**What data do cities like Orlando need to prepare for climate migrants?**

Hurricane Maria roared across Puerto Rico in late September 2017. The storm caused an estimated $90 billion in damage, demolished the power grid (SN: 2/15/20, p. 22) and left more than half of the island’s residents without safe drinking water. Dachiramarie Vila recalls the smell of gasoline from generators choking the air. “The smell was everywhere,” says Vila, a 33-year-old mother of two, through a translator. “We felt that we were breathing all those gases night and day.”The storm flattened Vila’s wooden home, forcing her family to move to her parents’ house, which was also damaged. Then Vila’s 13-year-old son began peeing blood, she says, probably from drinking contaminated water. There was little medical assistance available.Desperate for help, Vila’s mother, Maritza Garcia Vila, traveled high into the mountains in search of a working cell phone tower because the storm had knocked out 95 percent of the island’s towers. From there, she called Ana Cruz.Cruz is the coordinator of the Hispanic Office for Local Assistance, or HOLA, part of the city government of Orlando, Fla. HOLA has helped new arrivals to the city find jobs, housing and health care since 2004. But by the end of 2017, HOLA and Orlando faced a daunting task. Hurricane Irma had inundated many of Florida’s coastal cities in early September, and two weeks later, Maria hit Puerto Rico. Those two storms sent as many as 250,000 evacuees, including Vila and her family, into Florida’s narrow interior. “We were caught off guard,” says Chris Castro, a senior adviser to Orlando Mayor Buddy Dyer. That 2017 wave of climate migrants gave city managers a glimpse into a future for which they need to prepare. Orlando is now gearing up to become a destination for future climate migrations, Castro says. “No local government, to my knowledge, is prepared … to deal with the flux of environmental migrants and climate refugees,” he adds. “It’s now very much part of our thought process.” By 2050, scientists estimate, climate stressors — including hurricanes, wildfires, drought, extreme heat and flooding from rising seas — could compel between 25 million and 1 billion people around the world to leave their homes and jobs behind, some temporarily, some for good. For Orlando and other potential destination cities, preparing for those influxes of people, while also bracing for the local impacts of climate change, is a multifaceted challenge. As a starting point, the cities need data, some sense of how many people might arrive. But one of the biggest hitches in planning for the future is that so little is known about where and when people will choose to migrate. Scientists have devised ways to track and even anticipate modern-day human resettlements, as people move for economic reasons like jobs or for family reasons. There is also a growing body of research based on past migrations spurred by extreme climate events: the treks across the United States during the Dust Bowl era of the 1930s, for example, or the rush to Orlando following Hurricane Maria, or to Houston in the wake of Hurricane Katrina, which devastated New Orleans and much of the Gulf Coast in 2005. But when it comes to projecting such movements into the future, as climate change rapidly transforms landscapes on a never-before-seen scale, “I don’t think we know that much at the moment,” says Amir Jina, an environmental economist at the University of Chicago. “It’s hard to think of what’s going to happen with long-term [climate] change.”As newcomers poured into Orlando in October 2017, HOLA set up a welcome station at the city’s airport at Dyer’s behest. Among the first to arrive were Vila and 10 family members — her husband and two children, mother and father, younger brother and pregnant sister with her husband and two children. Leaving Puerto Rico “was very, very, very hard,” Vila says. The family left with only a few suitcases. “We were desperate, with nothing.” Vila’s mother headed straight to the HOLA table. “When her mother arrived, she started crying,” recalls Cruz, who served as the translator during my conversations with Vila. “I told her to relax, that she was going to be fine.”Orlando is home to about 280,000 residents, plus many more temporary guests. Each year, some 50 million travelers pass through the city’s airport, the busiest in the Sunshine State. Six-lane highways crisscross to speed tourists to Walt Disney World, Universal Studios, Sea World and other nearby theme parks. But nothing like the 2017 rush of climate refugees had happened there before. Orlando and neighboring cities in central Florida groaned under the weight of so many new people in such a short time. The city’s massive tourism industry turned out to be a silver lining, Castro says, with jobs and housing available, at least for the short term, in the region’s many hotels. In a two-week period after Maria, every hotel room in the area was full.City and emergency managers scrambled to find longer-term affordable housing, transportation, health care and other social services for the new residents. Teachers had to be hired, especially those who speak Spanish. An assistance center to help newcomers from hurricane-ravaged regions also opened in Kissimmee, half an hour’s drive south. Today, two and a half years later, perhaps a tenth of the estimated 250,000 climate migrants remain, Castro says. The rest returned to their homes in Puerto Rico, or sought some other safe haven. But for Castro and other city managers in Orlando, the experience was transformative. In 2019, the city kicked off an array of projects and partnerships to improve its resilience and plan for future