

TOM LEWIS | ALASTAIR MACGREGOR

FUTURE

READY

**YOUR ORGANIZATION'S GUIDE TO RETHINKING
CLIMATE, RESILIENCE, AND SUSTAINABILITY**



WILEY



Praise for *Future Ready*

“This book comes at a crucial time to help business leaders and decision-makers better understand the scope and scale of the climate challenges we are all facing, and the tools that are available to develop successful climate, resilience, and sustainability strategies. The authors channel their extensive experience in projects across multiple markets and sectors, bringing a unique understanding of effective solutions to create measurable, long-lasting sustainable impact. The book helps readers learn more about the risks and opportunities when developing resilient and sustainable projects, and how these are addressed in practice through a rich set of real-world examples. A practical guide covers effective pathways and strategies for organizations to jump-start their sustainability programs and measure, quantify, and improve their long-term sustainability performance. Overall, the book provides a guiding compass for organizations to rise to the climate challenge and help deliver a more resilient and sustainable world. It is highly recommended for executives, professionals, public officials as well as members of the public who want to learn more about how to make a difference.”

—**Dr. Andreas Georgoulas**

Director of Sustainability and ESG,
The Environmental Financial Consulting Group

“This literary work is a powerful and perfect primer combining all the tools needed for those just beginning to explore sustainability and resilience as well as a roadmap for seasoned and veteran pros in their journey for the world to be Future Ready. As the Executive Director of the Disaster Recovery Coalition of America (DRCA), whose members are the largest U.S. organizations leading pre- and post-disaster response and recovery, I have had the privilege to work with resiliency expert and inspirational leader Tom Lewis and his co-authors for the past 20 years on the urgent necessity of building more resilient and sustainable infrastructure. This book demands that we rethink and change our approach to the unequivocal and increasingly clear risk all Americans face because our planet is warming in an unprecedented way, driving more extreme weather. Towns, cities, states, the federal government, and private sector all have to take a more future-focused approach to close the gap in understanding what “doing better” means to address climatic deviations from what used to be considered normal. This book puts in your hands the geographical reality of the future.”

—**Casey A. Long**

Managing Director, The Disaster Recovery
Coalition of America (DRCA)

“Tom Lewis and co-authors Alastair MacGregor explore the job of confronting climate change and detail what is happening right now with stirring new innovations that have emerged in the battle against an ever-changing climate. Their book *Future Ready: Your Organization’s Guide to Rethinking Climate, Resilience, and Sustainability* is an amazing compilation of how organizations and professionals can begin or continue to better prepare the world to tackle this intimidating challenge.”

—**Thomas Abdallah**

P.E. LEED AP, Vice President and Chief Environmental Engineer,
MTA Construction and Development, New York City
Professor Columbia University—Sustainability Management
Graduate Program, SPS
Author of *Sustainable Mass Transit: Challenges and Opportunities
in Urban Public, Transportation*

“The world faces both a climate and a social emergency, yet for the most part, organizations are sleepwalking into a dystopian future, and at best, making incremental changes to their strategies. *Future Ready* challenges us, with real-world examples, to make a mindset shift, rethink everything, and embrace transformational change in the infrastructure systems that underpin our societies. Read, be inspired, and act before it is too late.”

—**Richard Threlfall**

Chair, International Coalition for Sustainable
Infrastructure, and KPMG Global Head of
Infrastructure, Government and Healthcare

“*Risk* and *vulnerability* are terms that we often hear when discussing the impacts of extreme weather events on infrastructure. We hear of many global projects illustrating how solutions are developed and implemented. In *Future Ready: Your Organization’s Guide to Rethinking Climate, Resilience, and Sustainability*, Lewis and MacGregor not only brought into one place some of these stories, but also took on a different meaning of risk and vulnerability. There is the risk of not providing enough detail or context to illustrate how they came up with the strategies they offer in the book. There is also the vulnerability of opening up their organization’s project portfolio and letting others critique the “why” of those strategies’ applications. I applaud the authors’ boldness in leveraging their vulnerability to ensure that the infrastructure industry learns from their experience in planning, designing, building, and maintaining sustainable and resilient programs and infrastructure. Part history and part best practice, the book balances the need to address the moment’s challenges, strategic solutions, and how one organization is making a difference: achieving innovative outcomes in

