here for today is the use of fill,” Jenkins, the Mathews planning, zoning and wetlands director, told state environmental officials during a virtual discussion in October on what new regulations about coastal resiliency should include. “How can we use fill in a way that accomplishes a resiliency goal but also continues to protect water quality?”

Scientists have generally agreed that adding fill – sometimes just topsoil, sometimes a combination of topsoil, sand and rocks – to the buffer zone to elevate land can have “detrimental effects” on water quality. One 2018 [report by the Virginia Institute of Marine Sciences and Virginia Tech](#) said adding fill to the coastal buffer would “run counter to the original intent” of the Bay Act. Besides potentially affecting water quality, fill can act as a barrier to wetlands retreating toward the shore in response to sea level rise, causing them to drown in place.

But for many landowners seeing their property transformed as marshes creep into the backyard and water laps ever closer to the house, fill is a lifeline.

“Where I think it’s getting to be more difficult is the homeowner who’s at three-foot elevation and he’s got marsh grass creeping up into his yard each year and seeing his yard turn into a marsh,” said Jenkins. “That’s the harder question to solve.”

According to Lawrence, whether topsoil is added to properties isn’t so much an “if” as a “how,” with some desperate landowners already bypassing the rules.

“They’re going to continue putting topsoil in their yard, no matter what the regulations say, because people will protect their asset,” he said. And, he added, “I don’t believe there’s a local Board of Supervisors out there that’s going to cite a local homeowner for reasonably protecting their land in a responsible way.”

Hodges has insisted that while water quality remains the first priority, property owners need more flexibility than the current Bay Act provides. He has repeatedly introduced legislation to loosen the restrictions, and just as repeatedly the proposals have been struck down.

“There’s so many layers of government, so many layers of regulations,” he said. “It really ties our hands to be able to come up with solutions.”

In 2020, though, Hodges got an unexpected lift from the Democratic administration, which has embraced climate change as one of its signature issues. In the spring, Gov. Ralph Northam quietly amended a [bill on preserving mature trees](#) to add “coastal resilience and adaptation to sea-level rise and climate change” as a factor for local governments in Bay areas to consider in their decision-making. So quiet was the change that many environmental organizations didn’t realize it had happened until it was done.

It was that amendment that would give rise to the regulations now being fast-tracked through the review process as Northam’s term winds to a close. And while many environmental groups

and officials have praised the administration for taking up the issue, they remain critical of the proposed solution, which they believe would open the door to fill too widely without instituting sufficient water quality protections.

As currently written, the regulation “is an invitation to localities that are hard-pressed to find solutions to sea level rise to just say yes to fill,” said Sanner. “And I say that without any blame to localities. They are hard-pressed.”

Even Stiles, of Wetlands Watch, was somewhat flummoxed by the extent of the problem.

“What are you going to do with these folks who through no fault of their own are in the wrong place given where climate change is headed?” he asked. “I don’t know, frankly, what the solution is. I do know that it’s going to take a hell of a lot more study than has been done in this statute and in the development of these regulations.”

Retreat

As the new Bay Act regulations, and an associated set of new wetlands guidelines, work their way through the regulatory process, they are raising a specter that in Virginia will become more concrete as time passes.

Let the discussion continue long enough, and eventually the word that starts to crop up with more and more frequency is “retreat.” As the seas are rising, the shoreline is retreating. So are the marshes. Eventually, humans will have to follow.

Virginia has only recently begun to acknowledge retreat as a possibility down the road. “We must recognize that protecting every component of the built environment exactly where it stands today is not realistic,” [the state’s Coastal Resilience Master Planning Framework released in October](#), states. “In time, some homes, businesses, roads and communities will become uninhabitable as sea level rises.”

Virginia’s rural coastal areas are far from that point. But the struggle to balance property owners’ desire – and rights – to protect their land with other competing public interests may be a prelude to broader discussions about how many resources should be put toward saving areas scientists predict will be underwater in the next few decades.

“Somebody needs to step in and say, ‘What is the life expectancy of this community given all the factors at play here?’” said Stiles.

That’s easier said than done. “People have this piece of land and it’s theirs and they love it,” said Jenkins. “And to know, ‘Is it going to be there? What’s it going to look like in 20 years?’ That’s tough.”

On maps, the trajectory of sea level rise is clear and even stark. But on the ground, the slow advance of the seas doesn’t always look so dramatic. Sometimes it just looks like a marsh, slowly overtaking a smooth green lawn.