climate migration booms. Among its partners is the East Central Florida Regional Planning Council, which represents eight counties, including Orlando’s Orange County. Jenifer Rupert, in charge of the council’s resilience efforts, says that Maria was a wake-up call for her organization, too. “I thought … we really need to get better at the way we’re handling this.”In addition to hurricane-related migrations, Rupert says, the council is concerned about waves of migrations as sea levels continue to rise. “What are we going to do when the state of Florida starts losing coastline, and people from Miami come up here?” Rupert asks. “What are we really putting in place now to start managing those types of numbers?” One might expect U.S. climate migrants to choose “climate beneficial” locations — cool, temperate places, such as Minneapolis or Seattle, rather than Florida or Texas, says Jina, the Chicago economist. “It seems counterintuitive: Instead of moving to more resilient cities, they’re moving to a city that can only really be livable in the future if you can afford air conditioning.”But other factors tend to weigh more heavily in migration decisions: available jobs, health care, family and community, says Mathew Hauer, a sociologist at Florida State University in Tallahassee. “Most migration tends to be short-distance, for economic and social reasons, like a better-paying job.” Take Orlando. It’s located in a state that is squarely in the path of rising seas and has seen record-breaking heat in the last year. But Orlando satisfies many of the other needs of possible climate migrants, at least in the short term. It is in the center of the state, far enough from the worst effects of possible storm surges and sunny-day flooding due to rising sea levels. It has jobs. And it has made an effort to be welcoming to migrants.Taking a holistic look at what drives migration is known as “migration systems theory.” Using that approach, in a study reported in 2017 in Nature Climate Change, Hauer identified 10 likely “climate destination” regions in the United States for the estimated 13.1 million people within the country who are expected to be displaced by rising sea levels by 2100. Based on his simulations, the top destinations include Austin, Orlando and Atlanta. Hauer’s study was the first to attempt to anticipate destination regions for U.S. climate migrants. He tracked large-scale, county-to-county migrations of people from 1990 to 2013 using annual tax data from the IRS. Then, based on observed patterns, which reveal residents’ past choices, he projected where people are likely to go in the future. Economists have used similar factors to create econometric models to forecast changes in populations. Such simulations can help local governments assess the need for everything from additional housing and transportation to shifting school district boundaries. That approach has been around for a long time, and when it comes to simulating climate-related migrations, “it works to a certain extent,” says Vivek Shandas, an urban planning researcher at Portland State University in Oregon. But more accurate simulations of widespread climate migration should consider one more dimension of the decision-making process, he says: how people might decide when it’s time to leave.That decision will likely be different depending on the type of climate trigger, Shandas says. A growing field of research called event ecology uses computer models to anticipate how an extreme event, such as a hurricane, might ripple through a community, altering population numbers and infrastructure. Those kinds of events — sudden, short-term and extreme, such as Katrina in 2005 — are called “pulse events.” Migrations spurred by pulse events are fairly easy to simulate. There’s one point of origin, and scientists can make knowledgeable guesses about where people might go from that point of origin based on proximity to other cities, family connections and job availability. Pulse event migrations also tend to occur shortly after the triggering event. But ongoing climate change can boost the frequency of pulse events. For example, climate change is increasing the risk of deadly and destructive wildfires, such as those that struck California in 2017, 2018 and 2019. Each event may trigger some migration, but over time those who stayed behind may also begin to wonder whether they, too, should move to a safer haven. Such slower, longer-term manifestations of climate change, or “press events,” can be more challenging when it comes to anticipating both when and where people may choose to move. Rising sea levels are the textbook example of a press event (SN: 2/29/20, p. 18). And it’s with these events that people’s different risk tolerances most come into play. “There are different thresholds that people are willing to put up with,” Hauer says. “For some, [that threshold comes] much sooner than when there’s water at the doorstep.” Many people will face the dire choice between individual migration, community-based movement away from the risk, known as “managed retreat,” or even deciding to find ways to stay in place. There’s no template for what will happen in response to widespread sea level rise, which will affect many different places at once. “We haven’t yet lived in a world with high tide flooding multiple days a month,” Jina says. “It will change housing prices, as well as whether or not people reinforce coasts.”Hauer notes that his destination city study, published in April 2017, came just a few months before Hurricane Harvey poured torrents of rain onto southeastern Texas, including Houston. Does that event push Houston off the future destinations list? Not necessarily, he