ADVANCES IN URBAN SUSTAINABILITY

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Adaptation Urbanism and Resilient Communities

Transforming Streets to Address Climate Change

Billy Fields and John L. Renne

ADAPTATION URBANISM AND RESILIENT COMMUNITIES

Adaptation Urbanism and Resilient Communities outlines and explains adaptation urbanism as a theoretical framework for understanding and evaluating resilience projects in cities and relates it to pressing contemporary policy issues related to urban climate change mitigation and adaptation.

Through a series of detailed case studies, this book uncovers the promise and tensions of a new wave of resilient communities in Europe (Copenhagen, Rotterdam, and London), and the United States (New Orleans and South Florida). In addition, best practice projects in Amsterdam, Barcelona, Delft, Utrecht, and Vancouver are examined. The authors highlight how these communities are reinventing the role of streets and connecting public spaces in adapting to and mitigating climate change through green/blue infrastructure planning, maintaining and enhancing sustainable transportation options, and struggling to ensure equitable development for all residents. The case studies demonstrate that while there are some more universal aspects to encouraging adaptation urbanism, there are also important local characteristics that need to be both acknowledged and celebrated to help local communities thrive in the era of climate change. The book also provides key policy lessons and a roadmap for future research in adaptation urbanism.

Advancing resilience policy discourse through multi-disciplinary framework, this work will be of great interest to students of urban planning, geography, transportation, landscape architecture, and environmental studies, as well as resilience practitioners around the world.

Billy Fields is an Associate Professor of Political Science at Texas State University. His research focuses on understanding the key elements of resilient communities. He is the co-editor of *Transport Beyond Oil* (2013) and leads the International Sustainable Transportation Engagement Program, an annual study-abroad program in the Netherlands exploring best practices in active transportation.

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Tara Tolford, AICP, is an urban planner and researcher in New Orleans. She has been a researcher with the University of New Orleans (UNO) Transportation Institute since 2011, specializing in active transportation planning, policy, and data. This has included managing a regional pedestrian and bicycle data initiative, developing and implementing the framework for a statewide pedestrian and bicycle count program, authoring Louisiana's Recreational Trails Program strategic plan, and coordinating the development and application of tools in support of smart growth, growth management, and transit-oriented development. In addition, she is an instructor for UNO's Master of Science in Transportation program, has organized various local and international knowledge-sharing and outreach projects, and serves on numerous local and state committees focused on fostering built environments that support sustainable transportation options, climate mitigation, and equitable use of public space.

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FOREWORD

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This is a beautiful book. It's about streets and how they can make more resilient cities. It took me back to a journey I began in 1972 when I went (with my wife) to study in Delft, the Netherlands. We were young, untraveled and had no experience of how different cities could be. It was a cultural shock as the first day after we arrived, we bought a car as we were from Perth and you couldn't live without a car in that city. It was deeply embedded in our psyche. Then we discovered that we hardly ever used the car. We just didn't need it to meet friends or go shopping or do anything really. We ran into our friends in the street, something we had never experienced before.

As we got to know our new city we discovered a big overpass at the entrance to the city that had never been finished. It hung in the sky like a huge, ominous threat. We discovered that Delft, like all cities in the world, had been subject to an American consultant's report that had said unless a major freeway was forced through the city it would never survive economically. The locals however had stopped it.

Instead of adopting the idea of creating more capacity for cars, Dutch cities across the country began to improve the opportunities for walking and biking with *woonerf*, a word that means "living streets." The engineering techniques for these streets included shared space (with priority for walking and biking), some traffic calming with objects like trees, tables, and chairs, and very low speed limits.

It was a powerful cultural education and this book will give you many such examples that are now mainstreaming across the world, especially new case studies in the Netherlands. They show that the approach has worked and continues to be rediscovered in these and other European cities.

But after this experience we had an even deeper one when I went to Stanford to pursue a post doc and we went to live in what is now called the Silicon Valley area. We started off trying to live like we had in Delft and bought two bikes only. They just didn't work to enable us to live properly; most destinations were just too

far away. And when we used them, despite bike lanes on and around the campus, we were in constant fear of our lives from the traffic. We had to get a car.

Not long after this, the first oil crisis hit and we witnessed the city go into a traumatic state as gas queues went for miles, people just stayed at home and deeply felt anger, and conspiracies raged about where the oil had been hidden in large caverns in the mountains. There was certainly no resilience strategy and no awareness of the inherent car dependence in the structure of the city with its fabric of bitumen that had been rolled out by the same kind of consultant's reports rejected by the Delft community.

These two experiences shaped my life for the next almost 50 years. We returned to Australia and chose to live in a more Delft-like urban fabric (Fremantle) where we have stayed ever since, and I began life as an academic determined to try and manage the automobile in cities across Australia and the world.

I ran activist campaigns that saved our railway and stopped freeways, and won. This gave me hope that cities could indeed overcome automobile dependence, the term Jeff Kenworthy and I created in 1989, based on data we collected over ten years of travel from 32 global cities.

We soon found that we couldn't just say what was wrong with the dominant traffic-engineering model of creating an endless growth in vehicle-carrying capacity. We had to present alternatives that showed how streets could be reclaimed by traffic calming for people to enjoy rather than being destroyed by traffic, how quality transit could enable cross-city travel even in a car-dependent city, and that we needed to build urban villages in the same way that European cities were doing.

This book shows how such approaches can be done and will improve the economy of cities. They will make people healthier and create solutions to the big problems of automobile dependence, including climate change and vulnerability to resource shocks. But it's not easy. There are always struggles as the culture of car-based planning is deeply set in our perceptions of what is right, even human rights. And these perceptions are embedded in highway-engineering manuals and professional standards.

When Jeff and I started going to cities to speak about our publications we found there were deep-seated objections from the local traffic engineers. For a number of years we never found a single engineer who would countenance the idea of traffic calming. Roads were for cars. We eventually found one in Portland and one in Boulder! A decade later we found one in Sydney. But that didn't mean we didn't help win many battles in the streets of American and Australian cities. The power of communities to see common sense and to achieve political change drove a different vision.

That world continues, though most of the ideas for new city development include traffic calming, more localized urban villages, and electric transit. The third book in our trilogy on automobile dependence suggests that most cities are "moving beyond car-based planning." Indeed COVID and the associated economic collapse seem to be accelerating these changes. So, get on board with the concepts and case studies in this book and start applying them in your own places, as you will find the doors are starting to open.

PROLOGUE

This is a book about streets and how they can be used to help make city life better. Better is, however, complicated. Better for whom? Streets have been defined as spaces for cars, spaces to speed away or towards somewhere else. That vision of streets opened regional development and far-flung neighborhoods where you have your life with a certain set of schools, services, and amenities and I have mine with a different set. As urban developer and scholar Christopher Leinberger (2010, p. xv) argues, "*transportation drives development*. The transportation system our society chooses to invest in will dictate the form of the built environment (italics in original)." Transportation and land use policy also drive segregation (Rothstein 2017) and greenhouse gas (GHG) emissions (Creutzig 2016). While there are multiple intervening variables, the places we build and the opportunities those places offer are defined by the streets we choose to build. We can keep building streets that burn through gas and separate our communities, or we can bounce forward towards something better.