often the most challenging circumstance. There is no one-size-fits-all strategy to combat the unique issues of the complex ecosystem of climate-related impacts. *Future Ready: Your Organization's Guide to Rethinking Climate, Resilience, and Sustainability* provides a menu of strategies that, at the time, may only apply to the circumstances of a city or a region. But a better picture emerges when combined with the lessons learned from other locations. We need an ecosystem of players and strategies to optimize solutions. Lewis and MacGregor challenge us to think about the future differently. Not only to be ready, but also to further minimize the increasing risks and vulnerabilities of infrastructure to the growing impacts of the climate status quo. We need to continually use the built infrastructure using the paradigms of the past. Through this collection of projects and the book's advice, this time, we're in a better place to succeed in doing the 'right project.'"

—**Dr. Cris B. Liban, P.E.**

2020 Engineering News-Record Award of Excellence Winner;
Distinguished Member, American Society of Civil Engineers
Fellow; American Society of Civil Engineers Chief
Sustainability Officer LA Metro

"*Future Ready* is more than the usual "how-to" guide for resiliency professionals. By advocating for equity and community empowerment as core project deliverables, this book provides a vision for *doing resiliency right*—and for the people who need it most."

—**Paul Gallay**

Director, Resilient Coastal Communities
Project, Columbia Climate School

"A must read for those responsible for building or retrofitting in our private sector as well as infrastructure and built environment owners and operators in local, regional, and federal government. With a perspective firmly anchored in the future, this book lays out in clear terms what the opportunity cost will be if we don't build with a focus on both sustainability and resilience. Put simply, it's not about the short-term cost of building efficient sustainable buildings and infrastructure, it's about the much greater long term cost if we don't! The authors are not only subject matter experts, but they advise and design for newly built as well as pre- and post-disaster sustainable and resilient solutions around the globe for both the private and public sectors."

—**David R. Soares**

President & CEO of Lexden Capital, LLC,
a New York real estate and infrastructure investment company

“A compelling account for an organization’s journey to rethink everything and coalesce around the idea of becoming Future Ready. Plenty of useful advice and tangible examples for those who are striving to bring sustainability, resilience, and climate action at the heart of their organizations. Embarking on a similar journey is urgent and necessary for all built environment professionals if we are to tackle the most pressing challenges of this decade and build a just, sustainable, and resilient future for all.”

—**Savina Carluccio**

Executive Director, International
Coalition for Sustainable Infrastructure

“In an era of an escalating human-based impact on climate change and runaway destruction of the environment and biodiversity, this timely book emphasizes the urgency for the client to seek the advice of engineers and other experts on selecting suitable projects with future-focused solutions.”

—**Spiro Pollalis**

Professor of Design Technology and Management at the
Graduate School of Design, Harvard University

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To
Christina, Alexa, Abigail, James, and Holly Lewis
Christine, Abigail, and Alexander MacGregor

And to our WSP
colleagues, clients, and partners
for challenging and inspiring us to be innovative, resilient, sustainable,
and Future Ready®

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Foreword

CHRISTIAN MENN, THE famous Swiss engineer and bridge designer, approached bridge design with safety being his utmost objective while designing beautiful bridges perfectly blended in the mountainous landscape. Safety in the 1970s and 1980s was simpler to understand and handle. The bridge should safely fulfill its intended use for pedestrians and vehicular traffic, designed according to code. But what would be “safety” today? Is it only about the bridge, the construct?

Expanding on the traditional definition of safety, which generations of engineers have inherited, we can include the prevention of the adverse effects of climate change on our own current and future projects. The utmost objective becomes the safety of the users and the safety of many more people who may live thousands of miles away.

Our projects impact nature, leading to ever-increasing loads on our constructs. Our designs should address how our constructs will continue withstanding natural phenomena, which will exceed the requirements of today’s codes. Our designs should be sustainable, that is, built within the capacity of our ecosystems, preventing the increase of extreme phenomena. The designs should be resilient to withstand the impact of future extreme phenomena, unavoidable to be completely contained. In a nutshell, today’s engineers, designers, environmentalists, and construction professionals should also be concerned about

how their projects affect the climate and how their projects protect the planet. Addressing the broader impact of projects in unchartered territories requires professionals to cross the boundaries of their own silos. Interdisciplinary collaboration is necessary for analyzing and understanding the issues, convincing the stakeholders to make the necessary decisions, and building meaningful future-oriented projects.