says. Post-Harvey resilience efforts in Houston can alter the calculus. And there are many other lingering unknowns when it comes to assessing people’s decisions. “We know very little about how different age groups would respond to different stimuli,” Hauer says. “Or how different climate impacts will interact with each other, [such as] how migration to Atlanta might affect migration to Miami.”Despite these challenges, climate migration is “something that we have to face,” says Yue “Gurt” Ge, an expert in risk and resilience management at the University of Central Florida in Orlando. Finding some way to assess the scale of the issue will be essential to creating climate adaptation strategies for his city, he says. It’s 3 p.m. in late February 2020, and the university’s new Urban Resilience team is holding its second meeting in a brand-new, glossy high-rise in downtown Orlando. This interdisciplinary team is the brainchild of Ge and emergency management expert Naim Kapucu, head of the university’s school of public administration.Ge, a slight, energetic man, eagerly ushers a group of about a dozen waiting scientists into the conference room, where they sit at long white tables and introduce themselves. Half a dozen more people are Skyping in. It’s a diverse group, with expertise in everything from artificial intelligence to wine. Resilience, reducing the impact of disasters, is the common link. Ge is anxious to build connections within the team. Periodically, he steps in, noting how each person is connected to the larger effort. Interdisciplinary teams have insights, he says. Perhaps as important, they get funding. He says he hopes to identify research projects for the team, as well as build partnerships to better implement best practices.First on the table might be developing a formal, research-driven way to count climate migrations to Orlando — a necessary ingredient for any city’s resilience plan. “We can contribute by proposing scientific studies, surveys, focus groups with climate refugees,” Ge says. The airport, local community organizations and shelters could be helpful in providing data. HOLA, he says, is a valuable ally in this effort as well. “When they accommodate or house these people, then they do have some numbers to tell us.”Finding good data to track migration remains a challenge. The IRS changed the way it records tax data in 2017, unfortunately “breaking” the time series that Hauer had previously used, he says. Those data also are collected annually, giving only a long-term picture of migrations. That’s also true of, for example, data on state-to-state migrations and changes to the workforce collected by the U.S. Census Bureau. For one measure of short-term movement, the Center for Puerto Rican Studies at Hunter College at the City University of New York used student enrollment data from state departments of education to show that many Florida counties saw a rise in Puerto Rican enrollees between December 2017 and February 2018, months after the hurricane. Overall, Florida saw a 12 percent increase, to 11,554 students from Puerto Rico enrolled in schools. Other states that saw rises included New York, New Jersey, Pennsylvania and Massachusetts.Social media, including Facebook and Twitter, may also be useful for tracking large-scale migrations due to climate events that occur on short timescales. Yago Martín, who studies urban resilience at UCF, and colleagues devised a way to use geotagged tweets to identify and track movements of over a thousand Puerto Rican residents in Maria’s aftermath. The methodology holds promise for tracking future migrations, the team reported in February in Population and Environment. The good news is that large research institutions are beginning to recognize the need to fund climate migration research, says UCF sociologist Fernando Rivera, who heads the university’s Puerto Rico Research Hub. He is gearing up to embark on a National Academy of Sciences–funded analysis of past and present climate migrations, focusing on changes in housing markets, financial services, health care, employment and economic development in the communities where migrants end up. The study zooms in on three migration events: from Puerto Rico to Orlando in 2017; New Orleans to Houston in 2005 following Hurricane Katrina; and the pending resettlement of the few dozen residents of Isle de Jean Charles, one of Louisiana’s coastal islands about to be drowned by rising seas. The goal, Rivera says, is to try to determine lessons for future destination communities, such as Orlando. Vila and her 10 family members moved together from hotel room to hotel room for several weeks after arriving in Orlando, unable to find permanent housing. Although they were able, barely, to afford the costs of this lifestyle, other Puerto Rican migrants were not so lucky. Monthly allowances for temporary housing provided by the U.S. Federal Emergency Management Agency to Maria evacuees dried up after about a year for many families. Eventually, most of Vila’s family returned to Puerto Rico. But she and her husband and their children stayed, deciding that the quality of life for their children would ultimately be better on the mainland. She and her husband found jobs: Her husband works in maintenance at their apartment complex. Vila worked at Disney World as a hostess until the parks closed due to social distancing restrictions from the COVID-19 pandemic. She recently completed coursework to become a medical assistant, graduating with high grades. It’s modest success, but Vila says she doesn’t feel quite at home. Still, she says she has no plans to leave. For one thing, her son is now doing very well. And life, she adds, is “peaceful.”