Moments of crisis like the coronavirus pandemic and the emerging climate crisis open moments to rethink the status quo, but the cost of that rethinking is the real pain and suffering of disaster. Disasters are not moments of opportunity, but instead challenging and complex times that call for deep reassessment of the status quo (Walker 2020). This book is about that reassessment, a rethinking of the role of streets and how to create places that better serve community needs.

Resilience: bouncing back is not enough

One of the primary ways to conceptualize crisis response is the emerging paradigm of resilience. During the coronavirus pandemic, for example, individuals and organizations struggled to cope with system failures across multiple sectors. From health care to education to the economy to navigating grocery stores and city

streets, systems seemed stretched past the breaking point. Resilience has emerged as a key theme focusing on the capacity of systems to bounce back from shock to create stronger and more robust social, economic, and community networks. During the COVID-19 pandemic, the term was applied to multiple areas from health systems (Legido-Quigley et al. 2020) to supply chain management (Alicke et al. 2020) to food systems (Foley 2020), and the education sector (Brown and Kafka 2020).

The multiple uses and spheres of resilience applications speak to the malleability of the term and its usefulness as a conceptual tool in responding to a world in flux. While resilience is frequently viewed as the capacity of a system to bounce back after a disaster, this approach can, however, limit policy responses to the narrow confines of preexisting pathways. This may be appropriate for places characterized by strong social, environmental, and economic systems, but it is a problematic way to frame crisis response in locations characterized by intense inequality and failing economic and environmental systems. The coronavirus pandemic has, for example, highlighted the unequal landscape of preexisting conditions and health care access that has resulted in significant racial fatality disparities (*New York Times* Editorial Board 2020; Ray 2020). If health care resilience is seen as bouncing back to conditions before the disaster, then the same conditions that created the health storm will be perpetuated. Bouncing back is not enough in the face of failing systems (Shaw 2012).

Community resilience at the street level

In *Adaptation Urbanism and Resilient Communities*, we examine another type of complex system, street systems. Streets have multiple purposes. From acting as the physical location for transportation, water, and electricity infrastructure to creating linkages to your home and neighborhood destinations, street spaces need to accomplish multiple goals simultaneously to help create strong communities. Many streets, however, are not designed to meet these multiple goals equally, but instead privilege the speed of vehicles moving somewhere else over the needs of residents whose front doors open on to these spaces. The result is high crash and pollution rates and social division as highways carve through some neighborhoods to open pathways for others to live in separated enclaves.

As traffic declined during the coronavirus pandemic and the need for safe spaces to walk, bicycle, or use transit at physical distance became more important, many residents looked out their doors and questioned how streets could better serve their community's needs (C40 Cities 2020). In a time when you can't travel very far, making *here* better takes on added significance.

Making here safe for all residents has, however, not historically been a consistent area of emphasis for transportation policymakers. Safe access to quality walking and bicycling infrastructure is often lacking in high-poverty neighborhoods with higher percentages of minority residents (Cradock et al. 2009; Lowe 2016). The result is often high crash fatality rates and vulnerability to pollution in these same

neighborhoods. These infrastructure disparities are often compounded by other public space and street concerns that move beyond pollution and the speed and volume of traffic. Cobbs (2020), for example, notes that:

> Livable streets advocates emphasize the need to make streets safer for children and elderly folks. It's time to broaden the definition of livable streets to include public space where all people are free from the threat of violence by the police or racists, as well as interpersonal violence.

Safe streets need to be welcoming places for all residents, and traffic safety is just one component of this larger system.

Instead of focusing on bouncing back after a disaster to streets of speed, pollution, and division, many communities are looking to bounce forward towards streets and public space systems that are better able to handle unexpected shocks like the coronavirus pandemic and, on a daily basis, make local neighborhoods livable places. In *Adaptation Urbanism and Resilient Communities*, we examine this growing movement of cities that are rethinking the role of streets. While most of the book examines the role of streets in addressing another impending shock, climate change, the pandemic has focused growing attention on how to better use street spaces to create safe spaces for movement in a time of physical distancing. Before we begin the deeper evaluation of resilience and how transportation and public space systems can be rethought to address climate change, the emerging transportation response to the pandemic provides an important moment to highlight the growing movement to rethink the large spatial footprint of cars in urban areas and how that space can be repurposed to help meet deeper civic needs to create truly resilient communities.

Car space and the resilient city

In the immediate months of the coronavirus pandemic, the promotion of physical distancing was one of the primary means of containing the outbreak. While limiting movement outside the home was a core component of the physical distancing policy response, transportation for essential workers, trips for critical needs, and, where safe, movement outside the home for exercise and mental health still needed to be safely managed. These needs placed demands on the allocation of city space.

While auto traffic numbers decreased dramatically during the immediate months of crisis, city space was still mostly dedicated to auto traffic. Approximately 30% of urban space is dedicated to streets (UN Habitat 2013) and, when car parking is added to street space, the figure jumps to approximately 50% of all urban space dedicated to car movement (Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015). Car-dominated cities also produce air pollution that may be a contributing factor in higher fatality risk to COVID-19 (Ogen 2020; Wu et al. 2020). This distribution of space and the negative externalities of transportation system increasingly became contentious issues in many communities as residents

sought safe neighborhood spaces for movement for essential needs and access to fresh air outdoors. The question of why street space was being allocated to cars over neighborhood residents was cast in sharp relief.

While most transportation decisions take years to plan and implement, many cities moved quickly to create open streets to allow for greater physical space for neighborhood residents. As of the end of May 2020, the National Association of City Transportation Officials (NACTO 2020a) identified over 100 cities around the world implementing various forms of traffic calming and street closures designed to open streets to create greater space for pedestrians, cyclists, and transit operations. Key guidance to emerge on the creation of these spaces from NACTO (2020b) includes six key principles: support the most vulnerable people first, amplify public health guidance, create safe streets for today and tomorrow, support local economies, bring communities into the process, and act now and adapt over time.

This guidance represents a key shift in planning for streets focusing on safety, local needs, and engagement. Most streets in the past have, however, been planned with radically different goals and processes. Most streets have been planned with limited public engagement and focus on the goals of pushing as many vehicles as possible through neighborhoods at high speeds. Planning to increase the capacity of vehicles and maintaining vehicle speed have been the administrative hallmarks of transportation planning (Hall 2001). While the NACTO principles apply to the pandemic recovery, these same principles can act as springboards for a new type of street planning with broader goals developed with the community based on improving neighborhood quality of life, improving safety, decreasing pollution, and providing access to community goods and services.

The immediate result of the initial interventions and demand from families for safe spaces to walk and bicycle resulted in a boom for active transportation. Headlines from around the world described large growth in bicycling use with pictures of families moving together in the formerly car-filled city streets (Laker 2020). At the same time, air pollution levels dropped significantly as car use plummeted (Ellis-Petersen et al. 2020). The moment for active transportation as a key component of a resilient transportation system seemed to have arrived (Schwedhelm et al. 2020; Vandyke et al. 2020).