The authors have a good understanding of these issues. They quote that “climate change is now and tomorrow. It’s local and global. It’s risk and opportunity.” They are members of a large engineering company, which identified early the need to act responsibly on the environment. They have participated in different fora researching the impact of engineering work on the environment. So, they undertake the responsibility to reach a wider audience. First, to share their knowledge. Second, to emphasize the imperative need for a broader and coordinated collaboration of the experts with the clients and the policymakers to have an impact on mitigating and adapting to climate change.

The book is not a traditional engineering textbook. Instead, it follows a different approach to engage the audience effectively. Based on case studies accompanying a narrative, the book attracts the reader’s interest, whom the authors consider their future collaborators in selecting and implementing suitable projects fulfilling the client’s needs and meeting this society’s expectations at large. The approach is convincing as the book presents cases known to the reader that can be repeated soon, like the Superstorm Sandy in New York. However, although the book uses examples familiar to most, they do it with the authority of having been engaged in addressing them as experts.

The narrative follows a carefully planned thread. It starts with the need for safety, as any responsible engineer would do, and very quickly introduces the concept of risk. In the past, the risk was addressed straightforwardly. Although the future cannot be predicted, analyzing the past leads to informed decisions about what is expected to happen in a probabilistic way. The assumption is that the external parameters remain the same. However, nowadays, it is more complicated to be based on past data. Extreme phenomena with unprecedented frequency have become the norm. What used to be the 100-year phenomenon may occur more than once in a decade. The risk becomes

a climate risk, which requires equal attention to adapting practices and mitigating future climate risks by selecting the proper projects.

Then, the transition risk is introduced, defined by international multilateral and nonprofit organizations as the risk of adapting practice to new conditions. The transition risk also includes leaving parts of the population and entire countries out of climate mitigation and adaptation benefits. Equity and the social dimension are essential to ensure the success of climate action. A step further, reflecting realism, the low-profit margins of the construction industry are emphasized. The industry is fragmented with too many players and mature technology, leading to price competition that leaves little room for research and innovation. The intervention of government and society fills the gap. At the government level, executive orders in the United States, like ARRA (American Recovery and Reinvestment Act, 2009) and IRA (Inflation Reduction Act, 2022), funnel large amounts of money to sustainable and resilient projects. These funds do not last forever, but the changes have a long-lasting effect, especially when pursuing sustainability and resilience proves less expensive than initially thought. If the right project is selected from the beginning, and if the proper steps are followed from the very beginning, the cost of the sustainable project may be a little higher in the short term, but cheaper in the long term. Sustainable projects have a higher risk-adjusted return on investment when considering future regulations and their societal acceptance of continuing operating. Furthermore, informed forward-looking communities authorize additional funds for sustainable projects that impact the daily life of their citizens and boost the local economy, with a primary example being the cleaning of the Santa Monica beach in California.

The authors look for alliances in calling for action on sustainability and resilience and identify three megatrends. The first megatrend is the extreme climate phenomena, evident everywhere on the planet. The reaction and demand of society in the most affluent countries is the second megatrend. Technology development and use of technology is the third megatrend, an enabler of effectively addressing climate change within the cost afforded by society.

Through examples, the book presents the issues effectively and powerfully and requires action. The authors' own firm demonstrates

how action can be taken. Sensibly, they recommend flexibility to address low-hanging fruits, paving the path for bold action. Quoting the book, “getting early wins is essential to building momentum and buy-in. Once employees see that establishing a new and better solutions-oriented framework produced results—being selected by key clients for large and high-profile projects—even skeptics will likely become converts.” They also strongly recommend working with nature and learning from nature, discounting the attitude of many years that human intervention can tame nature.

The effectiveness of developing sustainable projects depends on being next to the client when making decisions about which project to undertake to address specific needs. It also depends on the policymakers, who respond to societal demands, and provide the framework to select and develop sustainable and resilient projects. Design professionals have always desired to be the first to advise clients and policymakers, with fluctuating success throughout the years. Today, though, it is imperative for clients to seek the expertise necessary to select future-looking projects. The role of experts is more than executing the program of requirements of the client; the role of experts is to develop the program of requirements to fulfill present and future needs effectively, and equally importantly, efficiently with limited resources. It is desirable for the experts developing the program of requirements to execute it.

