**How to protect your home from disasters amplified by climate change**

A decade ago, climate change projections pointed to a distant future, 50 or 100 years down the road. But with each storm and fire season seemingly more ferocious than the last, it’s clear we’re already facing the impacts of climate change: Sea levels are rising, and storms, wildfires and droughts are intensifying, fueled by warmer oceans and a warmer atmosphere. In the coming decades, regions of the United States will be affected in different ways by flooding, severe storms, droughts and wildfires. Millions may be forced from their homes. But what about the people who choose to stay? What can they do to harden their homes, to improve the chance the structure will stand up against water and fire? How can people help their communities adapt to the everyday realities of climate change? Flooding is already the most common natural disaster in the United States, occurring in every state and killing more people each year than hurricanes, tornadoes or lightning. As warming drives sea levels higher, intensifies hurricanes and fuels more heavy rain events, more U.S. residents should expect to deal with flooding (SN: 8/17/19, p. 16), even at inland locations that have not flooded historically, says Glenn McGillivray, managing director of the Institute for Catastrophic Loss Reduction in Toronto. Climate models predict more extreme rainfall events over the next 80 years, across both wet and dry regions, according to a 2016 report in Nature Climate Change. “There’s a perception that your house will only flood if you live on the coast or right next to a big river. But some of the most destructive flooding events have occurred from heavy rainfall, which can happen anywhere,” McGillivray says. “Pretty much everybody is at risk of overland flooding, but most people have no clue what their level of risk really is.” Flood risk for U.S. homeowners has traditionally been calculated by the Federal Emergency Management Agency as part of the National Flood Insurance Program. FEMA software lumps properties into three categories: inside a 100-year floodplain (an area with at least a 1 percent chance of flooding in a given year) or outside the floodplain in areas of moderate or minimal risk. A 2018 study in Environmental Research Letters found that FEMA’s maps are outdated and underestimate the flood risk for over 28 million Americans. “FEMA’s maps create an illusion of safety for people outside the 100-year floodplain,” says Sharai Lewis-Gruss, lead adaptation specialist for the First Street Foundation, a nonprofit in Brooklyn, N.Y. “The maps are also historical — they only draw data from past flooding events,” she says. And the databases are sometimes decades old. The maps don’t account for projections of sea level rise, more intense hurricanes or increased rainfall. To help people better understand their flood risk, in June the First Street Foundation plans to release Flood Factor, a mapping program that the organization says will “calculate the past, current and future flood risk of every property in America.” Flood Factor’s National Flood Model, created through a collaboration of over 70 experts, will consider impacts from sea level rise and tidal flooding, hurricane and storm flooding, as well as flooding from swollen rivers and heavy rainfall events, Lewis-Gruss says. By applying various flood hazard scenarios, such as a Category 3 hurricane or 20 centimeters of rainfall, to specific properties and buildings, the model can calculate the historic and future impacts of floodwater for most, over 155 million, U.S. properties.Residents will be able to plug a street address into the website and get a detailed report with color-coded maps showing the impact from past flooding events, the likelihood of future flooding scenarios, as well as a Flood Factor risk score from 1 (low) to 10 (extreme). The aim is to create “a personalized narrative for how flooding could affect your property this year, in five years and in 30 years,” Lewis-Gruss says. After assessing your property’s flood risk, the next step to prepare for flooding is to buy flood insurance, says Melissa Roberts, executive director of the American Flood Coalition, a nonprofit advocacy group in Washington, D.C. Flood damage is not usually covered by homeowners insurance, and federal law requires only people living inside 100-year floodplains to buy supplemental flood insurance. “But we’re seeing more flooding events outside of that zone, often from heavy rainfall,” Roberts says. The American Flood Coalition “now recommends that everybody get flood insurance. The good news is, if you live outside that 100-year flood zone, it’s often pretty affordable.” Homeowners who take steps to physically protect their homes from flooding may get discounts on flood insurance premiums. Flood-control strategies can range from temporary measures that cost hundreds of dollars to pricier home redesigns. Not every homeowner needs to brace for historic hurricanes, but even heavy rain can do a lot of damage if water finds a way inside, Roberts says. For people in need of quick, lower-cost options to keep the water out, several companies offer updated alternatives to sandbags, such as water barrier socks that expand in water to function much like sandbags, but without the mess. A larger-scale version swells to a 45-meter-long vinyl tube, several of which can be linked together to encircle an entire property. Another tactic involves placing removable watertight plastic barriers across ground floor doors and windows. More permanent investments could involve installing sump pumps in the basement or low-lying areas of a property to remove floodwaters. But for solutions that depend on electricity, homeowners will also need to raise wiring and electrical outlets above flood levels and consider getting a generator or solar power system. Raising plumbing and heating and cooling systems away from the ground to minimize water damage to these costly components is also a good idea, Lewis-Gruss