As quickly as the moment for active transportation arrived, it was soon followed by larger questions about the future of commuting and transit and even questions about whether cities themselves would survive the crisis. Disasters are shocks to the system and often cause temporary changes and, occasionally, lead to long-term structural change. The 1970s gas crisis, for example, led to a bike boom across the world in the 1970s, but this quickly faded from view as many cities returned to car dominance. In some places, however, the gas crisis led to a radical rethinking of the place of the car in the city. In the Netherlands, for example, the gas crisis was the catalyst for a now decades-long revival of the bicycle as a key component of the transportation system (Wagenbuur 2011; Feddes and de Lange 2019). In Chapter 5 on Rotterdam, we discuss how the Netherlands translated that push into some of the safest and most livable streets in the world. When headlines ask whether the

"biking surge" will "last when cities open up again" (Peters 2020), the answer is not predetermined, but instead dependent on what citizens and their political leaders push for. The question today is whether cities will bounce back to the car once the crisis subsides or bounce forward towards a new, healthier transportation system.

While there are many forces at play and early indications from China pointing to a growth in car use to avoid crowded transit systems, there appears to be a growing awareness that bouncing back to the pre-COVID-19 transportation system is not enough. Across Europe, initial polling showed that 68% of surveyed residents in Belgium, France, Germany, Italy, Spain, and the UK wanted "to see air pollution reduction policies—including restrictions on car access to city centers—kept in place" (Posaner et al. 2020). Paris Mayor Anne Hidalgo, for example, argued that polluting cars would not be welcomed back into the city in the same way as before the crisis (Reid 2020b). In a speech before the Paris City Council, Hidalgo said that:

> It will make the health crisis worse. Pollution is already in itself a health crisis and a danger—and pollution joined up with coronavirus is a particularly dangerous cocktail. So it's out of the question to think that arriving in the heart of the city by car is any solution, when it could actually aggravate the situation.
>
> *(quoted in Reid 2020b)*

In the immediate months of the crisis, Hidalgo begun to implement this vision by creating a pop-up network of "corona cycle ways" (Reid 2020a) with the ambition of creating 650 km (403 miles) of new cycle facilities. This expanding network of cycle paths was aimed in the short term to act as a safer temporary substitute for metro trips that would essentially "use streets as public transit" (TransAlt 2020). The plan is the first phase of a long-term effort to improve walking, cycling, and extend transit access in the city (O'Sullivan 2020). These plans call for the creation of connected 15-minute city centers where "all city residents are able to meet most of their needs within a short walk or bicycle ride from their homes" (C40 Cities 2020, p. 30).

Efforts like those in Paris are being replicated in cities around the world. For example, in Italy, Milan has proposed a 15-minute city framework and plans to add 35 km (22 miles) of cycling facilities and enhanced pedestrian connections throughout the city (C40 Cities 2020). Rome, as well, has moved forward with plans to build 150 km (93 miles) of bicycle network improvements (Caballero and Rapin 2020). In North America, Oakland implemented a system of 74 miles (119 km) of slow streets (Lydon 2020). Up the coast, Seattle has created a network of "stay healthy streets" designed to open access for physically distant movement (Davis 2020). Across the continent, New York City, in fits and starts, also implemented a system of 100 miles (160 km) of open streets, but with significant equity issues associated with police enforcement and access in historically disenfranchised communities (Cuba 2020).

In Canada, Montreal planned a pop-up network of over 200 miles (322 km) of extended bicycle and pedestrian facilities (Montreal Gazette 2020) in conjunction with a new network of "family and active streets" (Scott 2020). In the Canadian Northwest, Vancouver opened the iconic Stanley Park roads to bicycles, with bike traffic surging 76%. In the words of a 10-year-old interviewed by the CBC, the results were "fun…I don't have to worry about cars" (Larsen 2020).

Providing access to fun, social movement options is an undervalued component of a resilient transportation system. Streets need to be permitted for freedom for 10-year-olds, 80-year-olds, and everyone in between. That freedom needs to be the same for all residents. Freedom of the street starts with freedom to be who you are and move safely through the community.

Resilient streets are not just movement corridors but can also be places for people, places of community. During the coronavirus crisis, these places should allow ample space for movement away from others. After the crisis, however, these same streets can be made "stickier" to help rebuild community connections. Resilient streets can be adapted to changing conditions quickly and repurposed to meet the needs during a disaster and, when the crisis recedes, help to create communities we are proud to call home.

Operationalizing the moment will take many forms in different places, but core changes that appear to be emerging focus on the promotion of slow, healthy neighborhood streets that provide expanded space for people to walk, bike, and visit local restaurants outdoors (NACTO 2020b). Many streets are being transformed into places for slow movement that encourage safety, health, and commerce. In some ways, this is like a pilot project to show what a healthy, resilient street network could look like. If the pilots are planned with community engagement and well used, they can create constituency for change and an opening to extend these new project types into much broader systems. The crisis response is like a test case of how to create a full network of healthy neighborhood streets, but, if history is any guide, the key will be whether local residents and politicians have the will and power to push through the inertia of the status quo. This process will likely be uneven with some communities springing forward and others snapping back into previous patterns.

In *Adaptation Urbanism and Resilient Communities*, we examine the resilient street transformation process through a series of case studies of resilience leaders in Europe and North America. We examine how Copenhagen, Miami, New Orleans, London, and Rotterdam are rethinking their streets to meet the present challenges of the coronavirus crisis and the emerging climate crisis. The challenges are serious, complicated, and contentious, but the urgency of the present crisis and the impending dimensions of the growing climate crisis are pushing new visions forward (C40 Cities 2020). The disaster experience often upends the possible. Things that seemed to be etched in stone often are not as solid as they once seemed. Possibilities that seemed closed sometimes open.

The transportation question is whether new models of streets can be created to help communities bounce forward to meet these emerging challenges. In *Adaptation Urbanism and Resilient Communities*, we examine the political and institutional forces

that are helping to define the answer to these questions and point to potential pathways forward that can help communities build streets that better meet community needs and are truly resilient.

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1

INTRODUCTION

Rising tides and flooded streets

The ocean has begun to wash into the streets of South Florida on sunny days when the breeze barely ripples the palm fronds. On Southlake Drive in Hollywood, FL, the tidal lakes push higher, and residents expect saltwater in the streets and in their yards during the highest tides of the year. These King Tides, combined with a slowing Gulf Stream and rising seas, push water up into the lakes and through the drainage system into city streets, making many areas impassable for hours at a time. Residents move their cars out of the way, watch water rise into their yards, and wait for the ocean tide to recede. It has become increasingly clear, however, that over the next several decades the water is not going to recede. Instead, what once seemed like an anomaly now seems like a harbinger of a future where climate change threatens to push the ocean into the streets, homes, and businesses of low-lying coastal communities around the globe.

Across the Atlantic Ocean in northern Europe, once-rare cloudburst events, when near tropical levels of rain fall in a short time, have become more frequent. On July 2, 2011, almost 6 inches (150 mm) of rain fell in Copenhagen in approximately 2 hours. The sheer physical quantity of the rain outstripped drainage capacity and flooded basements and streets with about $800 million (6 billion DKK) in damages (City of Copenhagen 2012). With climate change altering the temperature and humidity levels, these cloudburst events and, conversely, drought and heatwaves are becoming more common depending on the region (EASAC 2013). Managing water, both too much and too little, has become a key urban issue.