The book provides the opportunity for the clients of engineering works to comprehend the complex concepts of sustainability and resilience. The book is equally valuable for policymakers to act, following the advice of those who execute the projects and have demonstrated a commitment to serving society at large. Policies should effectively address climate mitigation and adaptation without overtaxing society.

In an era of an escalating human-based impact on climate change and runaway destruction of the environment and biodiversity, this timely book informs and emphasizes the urgency for the client to seek the advice of engineers and other experts on selecting suitable projects with future-focused solutions.

—Prof. Spiro N. Pollalis
Harvard Design School

—Anthony Kane
Institute for Sustainable Infrastructure

Introduction: Superstorm Sandy

ON THE NIGHT of October 29, 2012, Superstorm Sandy was everywhere. I had a hard time keeping my eyes off the TV, flipping back and forth between the Weather Channel and CNN's beachfront reporters, who were on the verge of being blown over or swept away by water. I was also getting first-hand reports of the flooding in lower Manhattan. At the time, I was the U.S. company lead for Louis Berger, the global professional services firm that is now part of WSP. Louis Berger was responsible for managing the Downtown Recovery Program where rebuilding work at the World Trade Center site was continuing over a decade after the September 11 terrorist attacks. That job had expanded my environment and sustainability technical focus to include disaster management, of which Superstorm Sandy would become an extreme example. The wall of water that was pushing in from the mouth of New York Harbor was threatening all the progress that had been made at the site.

Sandy also hit closer to home. Right outside my window, trees were bent parallel to the ground in 70-mph blasts of wind. My family lived in a small town in New Jersey, just outside New York City—and directly in Sandy's path. By midnight, the gusts weakened to 50 miles

an hour, but it took me another two hours to finally crawl into bed. It was a short night's sleep.

At approximately 4:00 a.m., an employee of New York City's Department of Citywide Administrative Services called my cell phone. He thanked me for picking up before moving straight into his early-morning pitch. "I'm making all kinds of calls because we need heroes right now. I'm having a hard time finding heroes. I'm hoping Louis Berger can be a hero."

"Absolutely," I said, walking out into the hallway. The wind was still hammering the south side of my house. "What do you need?"

"Everything."

"Let's start with the priorities," I said.

"We need pumps. We need generators. We need fuel. We need trucks. Whatever you can get me, I'm pretty sure I'll take it."

I was full of adrenaline as I marshalled together the initial equipment supply with my emergency management team. Over the next few days, I dove into the seemingly endless additional requests for emergency response support and materials coming our way. At the same time, our house had no power except a small gasoline-powered generator, so I was taking calls in my car with the phone plugged into the cigarette lighter.

Outside, the neighborhood had been transformed into a surreal landscape of downed powerlines and toppled trees. On Halloween, two days after the storm blew through, I drove across my neighbor's front lawn to get out to the main road and buy gas for our generator—it was the only way to get around the debris blocking the street. Once I got onto major roads, I searched for gas stations that still had fuel, but they often had hours-long wait times.

Yet, even as I drove past the wreckage around me, I knew we were lucky. We were alive—the storm killed close to 100 people in New Jersey and New York alone—and in a relatively undamaged house. Thirty miles away in Queens, a whole neighborhood had been inundated by flooding and then, after a flood-related electrical accident, burned to the ground. Down at the Jersey Shore, houses in expensive beachfront communities collapsed into the sand, while the streets surrounding them were reclaimed by the ocean. In just a few hours, one of the wealthiest parts of one of the wealthiest countries in the world had been devastated and humbled. It was clear that we needed

to do better, and my career and business focus expanded again to include a stronger and more direct blending of climate resilience and sustainability.

Arguably, 2005's Hurricane Katrina should have been the definitive wake-up call across the United States about the urgent necessity of building more resilient and sustainable infrastructure. The event's sobering death toll, around 1,800 people, the widely criticized local, state, and federal response, and the horrible inequity in who suffered the most—like many disasters, a disproportionate number of the dead were poor, Black, and elderly—were all shocking. I saw the inordinate toll on already underserved communities from the storm's damage and the subsequent, lagging rebuilding efforts first-hand in 2007, when I spent time in New Orleans supporting the long-term recovery. But for many people—and I was one of them—it was also easy to put a few asterisks next to Hurricane Katrina's impact. Unlike New Orleans, most U.S. cities don't sit on the hurricane-heavy Gulf of Mexico, surrounded by water, below sea level (and sinking), and reliant on an extensive system of pump stations and levies to stay dry and habitable.