says. The most expensive tactic is to raise an entire house above flood levels, usually by separating the house from its foundation, raising it with jacks and building a new foundation or propping the house up on posts or pilings. Costs depend on the size and construction of the home, but estimates range from $75 to $100 per square foot, or $187,500 to $250,000 for a 2,500-square-foot home. In 2015, 50 centimeters of rain fell over five days in South Carolina, flooding Susan Lyons’ Colonial-style house in the historic district of Charleston. Just 10 days later, a high tide brought even more water into her neighborhood. “After that double whammy, I had to file a federal flood insurance claim, my first in 30 years of living by the coast,” she says. She replaced her home’s HVAC system ductwork with waterproof PVC pipe and repointed the brick skirt around the foundation to keep water from seeping in through cracks.“I learned that making physical improvements to your own house is complicated and expensive, but if you live in a flood zone, you’re going to pay a lot now or pay even more later,” Lyons says. In 2016 and 2017, hurricanes Matthew and Irma delivered more flooding to Charleston. “It seemed like every season we were flooding. Repeated flooding is very traumatic,” Lyons says. But despite the pattern, she felt the city council still viewed flooding as a rare event that people just had to deal with after the fact. So Lyons helped start the advocacy group Groundswell! to get the mayor and city council to step up community flood-control measures. “We went from a few people around my dining room table to 300 families in a matter of weeks,” she says. “People were eager to help and be helped. We made ourselves heard and amazingly it worked!” In 2018, Mayor John Tecklenburg announced that battling flood issues would be Charleston’s top policy priority. The city is installing new drainage systems, pump stations and seawalls. By banding together, neighborhoods and communities can work toward flood-control solutions that benefit as many people as possible to help keep individual homeowner costs down. Community-level tactics may include adding or restoring floodable green spaces such as parks or marshlands (SN: 8/17/19, p. 16), building permanent flood barriers that protect blocks of houses and pressing local and state governments to take action. “There are certainly actions individuals can take to protect themselves, but a lot … are really costly and especially difficult for those who are already disadvantaged,” Roberts says. “Flood control isn’t something that should be left to individuals to deal with. Solutions have to involve everybody.” When it comes to climate-driven natural disasters, fires are as frightening as floods. In 2017 and 2018, California wildfires killed 147 people, burned 3.5 million acres and destroyed over 34,000 structures in two of the worst fire seasons on record. And wildfires are expected to become more severe across the West, says Max Moritz, a wildfire specialist at the University of California, Santa Barbara. “Warming temperatures are melting snow sooner and drying out vegetation so that we’re already seeing longer fire seasons and more available fuel.” Between 1990 and 2010, more than 12 million homes across the United States were built in what’s known as the wildland-urban interface, where flammable vegetation meets human development and sources of ignition, such as vehicles or power lines, according to a 2018 analysis in the Proceedings of the National Academy of Sciences (SN: 12/22/18 & 1/5/19, p. 8). All Western states are prone to wildfire, Moritz says, and he’s seen upward trends in the Midwest and Southeast, too, due to long-term drought, tree blights, insect-killed trees and a history of fire suppression that has allowed forest fuels to build up. California has long led the charge in wildfire management, with the Department of Forestry and Fire Protection, or Cal Fire, overseeing more than 31 million acres of fire-prone landscapes. Since 2008, new construction in high and very high hazard zones must use noncombustible exterior materials and fire-resistant features such as covered gutters that prevent the accumulation of flammable leaves and needles. A few other states, such as Oregon and Washington, have adopted similar building codes. The November 2018 Camp Fire that swept through Paradise, Calif., showed the benefits of fire-hardened homes: Fifty-one percent of homes that were built to code after 2008 survived; only 18 percent of older homes escaped serious damage. “Those numbers are stunning. Building codes really do work,” says Robert Raymer, an engineer with the California Building Industry Association in Sacramento. Adhering to fire codes does not add significant costs to building, according to a 2018 report by the nonprofit research group Headwaters Economics. Upgrading a roof with fire-resistant asphalt shingles tends to increase costs by about 27 percent, but using fire-resistant materials for the exterior, such as stucco or cement siding, can reduce costs by about 25 percent. Fire-resistant materials also tend to require less maintenance and have longer life spans than wood or plastic. California has no requirements for retrofitting older homes for fire resistance. “Building codes don’t take into account the millions of homes that were built in fire-prone areas before 2008,” says Steve Hawks, Cal Fire’s deputy chief of wildland fire prevention engineering. In January, California Governor Gavin Newsom announced a $100 million pilot program to help people finance fire safety features for older homes. Making fire-hardening improvements may lower insurance costs. Unlike flood insurance, fire insurance has traditionally been part of homeowners insurance. But with insured losses from the 2017 and 2018 fires totaling over $24 billion, insurers are scrambling to figure out how to stay in business. Some insurance companies have responded by drastically raising premiums or dropping high-risk customers. In December 2019, the