If the challenge of urban planning in addressing climate change were a singular problem for Hollywood, FL, or Copenhagen, a wise course of action might be to focus solely on adapting the lowest-lying and most flood-prone areas to withstand

sea level rise and increasing heavy rain events. If the problem were localized, a fair though painful process could be crafted, and the residents of Hollywood or Copenhagen could move forward.

The complicated challenge that confronts coastal residents and planners, however, is that the scale of the impending crisis is global, and the extent of the sea level rise and intensity of storms is dependent on how much more carbon is emitted. Adapting a single community to rising seas and heavier rains is necessary and complicated, but insufficient given the scale of the challenge.

The Intergovernmental Panel on Climate Change (IPCC), the United Nations body for assessing the science related to climate change, calls for measures to contain global warming to a 1.5°C average increase in global temperature by 2030–2052 (IPCC 2018). This corresponds to a rise in sea levels of 1–2 feet (30–60 cm) by the year 2100 (IPCC 2019). However, this goal will not be reached without widespread adoption of low- to zero-carbon lifestyles. A 2.0°C increase in the average global temperature, for example, corresponds to a likely 2–3.6-feet (61–110-cm) sea level rise over the next 80 years (IPCC 2019). Local adaptations in coastal communities will literally be swamped by the widening climate crisis without focused and lasting efforts to decarbonize urban systems.

The policy challenge, then, for coastal urban planning is to equitably adapt cities to withstand already-projected sea level rise and other climate impacts and simultaneously build landscapes designed to decrease greenhouse gas (GHG) emissions to mitigate potentially even more catastrophic impacts.

While planning for community abandonment and migration resulting from increasing sea levels and climate-induced disasters may also become more common during the 21st century, *Adaptation Urbanism* focuses on plans and policies to reduce carbon emissions and adapt streets and communities with the goal of making coastal communities safer, minimizing the need for abandonment. In other words, this book is about implementable solutions that can make cities more livable and resilient while protecting the sunk investments in real estate and infrastructure in coastal communities.

This challenge is large, difficult, fraught with uncertainty (Scott 2013), and simultaneously requires creating political capital necessary to *push* change. Business-as-usual transportation and land use policies, the bureaucratic pillars of how we build our cities, are not only ineffective at addressing the problems, but are often actively making the climate crisis worse. While pushing aside the bureaucratic and conceptual inertia of the present moment can seem daunting, a growing number of cities are innovating and creating highly livable, low-carbon communities that are being adapted to withstand the demands of a changing climate. These cities are increasingly opening new pathways forward to address the climate crisis. While this book addresses serious deep-seated problems, there is hope for a resilient future through overcoming fossil fuel dependence to foster inclusive, healthy, and biophilic cities (Newman, Beatley, and Boyer, 2017).

Adaptation urbanism: redesigning coastal cities for climate change

In *Adaptation Urbanism*, we examine two interlocking dimensions of the urban climate policy: (1) whether and how streets and connected public spaces can be reconceptualized to help cities better adapt and decrease emission levels to mitigate climate change; and (2) how these policies are being politically negotiated at the urban level. We thus examine the technical capacity to use streets and public space to manage climate change and the climate politics of urban transportation policy.

The promising news is that our review of policy efforts from leading coastal cities in Europe and North America finds that streets can be redesigned to help manage carbon emissions and better adapt urban areas to withstand more powerful and potentially frequent storms. Specifically, analysis of the case study cities of Copenhagen, London, Miami, New Orleans, and Rotterdam highlights efforts to rethink urban movement and the space dedicated to mobility in cities. Our analysis of these case study cities and other innovative communities in Europe and North America such as Barcelona, Vancouver, Amsterdam, Delft, and Utrecht finds evidence of a growing movement to reposition streets as central tools in adapting to and mitigating climate change. New designs are being developed that prioritize low-carbon transportation options and incorporate green and blue infrastructure and connected public spaces to minimize flooding and pollution runoff and enhance quality of life.[1] These changes achieve important climate policy goals and, importantly, create new neighborhood amenities that improve the quality of life for residents. In addition, we find that if this process is strategically managed with broad citizen engagement, it can help to create the political capital necessary to create momentum for change. We define this movement as adaptation urbanism, where streets and public spaces are redesigned to manage and minimize climate impacts and enhance urban quality of life.

Analysis of case study cities shows the current opportunities and struggles in changing the role of streets and public spaces in transport policy and highlights key weaknesses of current approaches, particularly in terms of the need to enhance equity outcomes and better negotiate the political barriers to change. In essence, current technology can significantly decrease transportation emission levels, adapt to more intense storms, and improve quality of life, but political barriers are slowing and often halting the transition to more climate-resilient urban outcomes related to transportation and public space. While enhanced technology will help improve outcomes, the current technology of urbanism that exists today can already significantly decrease GHG emissions and make safer, highly livable and sustainable communities that can better withstand a changing climate. What is often lacking, however, is the political will and robust governance structures to implement these proven approaches for the benefit of all residents. In this introductory chapter, we lay out the basic structures of this case and provide a roadmap for the rest of the book.

Streets: a hidden resource that occupies 30% of cities

The need to rethink urban transportation is pressing as the overlapping climate, public health, and spatial impacts of the current transportation system threaten long-term sustainability. To summarize the data presented below, the design of streets is a driving force behind climate change and a leading cause of premature death from crashes and air pollution. The way we design our streets is helping to propel a climate and public health crisis. The data are not hidden, but the issue is nearly invisible from most policy discussions. Rethinking the role of streets can help to address these serious issues and help improve the quality of life of cities and position streets as central places within our communities. William Whyte (1988, p. 7) summarizes this view by arguing that: "And of the primacy of the street. It is the river of life of the city, the place where we come together, the pathway to the center. It is the primary place."

The transportation sector is the single largest source of emissions in the United States, generating about 30% of total GHG emissions (EPA 2019). When indirect sources of GHG emissions from the transportation sector such as fuel drilling and processing are included, the overall contribution of transportation rises to about 40% of all emissions in the United States (Replogle 2019).

The consequences of inaction on climate and the potential impact on coastal residents can be quantified down to the rising tides. Strauss et al. (2015), for example, model baseline and lower emission scenarios for risk in United States coastal populations. Their findings suggest that business-as-usual emission scenarios will result in high-tide flooding of 1,596 US cities with a population of 27.4 million people by 2100. Lower-emission scenarios across multiple sectors can help prevent 900 US cities with a total population of 15.8 million people from being subject to flooding at high tides by the year 2100. Overall, Strauss et al. (2015) conclude that "rapid and deep cuts in carbon emissions could help many hundreds of coastal US municipalities avoid extreme future difficulties." From a coastal planning standpoint, the implications are stark. Business-as-usual emissions scenarios will result in high-tide flooding for millions of residents and, even with deep cuts in GHG emissions, just under 12 million Americans will be subject to high-tide flooding by 2100. Coastal communities need to lead in significantly cutting GHG emissions to limit projected impacts and simultaneously begin to adapt at-risk populations for near-term projected flooding.

While detailed analysis points to the impacts in one country, the impact on the US coastal populations is just one small part of the global impact of sea level rise as North American coastal populations represent less than 5% of the total global at-risk coastal population (Strauss et al. 2015). The impending impact of these calculations will ripple across coastal communities around the globe where action or inaction will be measured in the high-tide lines and determine who is safe and who is at risk.