In that sense, Sandy was different. First, it made climate change very personal to me by putting family at risk. But, more broadly, it was irrefutable evidence of how much more of the United States was at risk. If New York City could effectively be paralyzed for weeks, nowhere along the densely populated East Coast of the United States could be considered safe. However, by the time Sandy hit in 2012, the science on climate change was unequivocal and the risk increasingly clear. Over 90% of climate scientists agreed that the planet was warming in an unprecedented way, the warming was largely driven by human activity, and the changing climate was driving more extreme weather. Thousands of scientists around the world contribute to the Intergovernmental Panel on Climate Change's (IPCC) climate modeling, but the basic dynamic behind global warming is high school physics. Putting more heat in the atmosphere and oceans means they also contain more energy. This additional energy will, in turn, be released in larger and more anomalous storms and other climatic deviations from what used to be considered normal.

Predicting exactly what types of weather events global warming will produce is trickier. No single event can be ascribed to climate change. In fact, explaining any one weather event at all is complicated

since they are all the result of numerous, complex interrelated dynamics acting across a spatiotemporal scale. However, we do know what *kind* of storms will be more frequent and severe as a result of climate change. Sandy, an extreme storm and huge flooding event, fit that profile—we’ll dig into some specific details later.

However, for anyone waffling on whether climate change was “their problem,” getting walloped by Sandy put an exclamation mark on it. The extreme weather predicted in the relatively dry and dense IPCC reports that span thousands of pages is happening now. Sandy gave the New York metro area a peek into what life in the era of climate change looks like—flooded subway tunnels, destroyed neighborhoods, and millions of people without power or heat as winter approached.

The good news was that many people in businesses, government, and other organizations got the message. In the years following Sandy, I met hundreds of very smart, capable people working passionately on innovative solutions. They were climate scientists and modelers, architects, planners, engineers, and project managers at state and federal infrastructure agencies and environmental departments, logistics experts and disaster preparedness specialists at the Federal Emergency Management Agency (FEMA), and sustainability executives at corporations across the spectrum. We all shared a conviction that climate change is humanity’s most urgent issue and that we need to make better choices, and tens of millions of other Americans agree with us.

At a fundamental level, there is no great mystery about what “doing better” means. Towns, cities, states, the federal government, and the private sector all have to take a more future-focused approach and do two specific things better. First, we must reduce our greenhouse gas (GHG) emissions and consider full life-cycle costs and impacts by enacting sustainability measures. Second, we should limit our short- as well as long-term vulnerability to extreme weather through climate adaptation and resilience measures. These goals are deeply interrelated. If we don’t rapidly reduce our GHG emissions, we’ll never be able to build barriers that are high, wide, and strong enough to be resilient. Similarly, if we don’t improve stormwater management and integrate naturally adaptive measures, our cities will repeatedly flood and/or run short of critical resources like clean water before our sustainability measures are able to bend the curve of emissions.

If we had started two or three decades ago, arguably, rapidly reducing GHG emissions would have been sufficient to avoid the need for massive climate adaptation and resilience measures. That moment has passed. Today, the pace and advanced state of climate change means there is no either/or option—we need to reject false choices and build a resilient *and* sustainable future. There was also little doubt about what we *didn't* need after Sandy: a return to business as usual. That was what got us into this mess in the first place.

Since then, I've worked on countless projects in New York and New Jersey and across the United States that focused on resilience and sustainability. Yet, even as I could feel a shift toward these aims, it was clear we weren't all aligned. Some people had short memories about the last flood or drought or wildfire, or simply tuned out when faced with a phenomenon as complex and massive as climate change. Other times, I encountered some of the same old false choices and unsustainable leadership mindsets that create systemic blocks to building resilience. I also heard well-intentioned experts say that we should focus our attention and resources on climate mitigation alone rather than climate adaptation and resilience at the same time.