state insurance commissioner imposed a one-year moratorium on policy nonrenewals. And the California Fair Access to Insurance Requirements Plan expanded to provide fire insurance to homeowners when all other insurance options have failed. In a wildfire, most houses are ignited not by walls of flames but by embers — small sparks that can travel far from the main fire, Hawks says. House fires can start when one or a few of these sparks land on combustible material, such as dry leaves in a gutter, or if embers find their way inside the house through a roof vent or open window. For homes built before 2008, Cal Fire suggests some low-cost retrofitting strategies, including sealing any gaps with caulk, weather stripping or fine metal mesh screens; removing dead or dry vegetation from around the house and regularly cleaning leaves and other flammable material from gutters and under decks. More expensive investments include replacing roofs and decks with fire-resistant materials and upgrading windows to multipaned tempered glass that can withstand high temperatures. One of the most important strategies, required by law in some fire-prone states, is a 100-foot (30.5-meter) radius of defensible space around the home that is kept free of dead or dry plant matter. At least five to 20 meters of cleared space around a structure can slow or stop the spread of a wildfire and protect a home from catching fire from direct flame contact or radiant heat, according to a 2014 study in the International Journal of Wildland Fire. “I don’t stop at 100 feet. I clear everything around my ranch out to 500 feet. Defensible space is the most effective tactic I’ve seen for protecting property,” says retired Kern County firefighter Carrie Shreffler, a resident of Posey, Calif. Every property is unique in terms of fire risk. “If you really want to assess a home’s vulnerability, you also have to look at weather, topography and fire history for the given area,” Hawks says. “What is the home made out of? How is it constructed? Does it have defensible space? Is there water available for fighting a fire? How close together are the neighboring homes?” In densely built areas, the houses themselves can fuel fires. “You’ve probably seen aftermath photos where a fire has swept through a town and all the homes have burned, but there are still trees standing and green vegetation,” Moritz says. “That’s what happens when the homes themselves are the fuel. It’s not a land management problem where you should have cleared more brush. You can’t thin the fuels because the homes were the fuel.” As more homes are built in fire-prone areas across the United States, community-level fire safety approaches will be needed, Moritz says. “A whole suite of risk-reduction measures can be applied at the community scale,” he says. “We need to pay attention to how we lay out communities, with buffer zones between houses and between the community and the surrounding landscape.” In a report published in April by the University of California Division of Agriculture and Natural Resources, Moritz and colleagues also recommend burying power lines, creating water storage facilities for fighting fires, hardening emergency facilities and creating community refuges where people can take shelter. Some communities are already taking steps to prepare for emergencies. In Sequoia National Forest, the Posey Area Fire Auxiliary has been meeting every month for over two decades to educate residents about fire prevention. In 2016, the Cedar Fire burned right to the edge of the mountain community, located within the national forest, but no lives were lost and of about 300 homes, only three abandoned cabins burned, in part due to the community’s diligence. “We all learned a long time ago that we need to be our own first line of defense,” Shreffler says. After the Cedar Fire, Posey and other surrounding communities were struck by several rain-triggered floods. Flooding after a wildfire is common, Moritz says, because the charred ground cannot absorb water as readily as it once did. These flood events can sometimes evolve into highly destructive debris flows, a thick slurry created when ash mixes with floodwater.Homeowners living in fire-prone regions near creeks or drainages should consider the possibility of needing to fire- and flood-proof their homes, Moritz says. “The vision is that someday, we will build such hardened and sustainable homes that natural hazards will just be something that happens outside,” Moritz says. “We’ll [be able to] watch fires go by like violent rainstorms.” Adapting to climate change may seem daunting, but for many in the United States, the impacts won’t come in the form of devastating floods or fires. Instead the seasons will gradually get hotter. For those not facing catastrophe, many of the most effective climate resiliency tactics are rooted in common sense and self-sufficiency, says Alexandra von Meier, an electrical engineer at the University of California, Berkeley. “A small amount of preparation can go a long way to making any situation more livable,” von Meier says. For example, a solar power array and battery bank, or an emergency generator or portable solar setup, “can make a big difference” in maintaining basic home systems and lines of communication. Installing rainwater collection barrels can help see your garden through a dry season and help you keep water on hand in emergencies. And making upgrades for a better insulated, more energy–efficient home will help lower home operating costs, as well as your carbon footprint, Raymer says. That preparation is key, von Meier says. “Whether people will be able to stay in their own homes in the aftermath of a natural disaster or a long-term power outage will ultimately depend on their level of preparedness. Do you have enough food and water on hand? Do you have a plan for when the lights don’t work or water stops coming out of the faucet? Do you have ways to communicate with the outside world? These are very basic needs that people should know how to meet.”