While the climate impacts from the transportation system are coming into focus, the public health impacts of the current transportation system are becoming more dire. In the United States, there were 37,133 fatalities and an additional

2.7 million injuries resulting from transportation crashes in 2017 (California State Transportation Agency 2020). Analysis of air pollution data by Caiazzo et al. (2013) estimates an additional 53,000 premature deaths per year in the United States are due to transportation-related air pollution. Worldwide, 1.35 million fatalities resulted from crashes in the transportation sector in 2016 (WHO 2018a). Outdoor air pollution from multiple sources including transportation results in 4.2 million premature deaths per year (WHO 2018b). Transportation's impact on air pollution varies by region but is a significant and growing contributor in areas with high auto use like North America, Europe, and increasingly many parts of Asia (Watts et al. 2018). This air pollution, as was previously discussed, also may be a contributing factor to higher fatality risk to COVID-19 (Ogen 2020). Overall, five of the top ten leading causes of preventable death and injury result from transportation pollution and crashes (Global Road Safety Facility The World Bank 2014, p. 22).

While the current health impacts of the transportation system are significant, the impending health impacts resulting from a changed climate are deeply worrying, with increasing susceptibility to infectious diseases, drought, heatwaves, storms, and flooding putting pressure on public health systems (Watts et al. 2018). The result is what the Global Climate and Health Forum (2018) described as a "global health emergency" where "Climate Change threatens to undo decades of health and development gains." While the coronavirus pandemic is, hopefully, a once-in-a-generation disaster, climate change threatens to become a long-term, cascading catastrophe. These serious impacts have caused the World Health Organization (2015) to describe "[c]limate change [as] the greatest threat to public health in the 21st century."

The pressing public health demands are, however, only another important link in a chain of problems with the present transportation system. More intense rainfalls and rising seas due to climate change present a physical challenge for cities to find more space to store and channel water away from homes and businesses. Analysis of the extent of space required for transportation in cities reveals that streets and car parking are currently the dominant land use category in many cities. While the space dedicated to streets varies, analysis of 30 leading global cities puts the overall average at around 30% of urban space dedicated to streets (UN Habitat 2013). When parking spaces are added, the figure jumps to approximately 50% of all urban space allotted to streets and car parking (Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015).

To put this directly, up to 50% of urban space is predominantly dedicated to automobile use. Donald Shoup from UCLA has shown that cars are parked about 95% of the time and occupy more land area in the United States than housing (Shoup 2017). In a specific analysis of San Jose, CA, Shoup found that "[f]or many land uses, the parking lots are bigger than the buildings they serve…there is more space for parking than for people" (Shoup 2018, p. 9). Scharnhorst (2018, p. 1) discovered similar results and reported that in Seattle population density is less than half that of parking density. In addition to the high spatial cost of parking, Shoup (2018, p. 13) found that "the U.S. probably spends more to subsidize parking than

for all the rest of its transportation infrastructure combined" with total costs for transportation infrastructure in 2002 estimated at $190 billion and the costs for parking estimated to be $127–374 billion.

While our streets and car parking dominate the physical geography of cities, the sheer quantity of space dedicated to these land uses remains almost hidden from most policy discussions. Street space is mostly seen as a needed sacrifice zone for movement away from and towards someplace else. Street space and parking areas are rarely seen as physical assets that could be changed to meet broader policy needs of housing affordability, active transportation access, or green and blue spaces to manage water and improve neighborhood quality of life. Our budgets and urban space could be more efficiently used to meet the needs of people rather than the needs of cars.

While the demands of car culture push at city budgets and space, an entirely different view of the role of the street and the underlying components of urban life has begun to emerge to challenge the status quo. As discussed previously, the COVID-19 emergency has highlighted the spatial disparities of our streets and begun to move many city leaders to question whether street space could be better used to create more opportunities for local accessibility. The COVID-19 response and growing climate awareness could combine to create a powerful rationale for reevaluating the role of streets in creating safer, healthier cities.

The increasing focus on rethinking streets can draw from a long lineage of scholars and practitioners who have laid the conceptual and practical groundwork for change. Instead of the street as a space of speed and division, the quote that begins this section by William Whyte speaks to how the street can (and should) be the central place of the city. Whyte's pioneering work laid out the underlying social, environmental, economic, and spatial problems with the dominant approach to transportation planning and pointed to a different way of viewing the street and planning for livable neighborhoods where the street has both a movement and place function. Whyte's work, along with that of Jane Jacobs, Jan Gehl, Kevin Lynch, Donald Appleyard, Allan Jacobs, and many others, has helped to trace the outlines of a new way of seeing city streets.

This new way of understanding the street is more important today as the spatial, public health, and emissions implications of the current transportation system come into greater focus. Policy debates about the size, design, and overall role of streets are increasingly becoming front-line issues in urban political battles to adapt and mitigate against climate change. Instead of accepting the status quo limits on city space, many cities are seeing the extent of street space as emerging spatial resources that can be redesigned to meet the needs of local residents. For example, former New York City Department of Transportation Director, Janette Sadik-Khan has noted that "streets are some of the most valuable resource[s] that a city has and yet it's an asset that is hidden in plain sight" (Sadik-Khan 2013). By rethinking the use of these community spaces, cities could begin to bend transportation emissions trends downward and simultaneously create green places that could become important community resources for adaptation and improved quality

of life. Streets can have movement, place, and climate resilience roles. Put another way, imagine that 30–50% of city space has the potential to be transformed from privatized spaces of speed and division into truly public spaces for the community. These repurposed streets could then be used to address our most pressing problems and simultaneously add livability into the heart of the city. Streets are public spaces that can be transformed to meet community needs.

Instead of starting from the status quo framework that focuses on the auto-orientation of city space, many cities are reimagining streets and searching for opportunities to connect zero-carbon transportation options for short journeys and dedicated public transportation and rail for longer trips. Because these forms of travel are more spatially efficient than auto-oriented approaches, this transition opens additional room for parks and greenways that could store water during intense storms and act as community amenities and active transportation corridors during calm days. This vision of improved efficiency, safety, quality of life, and climate security does not require new technology. Instead, this vision demands rethinking how we distribute urban space in the transportation sector and requires generation of the political capital to *push* change to move beyond the status quo transportation system.

Streets of the past/streets of the future

On a recent trip to Amsterdam, we toured the city with Cornelia Dinca of Sustainable Amsterdam. She took us to what she called "the street of the future" (Figure 1.1). Plantage Middenlaan, a street next to the botanical garden not far from Centraal Station in the core of Amsterdam, was redeveloped over the course of several decades from a typical road engineered for cars to one that accommodated bicycles on the fringe, and then finally to a street with transit in the green center median with bicycles and pedestrian options on both sides. Sections of the street outside this zone allow slow-speed access to cars, but the design focus is centered on expanding transit and active transportation and improving quality of life.