Engineers are ethically bound to look for solutions that will endure, so they can't focus on only one condition at a time. That meant that, post-Sandy, when I was driving on my neighbor's lawn to avoid the dangerous, downed powerlines, I was also thinking "This is crazy! We've got to get those things underground." It turns out, however, that the poles are owned by the town, which rent them to the utilities. If the utilities buried their wires, the town would lose the income stream. Just like that, a relatively cheap and easy way to save human lives and protect part of our infrastructure becomes a nonstarter in many locations.

Despite these headwinds, I knew I was in the right sector to make a difference. Infrastructure including in what is also referred to as the built environment—hospitals, schools, offices, airports, railroads, water, sewers, power, housing—accounts for a full 70% of the GHG emitted in the United States every year. It's easier to visualize the pollution coming from a large truck rumbling by than the apartment building it's passing, but we need to pursue the decarbonization across our infrastructure. Even if everyone in America switched to electric vehicles (EVs) overnight, we'd still be a long way from meeting our

long-term climate goals and truly doing our part globally. Until we rethink the roads we're driving on—and the rest of the built environment around us and the associated role that different organizations and sectors play in that environment—we don't have a chance of overcoming the climate crisis that threatens our planet and our collective future.

In the aftermath of any disaster, there are thousands of heroes—paramedics, firefighters, police, and ordinary citizens—who ignore political and ideological differences and go out of their way to save the lives of strangers and protect their neighbors. But, between storms, we need dedication to the same goals every day. This kind of quiet heroism and selflessness requires different skills, like persistence, flexibility, curiosity, collaboration, and diplomacy.

The climate, as well as other future conditions, are changing rapidly, so building just like we did (and sometimes even where we did) last time is reckless. The challenge is urgent, so exploring new technologies, materials, and processes is essential. Innovation is vital, so integrating people and their expertise in unprecedented ways is imperative.

In a way, the journey that was kicked off by that 4:00 a.m. phone call never ends. In this book, my co-authors, Alastair MacGregor, and I explore why it's taken the planet so long to begin the job of confronting climate change in earnest—and what is finally moving the needle. We discuss some of the most exciting innovations that have emerged since Hurricane Sandy tore through New York and New Jersey. We help you and organizations like yours avoid the false choices, maladaptation, and perverse incentives that stymie efforts to plan and design for a very different future. We share our commitment to climate action and creating better infrastructure that blends sustainability, resilience, and a just transition to a green economy. Most importantly, we want to inspire other people and organizations to rethink what is possible on their journeys toward truly Future Ready® cities, communities, and companies.

1

Rethink Everything

ON OCTOBER 22, 2012, meteorologists at the National Hurricane Center (NHC), a cement fortress in Miami, Florida, registered Tropical Depression 18 in the southwestern Caribbean Sea. The event was then just a line of thunderstorms moving across the turquoise water, but it represented a serious potential risk. Hurricanes and other weather-related events kill an annual average of hundreds of people and cause hundreds of billions of dollars in damages in the United States alone.

The NHC, which is tasked with predicting the future risk of these low-pressure systems across the United States, jumped into action. It dispatched one of the Air Force's Lockheed Martin Super Hercules aircraft for observation. Despite all the data that streams in from geostationary satellites, as well as other land- and water-based weather stations, flying an 80-ton airplane into a furious windstorm is currently still the best way to gather some information.

In Miami, experts in meteorology, satellite data, and remote sensing poured over the reports and fed it into multiple hurricane forecast models that predicted the event's future direction and destructive potential. Many tropical depressions fizzle out, but the environment surrounding Number 18—including warm waters and local atmospheric conditions—caused it to intensify rapidly with a defined circulating pattern and winds above 38 miles per hour (61 kmh), thus earning it a name: Tropical Storm Sandy. Over the next few hours,

Sandy's increasing wind speed and structure quickly took it to hurricane-strength. The NHC issued warnings to Jamaica, Cuba, and other Caribbean islands in its likely path, saving lives and reducing damage, while keeping an eye on potential risk to the United States.

Well before Sandy made landfall in New Jersey on October 29, the NHC had released a continual stream of updates and warnings for areas likely to be impacted, the National Weather Service had issued watches, governors had declared states of emergency—and even mandatory evacuation orders for certain areas. All these advisories were picked up and spread by local police and emergency officials, television, newspapers, and social media. However, even mandatory evacuations are rarely enforced. Once the expert advice about Hurricane Sandy's risks reached residents, it was up to them to decide what to do. Many chose not to heed the warnings; 186 Americans died in the storm.