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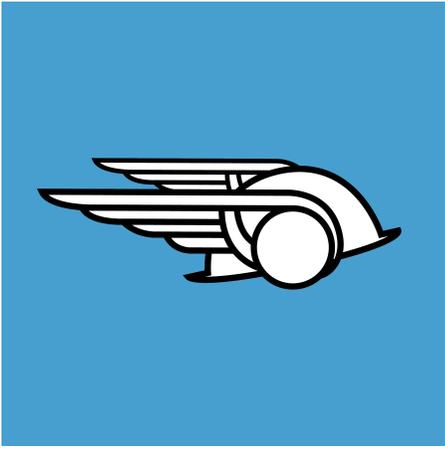
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ENERGY + ENVIRONMENT

Yes, Virginia, we are seeing more – and more intense – rainfall

Climate change risks overwhelming infrastructure

BY: **SARAH VOGELSONG** - AUGUST 20, 2021 12:02 AM



 A flooded road outside Richmond. (Ned Oliver/Virginia Mercury)

Record-setting rainfall in 2018. A [month's worth of water](#) that drenched Northern Virginia in an hour in July 2019. Neighborhoods that [flood repeatedly](#) in Richmond's Southside and [Petersburg](#).

In Virginia, conversations about climate change have tended to focus on sea level rise, the waters that surge up from oceans and coastal rivers to overspill their traditional bounds. But climate change isn't just driving waters up. It's also driving them down, increasing precipitation – and especially the intensity of precipitation – throughout the commonwealth.

“Broadly across Virginia ... there seems to be a consensus that there is more water around, and that the storms are heavier and they dump more water when they come, and that's a problem,” said Ann Phillips, the state's special assistant to the governor for coastal adaptation and protection. “And that impacts people not every day, but often enough.”

Climate change is affecting precipitation globally, but the impacts aren't uniform everywhere. Rising global temperatures in some cases are [leading to increases in drought](#), as has been apparent in the western U.S. Overall, the most recent report by the Intergovernmental Panel on Climate Change, which was approved by all 195 member states of the United Nations, found that precipitation over land “has likely increased since 1950, with a faster rate of increase since the 1980s.”

Even more critically, though, the hundreds of scientists who contributed to the IPCC report found that climate change is leading to jumps in the frequency and intensity of heavy precipitation – a trend likely to continue as temperatures warm.

“It is very likely that heavy precipitation events will intensify and become more frequent in most regions with additional global warming,” the report concluded. “At the global scale, extreme daily precipitation events are projected to intensify by about 7 percent for each 1°C of global warming.”

Those patterns are also being seen in Virginia, scientists say.

“We know rainfall patterns are changing – more intense, more frequent storms,” said Jonathan Goodall, an engineering professor at the University of Virginia who co-chaired a recent study for the General Assembly on climate change impacts in Virginia, during a presentation to the Joint Commission on Technology and Science earlier this week. “Those aren't limited to the coast. Those will happen across the commonwealth.”

[Time series data](#) from the National Centers for Environmental Information, which operates within the National Oceanic and Atmospheric Administration, show a trend of increasing precipitation in Virginia since 1895.

📷 Virginia precipitation has been on the rise. (National Centers for Environmental Information)

In a more localized [study that examined data from 43 locations across Virginia](#) between 1947 and 2016, researchers Michael Allen and Thomas Allen (no relation) at Old Dominion University found that both average annual precipitation and heavy rainfall frequency increased statewide.

“Heavy rain events are increasing pretty uniformly across the commonwealth,” said Michael Allen. “We often think in Virginia of flooding as a coastal phenomenon, where the reality is a lot of our flooding has taken place in non-coastal areas.”

Jeremy Hoffman, chief scientist at the Science Museum of Virginia, said that precipitation increases are “pretty much ubiquitous across the commonwealth” but will vary depending on the season.

“The biggest precipitation changes have been that our fall and spring have gotten relatively rainier or at least relatively wetter at the expense of our summer,” said Hoffman.

Increasing unpredictability in precipitation is also likely to characterize the future, with consequences for not only infrastructure but also patterns of living, working and traveling.

“Because we’ll switch between these longer drier periods interspersed with these deluge conditions, that becomes really hard to manage,” Hoffman said.

Overwhelmed infrastructure

In some neighborhoods of Richmond’s Southside, the struggles of managing increased and more intense rainfall are already apparent in frequent flooding that leaves streets and yards waterlogged for days.

“This is the type of flooding that happens in certain parts of Southside every time it rains,” said Amy Wentz, co-founder of local nonprofit Southside ReLeaf, which works to reduce environmental disparities as the climate changes. “Flooding is one of the big things we’ve heard from our community members that they’d like the city to address.”

Infrastructure statewide, whether for stormwater, roads or dams, has been designed and engineered to withstand rainfall patterns that increasingly no longer exist.