The capacity for moving people on the street has increased with light rail (locally known as trams) moving 100 or more people in a single, almost silent train and pedestrians and cyclists steadily moving by on the sides of the green center median. Data from the National Association of City Transportation Officials (NACTO) *Transit Street Design Guide* (2016) show how efficient these types of streets can be compared to car-only designs (Table 1.1). Rather than focusing exclusively on car-only lanes that can carry 600–1,600 vehicles per lane/hour, green transit streets can carry 4,000–8,000 people per 10-foot (3-m) lane area. When a green transit street is linked with potential pedestrian loads of 9,000 people per hour and cycle tracks at 7,500 people per hour, even greater spatial efficiency of movement is achieved. When you couple this with the fact that each of these transit and active transportation users does not require a car-parking space at the beginning and end of the journey, the true spatial efficiency of the green transit street comes into focus. In addition to increasing capacity for moving people, the new design opens up space

FIGURE 1.1 Plantage Middenlaan Amsterdam: "the street of the future."

TABLE 1.1 Hourly person lane capacity

Mode	*Hourly person capacity (10-ft (3-m) lane)*
Cars	600–1,600
Mixed traffic (cars and buses)	1,000–2,800
Two-way protected cycle track	7,500
Dedicated transit lanes	4,000–8,000
Sidewalk	9,000
On-street transitway (bus or rail)	10,000–25,000

to manage water through the insertion of more permeable surfaces, helps to address the urban heat island effect, and significantly decreases emissions by privileging transit and active transportation. The quiet efficiency of the street of the future also becomes a neighborhood amenity, a place, where flows of people pass along a park-like corridor.

In terms of tradeoffs, the street design makes driving vehicles across Amsterdam more complicated and time consuming. The design of the green transit street forces cars to take a short bypass around the area, but allows bicycles, pedestrians, and trams direct access to the multi-block long green corridor. The tradeoff is made more politically palatable through faster connections via transit and cycling and the enhanced quality of place generated by the new design. With new street designs like this, the transportation consumer can choose between faster connections for transit

and active transportation and slower, private auto connections. By making the efficient choice for short trips the climate-positive choice, Amsterdam achieves one of the world's highest bike modal shares of 53%, a transit mode share of 21%, and 24% of trips by car (Frame et al. 2017). This helps to decrease the transportation climate footprint of the city.

Green transit streets like this also create beautiful, livable city neighborhoods (an amenity advantage) that help to build political capital for change even in the face of contentious political debates. The Amsterdam of bicycles and green transit streets was, in fact, not the Amsterdam of the 1970s when plans for large highways and a high child transportation fatality rate were the norm. The green Amsterdam of today with its street of the future is the product of strong political coalitions that pushed for change to overcome the same bureaucratic and political barriers that seem to dominate most transportation policy debates around the world (Feddes and de Lange 2019).

The street of the future in Amsterdam is only one of many examples of a new wave of streets that we found in our research. We found many good examples of complete streets that prioritize pedestrians and bicyclists while still allowing slow-speed access for cars and trucks. Such streets also serve water management and urban heat island reduction goals through landscape design.

These streets of the future are the first examples of resilient streets designed to be better adapted to a changing climate and simultaneously minimize GHG emissions (Table 1.2). Some of the examples are fully formed resilient streets with both adaptation and mitigation components woven together. Many other examples represent beginning attempts to tie these resilience concerns together. Subsequent chapters in this book examine key components of these streets in more depth, but it is important at the outset to understand that a new template for what streets can be is emerging in cities around the world.

While the *streets of the future* are taking shape in Amsterdam and a select set of other cities, the *streets of the past*, paradoxically, continue to be built as part of

TABLE 1.2 Emerging examples of streets of the future

Streets of the future	*Location*	*Streets of the future*	*Location*
Plantage Middenlaan	Amsterdam	Hof van Delft (Klimaastraat)	Delft
Frans Halenstraat	Amsterdam	Exmouth Market	London
Bellamyplein	Amsterdam	Orford Road	London
Super Ilas	Barcelona	Cherokee Street	New Orleans
Bülowsvej	Copenhagen	Ackney Street	Portland
Hans Tavsens Gade	Copenhagen	Spoorsingel	Rotterdam
Sankt Kjelds Plads	Copenhagen	Catharijnesingel	Utrecht
Sankt Annae Plads	Copenhagen	Bute Street	Vancouver
Westerstraat Neighborhood	Delft	Union/Adanac Streets	Vancouver

standard practice in most cities around the world today. The bureaucratic inertia and political power of auto-oriented interests continue to perpetuate street designs that could have been drawn up 75 years ago. At the edges of metropolitan areas, particularly in the sprawling Sunbelt of the United States, new, wide residential streets are rolled out in pop-up suburbs. Moreover, overly wide streets and excessive parking standards have been institutionalized in planning, engineering, and fire department regulations in municipalities across the United States, Australia, and other nations. Such regulations inhibit compact infill development projects, transit-oriented developments, and other forms of sustainable development.

In Leander, TX, 27 miles from downtown Austin, Texas, for example, 30-foot-wide (9-m-wide) residential streets are being built to connect into a high-speed network of arterials and highways. At the corner of True Grit Cove and Painted Sky Bend, new homes are being manufactured and plugged into a street network straight out of planning documents from the 1950s. The mode share for walking, biking, and transit together is only 1.7% (Census 2019). There are almost no destinations close enough or safe enough to walk or bike to, and, with extremely limited transit options, almost no transit connectivity. Thus, the private car becomes necessary for virtually all activities. When periodic intense rains come, the hillside streets cascade with water. Continuing to build these streets of the past in fast-growing places locks in high emissions and flooding problems for years to come. Such business-as-usual decisions for transportation infrastructure and land use practices are projected to result in 20–50% more transport GHG emissions compared with more comprehensive and progressive transportation policy approaches (Creutzig 2016, p. 348).

The wide, fast roads are, in fact, achieving the very tasks that they were originally designed to accomplish. The sprawling road template of today is an almost exact model of the vision of the future from the 1930s. Modernist architect Le Corbusier (1964, p. 120) argued that the multi-purpose street where people and vehicles mixed was "an obsolete notion." He instead argued for a new road system of high-speed mobility where he would

> live 30 miles from my office in one direction, under a pine tree; my secretary will live 30 miles away from it too, in the other direction, under another pine tree. We shall both have our own car. We shall use up tires, wear out road surfaces and gears, consume oil and gasoline.

This vision became the template of the *streets of the past* as they were designed to create a fossil fuel economy based intentionally on burning through oil, wilderness, and space, creating class divisions as suburbs were sorted by wealth (Wells 2013). While the planning paradigm of "a city of infinite mobility" (Hall 2014, p. 9) has broadly changed since Le Corbusier's prophetic quotation, the physical design of streets has not changed much in the last 75 years. The world has changed, but our roads remain stuck in the past.