A later Center for Disease Control and Prevention (CDC) report detailed the fatal consequences of ignoring official advice. The leading cause of death related to Sandy was drowning due to the storm surge and associated flooding, which accounted for nearly half of the fatalities. Of those drowning deaths, over half were people who died in homes located in primary evacuation zones. The result was that, in 2012, more Americans drowned in their own homes than were killed during violent home invasions, sexual assaults, or carjackings.

A decade later, on September 28, 2022, category 4 Hurricane Ian tore into the southwest coast of Florida. Governor Ron DeSantis had declared a state of emergency four days earlier and mandatory evacuation orders covered all or part of 12 counties. Once again, though, many people did not evacuate. Nearly 130 people died in Florida, many of whom, again, drowned near or in their houses located in evacuation zones.

There is a wide range of circumstances that make it harder for certain people to evacuate—some have physical or mental disabilities, some don't have transportation, others simply can't afford to leave. But there are also large numbers of people who remain in the path of storms by choice. Hurricanes are known killers, so what leads those in mandatory evacuation zones to decide against following the expert advice intended to save their lives?

We could ask similar questions about our historic lack of urgency around climate change. The accelerating buildup of greenhouse gases

and resultant increase in heat energy trapped in our planet's atmosphere represents a destructive and global threat that causes billions of dollars in damages and directly or indirectly kills thousands of people a year. It is also a phenomenon we have been publicly and repeatedly warned about by scientists since the 1980s. So why have most of us routinely ignored expert advice and downplayed this accelerating threat?

It turns out that our stuttering responses to both specific events like hurricanes and the global phenomenon of climate change are deeply interrelated—both largely determined by human risk perception. Though risk is one of our greatest motivating forces, we also evaluate risk in deeply inconsistent ways that are poorly attenuated to recognizing certain threats. For example, humans tend to react more urgently to near-term, immediate risks—even if the future risks are ultimately much greater. Of course, from an evolutionary standpoint, prioritizing “avoiding hungry tigers” makes a lot of sense. However, the same life-saving perception of immediate risk also introduces a tendency to discount the future. Likewise, we tend to react more urgently to threats with which we've had negative personal experience. Again, deciding not to eat mushrooms of a certain color has distinct evolutionary advantages. But privileging personal experience also tends to reduce the importance of potentially life-saving advice from other people, including those with scientific expertise.

Today, the biggest threats humans face have changed dramatically, but our risk perception is still saddled with evolutionary baggage that gives primacy to risks that are immediate, near-term, and personal. For many people, neither hurricane forecasts nor climate change make that list. However, climate change faces additional obstacles to being perceived as a serious risk. For one, the phenomenon is complex and described most accurately in nuanced scientific terminology—language that doesn't register climate change as a dire threat for many people. Accepting the broad scientific consensus around climate change has also become deeply politicized in the United States, forcing people to “choose sides” rather than dispassionately evaluate risks. The cumulative result of these factors is that, for decades, humans haven't responded appropriately to a potentially existential threat largely because so many of us didn't perceive climate change as carrying meaningful risks.

Making Climate Risk Real

In 2022, the United Nations' Intergovernmental Panel on Climate Change (IPCC), the most authoritative source of scientific data on climate change, issued its sixth assessment. Hoesung Lee, the Chair of the IPCC, described the report as “a dire warning about the consequences of inaction.”¹ António Guterres, the United Nations (U.N.) secretary general, added that the assessment represented “an atlas of human suffering and a damning indictment of failed climate leadership.”²

The only good news was a notable shift in how the report was received. In parts of the private sector, there was an urgency around the issue of climate change that hadn't existed even five years previously. After decades of collective foot dragging—amid increasingly specific and stark warnings from the IPCC—what has changed? Why have organizations finally decided to take climate action seriously?

Once again, the primary driver is risk perception. Decades of resistance to taking climate change seriously is rapidly dissolving as more people believe it poses a near-term, personal, material risk. As investors, shareholders, and business leaders rethink the threats—and opportunities—climate change represents, climate action is finally emerging as a mainstream priority.