“The challenge is if the infrastructure was built and put in place 50 years ago assuming certain properties of extreme rainfall events and certain probabilities ... and now we have a different reality, it will be overwhelmed,” Goodall told lawmakers on the joint commission earlier this week.

Most pressing to the state is the need to update the rainfall projections on which federal engineering standards are based, a set of data collected by the National Weather Service known as Atlas 14 that for Virginia has not been revised since 2006.

“That is the federal standard upon which stormwater infrastructure is based,” said Phillips. “Updating that data is critically important.”

State and local officials have known for a number of years that the existing Atlas 14 projections were lowballing rainfall. A [2018 report by engineering firm Dewberry](#) for the city of Virginia Beach found “a robust, statistically significant increase in heavy rainfall not only in the immediate area but also in the region” and recommended the city increase its rainfall intensity design standards by 20 percent. Similarly, research by the Virginia Transportation Research Council found consistent bumps in rainfall and intensity statewide, leading the Virginia Department of Transportation in 2020 to order that “[a 20 percent increase in rainfall intensity](#) and a 25 percent increase in discharge shall be used in design of bridges.”

“We have seen an uptick in the intensity of” rainfall events, said Robert Carey, chief deputy commissioner of VDOT. “Traditionally, that has not been the kind of information that was necessary to be updated frequently.”

Today, that’s no longer true. Culverts, curb inlets, tunnels and other stormwater infrastructure VDOT designs, builds and maintains are being required to handle larger volumes of water in shorter amounts of time.

“It’s intensity, it’s amount, and it’s duration” that are important, said VDOT engineer Chris Swanson. “They’re all taken into consideration.”

 A flooded road in Chesterfield in 2020. (NBC12)

Cities, towns and counties face the same dilemma. In coastal jurisdictions, sea level rise can exacerbate the problem: in Norfolk, standing water in the stormwater system means that “the system’s ability to drain streets after a rainfall [has been curtailed by as much as 50 percent in some areas.](#)”

Overwhelmed systems can also trigger a cascade of other problems. In Richmond, Alexandria and Lynchburg, where century-old combined sewer systems channel stormwater through the same pipes that carry wastewater, high-intensity rains can lead to overflows of raw sewage into waterways. The cities and the state have poured hundreds of millions into fixing the situation, but [remaining costs total more than \\$1 billion.](#) Norfolk’s struggling stormwater system has “led to more frequent road closures and exposes infrastructure not designed for frequent inundation to general deterioration and corrosion,” the recent [report on Virginia climate change impacts](#) led by Goodall noted.

As Virginia begins reworking its infrastructure to accommodate the changing landscape, two tools will be critical. In 2020, the National Weather Service put forward a proposal for updating the Atlas 14 precipitation estimates for not only Virginia, but Delaware, Maryland and North Carolina. Phillips said the work will start sometime this fall, at a cost to the commonwealth of \$405,000, all of which is being funded by VDOT and the Department of Environmental Quality.

Separately, research funded by the Chesapeake Bay Trust released this year has also sketched out [new projections of rainfall intensity, duration and frequency](#) throughout the bay watershed – and, at the request of the commonwealth, the entire state of Virginia.

“This will be tremendously helpful for the commonwealth,” said Phillips. “If you only do the bay watershed, you lose a third of the state.”

Still, updated rainfall projections are only part of the picture as Virginia adjusts to a wetter, less predictable future. As Wentz of Southside ReLeaf cautioned, historic inequities have in many places led to a lack of infrastructure investment in low-income and minority neighborhoods, compounding problems found statewide.

“You can sort of tell where the neglect is happening, because that’s where the flooding is happening,” she said.

The fixes will be expensive, she acknowledged. But without them, the effects will continue to be far-reaching.

“It affects homes. It affects communities. It affects businesses,” she said. “Stormwater issues can disrupt networks, vital services or resources. It’s not just only economic losses, but it also brings a lack of quality of life.”



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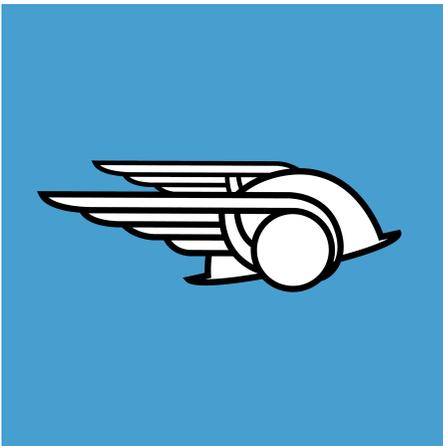
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