In *Adaptation Urbanism*, we argue that streets of the past cannot be used to usher in a new era of resilience. The design of streets of the past fundamentally privileges

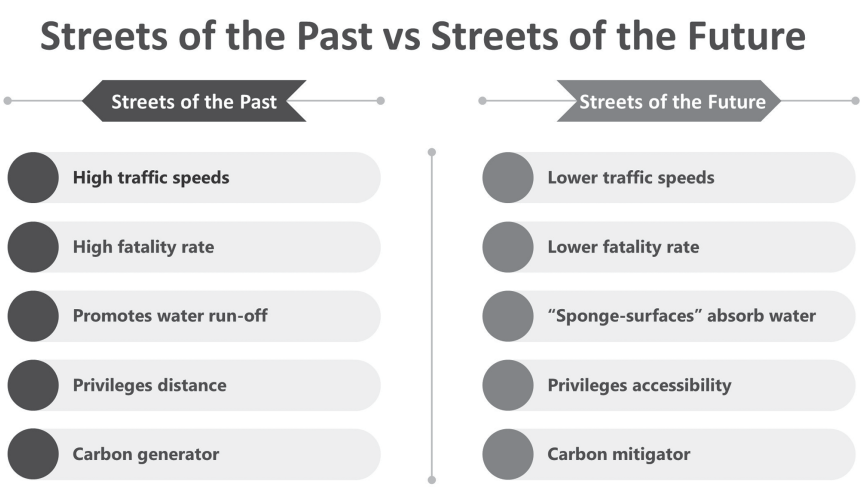

FIGURE 1.2 Streets of the past/streets of the future.

high-speed mobility that empirically has resulted in high fatality rates, high carbon emissions, and high levels of impervious cover that accentuate flooding and contribute to the urban heat island effect (Figure 1.2). The result in the United States, for example, is the third largest per capita transportation emissions in the world (over three times the European Union average) and the second lowest population density among OECD countries (World Energy Council 2016; World Bank 2021). While this matches Le Corbusier's vision of burning through energy and space, the unintended, but foreseeable, consequence has been high fatality rates, the highest per capita number of fatalities among developed countries (World Health Organization 2018a).

The vision of the future from the 1930s is not an appropriate guide for addressing the pressing problems of urbanism in the era of climate change (Calthrope 2010). Our streets have been, as former New York City Department of Transportation Commissioner Janette Sadik-Khan argues, in "suspended animation" for too long (Cohen 2016). It is time to rethink streets from places of speed, division, and even death to places of safety, sustainability, livability, and green urbanism.

Competing visions of the future

While evidence suggests that the 1930s vision of the future has reached its limits, a new futurist vision is developing in the form of the potential for electric and/or autonomous vehicle technologies to remake transportation. Popular media accounts point to a new future of driverless, electric cars that promise pollution-free, frictionless movement. We'll discuss this in more depth in Chapter 3, but it's important at the outset of the book to note the limits of this vision before a contemporary Le Corbusier promises that you can live 30 miles from your job and move easily in

a wheeled bubble of free time. Making cars more energy-efficient is an important and surprisingly complicated component of decreasing overall carbon emissions but fails to address the underlying spatial demands of vehicles in urban areas discussed earlier in this chapter.

Automobiles are a spatially intensive form of movement that often act to spread out urban development. Calthrope and Walters (2017), for example, point out that autonomous vehicles could "cause congestion, eat up energy, exacerbate sprawl, and emit more carbon per passenger mile." Litman (2018) describes the preoccupation with autonomous vehicles as a technological solution with limited benefits towards reducing congestion and crashes, improving public health, increasing affordability or improved mobility options for non-drivers.

Autonomous and electric vehicles will have a role to play in future cities, but the question is what role they should have and how they should be used to achieve key city-planning goals in a world constrained by climate change (Schlossberg et al. 2018; Green 2019). The goal, after all, is not to create a new type of movement that intensifies the inefficiencies and weaknesses of the streets of the past, but instead to create streets that are better adapted for the demands of climate change and significantly decrease emissions. Without clear policy guidance for how to integrate electric and autonomous vehicles into the transportation system, we could simply be replacing dirty congestion with the "clean congestion" (Winkleman et al. 2019) of electric vehicles. This is not a template for resilient streets. Instead, we need better access to places that improve the quality of life for all city residents, minimize GHG emissions, and adapt the city for climate change. This is the high bar that transportation planning must meet in the face of the unprecedented demands of the new climate era.

With this in mind, moving from vision to practice is likely not a purely technological challenge of replacing one type of vehicle with another. Instead, we need a better vision of the future to address the complex challenge of urbanism in the climate change era. Beatley (2012), for example, calls this a "failure of imagination" to see what is possible. Instead of seeing change as about "deprivation," Beatley argues that "a green urban agenda" needs to be seen in the context of creating "an opportunity for a more lively, livable, rich, and healthy lifestyle with a smaller ecological footprint" (2012, p. 221).

Adaptation Urbanism traces the beginning movements of this new way of thinking about the role of streets that highlights the opportunities of change. Innovative street archetypes like Plantage Middenlaan in Amsterdam are the seeds of a new type of vision for the future with safe streets and green park corridors that privilege walking and bicycling for short trips and other less carbon-intensive modes for longer, higher-speed trips. Overall, this creates a city with slower speeds on city streets, but greater accessibility for both local and regional trips. These green climate streets better manage water and directly insert new green amenity places into the core of neighborhoods.

Resilient streets like this marry the emerging Vision Zero movement's goal of slower, safer, complete streets with resilience planning goals of climate adaptation

and mitigation. At this point, Vision Zero and resilience planning are not consciously organized together into a coherent political movement, but instead occasionally overlap in a set of scattered pilot projects and fractured political actions. Chapter 11 details the potential of these movements to work together to create a powerful political coalition that combines expertise and energy from the transportation, public health, equity, design, and environmental communities to help visualize and implement safer, low-emission green streets (Fleming 2019; Sansone et al. 2019).

Right now, the streets of the future are here if you know where to look for them, but they may not be *here* where you are today. William Gibson has pointed out that "The future is already here. It's just not evenly distributed yet" (Kennedy 2012). Some places have jumped forward and some places remain locked in the past.

Paraphrasing William Gibson, the future is unevenly distributed and only actualizes in certain places because of the convergence of vision, politics, and push. The potential to transfer new ideas from city to city to create more livable places is a powerful vision. In this real-life alternate history, the idea of what streets could be starts with a resonance in the mind and slowly transforms the places around us through the push of change agents and the shift of funding and bureaucratic priorities. Each project moves the ideas forward from the foreign planet of Copenhagen or Amsterdam or Vancouver to the city in your region to the street in your neighborhood. Knowledge transfer and alternate histories, disruptors and the status quo, climate change and the tools to manage risk, equity and the uneven distribution of resources: we stand as ever at the precipice of potential and change. As this future remains mostly unwritten, now is the time to examine the potential and underlying tensions of this nascent movement to change city streets.

Creating a meaningful urban policy platform for resilience: adaptation urbanism

Planning and political issues are mediated through conceptual lenses that define how we see the potential and limits of the present moment. These lenses and accompanying planning movements change over time and emphasize different sets of values that can translate into radically different policy proposals (Hall 2014). The discussion above about the streets of the past/future highlights these differing ideals and underscores how climate change is impacting the perceived goals, roles, and design of streets and public spaces.

As discussed in the prologue, one of the most prominent movements to emerge in urban planning over the last two decades is resilience. Resilience planning developed in the early 2000s from environmental sciences as a promising way to help understand how systems can bounce back from shock. With climate change fundamentally challenging the long-term stability of the present system, applications of the resilience concept to urban planning have begun to question whether bouncing back from shock is enough. Instead, many articulations of resilience have called for

a type of evolutionary resilience (Davoudi et al. 2013) or bouncing forward towards cities with green infrastructure and sustainable design for resilient cities (Shaw 2012; Infield et al. 2019). This begins to take resilience from a reactive emergency response articulation and towards a more holistic focus on resilient placemaking (Coaffee 2013).