Climate-related risk is certainly not hard to find—nor is it new. But while deadly and destructive climate-linked extreme weather used to be viewed more like a black swan event, it is now an annual inevitability. Every year, wildfires, droughts, hurricanes, and other extreme weather will exact a toll—the only questions are exactly how many human lives or billions in dollars. Take, for example, the cumulative financial damage from climate-related events in 2021. Wildfires in the western United States cost roughly \$11 billion, a pervasive drought and record-setting Pacific Northwest heatwave cost \$9 billion, a historic winter storm cost \$25 billion, and Hurricane Ida cost \$78 billion. Globally, the losses were even higher—flooding alone hit \$90 billion.³ In short, the massive losses caused by extreme weather were finally making climate risk unignorable.

In the past five or so years, however, a whole new dimension of climate risk has also emerged. Physical risk refers to disruptive, costly events like buildings flooded by hurricanes or supply chains disrupted

by wildfires. In contrast, transition risks result from the transition to a lower-carbon economy, and are related to policy and legal actions, technology changes, market responses, and reputational considerations. For example, governments at all levels are introducing and tightening regulatory mechanisms like energy efficiency mandates or requirements on greenhouse gas (GHG) reductions. Companies that don't transition quickly enough risk experiencing severe reputational and brand damage, or being excluded from certain markets. Changing expectations about future profitability within carbon-intense industries can lead to significant loss of asset value. Similarly, changed water conservation policies could negatively impact agricultural companies.

Transition risk also refers to missed opportunities—the new markets and growth that are open to leaders in decarbonization efforts, as well as those organizations that are more progressive with regard to the mainstreaming of resilience and sustainability approaches and technologies. Tesla, for example, is a massive beneficiary of national GHG emission reduction goals. The United States, Europe, China, and other countries offer automakers that can't meet mandated emission reductions the option of buying credits from car companies that have surpassed regulatory goals. Tesla, which primarily sells electric vehicles, has been able to maintain its profitability in the U.S. market largely because it sells so many carbon credits to other carmakers—\$1.5 billion worth in 2021.⁴

The third factor driving awareness of climate risk is coming from investors, shareholders, and other company stakeholders. Over the past few years, investor demand for Environmental, Social, and Governance (ESG) reporting—in which companies account for their GHG emissions and climate resilience, and other Environmental, Social, and Governance (ESG) metrics—has soared. ESG assets, like companies that issue annual ESG reports and employ corporate policies to act more responsibly as environmental stewards and community partners, were a relatively niche category 10 years ago. Today, they are on track to reach \$53 trillion assets under management (AUM) by 2025, or a third of the global total AUM.^{5,6} Though there is no universal framework for ESG declarations nor legal requirement for action, even the process of reporting on GHG emissions has created a whole new driver—as well as a growing industry—for taking climate action seriously.

The meteoric growth of ESG reporting and as a class of investment is also creating a sort of virtuous ecosystem. When companies elect to voluntarily disclose their climate-related financial risks and other ESG criteria, it sends signals to the broader marketplace that these issues are important for organizational decision-makers, employees, customers, and investors of all types.

Increases in ESG reporting also drive more consistent understanding of ESG risks over time. (Although that understanding is still quite inconsistent and messy today—a topic we explore in the second section of the book.) Improving literacy around ESG reporting, in turn, encourages changes in the regulatory landscape to meet investor needs. The European Union (EU) already requires corporate sustainability reporting from a growing number of companies.⁷ The U.S. Security and Exchange Commission (SEC) is also expected to require publicly held companies to disclose climate-related information as well as other ESG data.⁸ As these disclosures become expected by more consumers and the public, privately held companies are also more likely to voluntarily release information. These reactions, in turn, send additional signals to the marketplace, further accelerating the cycle of normalizing and expanding ESG disclosures.

The public sector is also moving to limit its exposure to climate risk. Not surprisingly, the areas in the United States that are most at risk of experiencing loss are often among the leaders in building sustainable and resilient infrastructure. For example, Florida and California—on opposite coasts and sides of the political spectrum—are two of the states with the highest climate risk. However, cities, counties, and other stakeholders in both states have invested heavily in sustainable and resilient infrastructure.

Driving toward Zero

One of the most common goals to combat the risk of climate change is what's called "net zero." Net zero effectively means cutting an organization's GHG emissions to as close to zero as possible, with any remaining emissions reabsorbed from the atmosphere—for instance, by forests that naturally store carbon dioxide or by technological means of carbon sequestration.⁹ To date, over 70 countries—including the United States, China, and the European Union—have set net zero