As the resilience movement has become a near ubiquitous conceptual urban planning lens for the climate change era, figuring out how to negotiate its meaning, boundaries, and potential has increasing importance. Resilience is, as Swanstrom argues, "inherently a normative concept... [and] can only be understood with reference to some desirable outcome. Resilience toward what?" (2008, p. 19). We examine resilience at the place level seeking to define what the role of streets and public space *should* be in the emerging resilient city.

We argue that resilient streets and open space in the climate change era should act to both decrease GHG emissions and to create safer, more livable adapted places to a changing climate. Resilient streets have both a movement function that should be designed to limit GHG emissions (climate mitigation) and a place function that helps to create more livable communities that better manage water, heat, and other changing environmental conditions (climate adaptation). Great streets are designed to both enhance the safe movement of people with limited GHG emissions and create livable places that help to manage water through green and blue infrastructure. Bouncing forward towards the great street of the climate change era needs to be one of the central goals of urban resilience and requires planning for both the movement and place functions of streets.

Our analysis of current projects, however, shows that resilience planning for streets and open spaces has, to this point, focused on addressing only half of the central climate change equation. Existing transportation resilience projects have focused almost exclusively on the climate adaptation element of resilience and have failed to address the need for climate mitigation to fundamentally reshape the carbon generation components embedded in current roadway design. Transportation climate mitigation has often been seen as national level concern focused on improving fuel economy rather than a local planning issue that could be addressed through changing street design policy. As the examples at the beginning of the chapter explain, adapting to climate change is a necessary but insufficient policy response to the scale of the climate crisis. Cities need to adapt to climate change and simultaneously decrease emissions.

Our analysis of resilience projects has, however, also uncovered an emerging wave of projects currently in development that begin to connect climate mitigation and adaptation concerns in a more integrated fashion. These types of projects increasingly combine both green/blue infrastructure systems in ways designed to adapt cities to a changing climate and simultaneously accentuate urban mitigation potential by facilitating highly livable, compact development. At the city level, we call this emerging wave of resilience projects *adaptation urbanism*, where streets and public spaces are intentionally designed to encourage walking, bicycling, and transit to mitigate GHG emissions and adapt the city to climate change through the use of

green and blue infrastructure. Adaptation urbanism is the developing physical form of resilient streets and public spaces that links climate adaptation, mitigation, and placemaking together as the foundation for the safe/climate/spatially efficient and equitable city. As the example of Amsterdam discussed earlier shows, resilient streets make the low-carbon transportation options the safest, easiest, and least expensive choices while adapting the landscape to better places that handle the stresses of a changing climate.

Chapter overview

To accomplish these aims, *Adaptation Urbanism* identifies key strengths/weaknesses of the current policy approaches to urban resilience (Chapter 2) and situates these developments within the planning structures for streets and water management (Chapter 3). We then create an exploratory normative evaluation model to determine how well or how far cities are from integrating adaptation/mitigation components into the urban street and public space projects (Chapter 4). We use this adaptation urbanism framework as an applied method that links the broader resilience literature directly to urban transportation policy to help steer cities towards addressing the short-term impacts of climate change through adaptation of streets and contribute to longer-term solutions through climate mitigation by decreasing transportation emissions.

Studying a nascent movement like adaptation urbanism presents challenges and opportunities. Most of the project examples we analyze in the chapters are not fully formed, but instead represent different component parts of the adaptation urbanism framework. For example, some projects may emphasize the transportation features designed to increase active transportation accessibility, while other projects emphasize the climate adaptation components of improved water management. Different city departments and funding streams often emphasize divergent resilience project characteristics. Some may directly focus on climate mitigation, while others may focus on climate adaptation. Climate adaptation and mitigation components, at this juncture, are only rarely actively woven together in specific city projects. The result is that there are few fully formed resilient streets emerging from standard practice at this point in time.

While we point to the central need to weave climate adaptation and mitigation together, our own training and background are more in the transportation sector. *Adaptation Urbanism* builds from a transportation analysis of the policymaking and bureaucratic structures and then looks towards linkages with the public space and water management sectors. For water management and park and open space professionals, this may seem to overemphasize transportation policy issues. Building multi-disciplinary knowledge is vital to bridging disciplinary divides that can act to silo projects and limit the potential power of projects to achieve both climate mitigation and adaptation goals simultaneously. We encourage water and park and open space professionals and their transportation counterparts to begin to build interdisciplinary bridges to push multi-sector projects forward.

We argue that the adaptation urbanism analysis framework can help to build those bridges by focusing on the need to tie climate adaptation and mitigation together at the project level. Adaptation urbanism links safe streets focused on decreasing GHG emissions with improved public places that act to better manage water. Linking street and public space design to water management expands the design focus of streets from a pure movement focus to a broader purpose of addressing rainwater and, vitally, improving neighborhood quality of life. This creates a new mission for streets and public spaces in the age of climate change and helps provide a compelling new set of goals for street, water, and public space designers as they come to terms with the pressing new demands of the climate crisis. Our analysis of case study cities in Chapters 5 through 9 of Rotterdam, Copenhagen, London, New Orleans, and Miami shows a diversity of responses currently in development in Europe and North America. While no individual city currently represents all of the potentialities of adaptation urbanism, the case cities taken as a whole present a strong set of examples that can point the way forward for an urbanized resilience.

We recognize that our case study cities provide only a small sample of the universe of new and innovative efforts to improve the resilience of streets and open space systems. In Chapter 10, we take a wider view of developments in adaptation urbanism by examining projects from Barcelona, Vancouver, and around the Netherlands (Amsterdam, Utrecht, and Delft). These European and North American examples show the development of adaptation urbanism within a Global North planning framework. More detailed work on resilient streets and green infrastructure from a Global South context is needed (Moyer and Becerra 2018; Vasquez et. al. 2019). With this background examined, we propose a targeted policy approach geared towards Global North cities to plan for and implement adaptation urbanism projects (Chapter 11). We close (Chapter 12) with a final synthesis of the challenges and possibilities that face urban planning in the climate change era.

Note

1 We examine the broader conceptual foundations of green and blue infrastructure in Chapter 3. The basic framework is that green space and water areas can be used specifically as a form of community infrastructure to achieve multiple benefits, including water management, environmental conservation, and enhanced livability. Green and blue infrastructure is often contrasted with gray infrastructure like drainage pipes that are buried and designed to hide water and move it away. Green and blue infrastructure can be seen as a "a new living with water framework that focuses on" creating systems that act "in concert with structural engineering systems" (Fields et al. 2017). Lawson et al. (2014) provide a useful list of key blue and green infrastructure components, including the blue infrastructure components of "ponds, flowing waterways, wet detention basins and wetlands that exist within the drainage network" and the green infrastructure components of "natural land and plant based ecological treatment systems and processes. This comprises open spaces, parks, recreation grounds, woodlands, gardens, green corridors, vegetated ephemeral waterways and planted drainage assets that undergo a wet/dry cycle due to runoff flow, e.g. green roofs and street trees."

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