Hixon Center Urban Conference

Cities as Solutions to Climate Change

Perspectives from IPCC Authors

September 23, 2022

KLAUS TAN / UNSPLASH.COM

Yale

Co-convened by the **Hixon Center for Urban Ecology** at the Yale School of the Environment, and **Yale Planetary Solutions Project**

On September 23, 2022, the Hixon Center for Urban Ecology at the Yale School of the Environment (YSE) and the Yale Planetary Solutions Project convened the 9th annual Hixon Center Urban Conference, "Cities as Solutions to Climate Change: Perspectives from IPCC Authors." The conference gathered researchers and practitioners focused on the potential of cities for climate change mitigation and featured two vice-chairs and seven authors from the Intergovernmental Panel on Climate Change (IPCC), the United Nations body for assessing the science related to climate change. Over 500 people from over 30 different countries registered for this conference, which was held in a hybrid setting online and in Burke Auditorium at YSE (See Image 1).

Dr. Michael Crair, vice provost for research and William Ziegler III professor of neuroscience and professor of ophthalmology and visual science, introduced the conference, connecting cities as solutions to climate change with "our broader planetary solutions goals for the university."

Dr. Karen Seto, Frederick C. Hixon professor of geography and urbanization science at the Yale School of the Environment and IPCC Working Group III coordinating lead author, welcomed the speakers, participants, and attendees from all over the world. She contextualized cities within climate change: "They're clearly a point, a place where there are tremendous opportunities to generate solutions." Dr. Seto said generating science is not enough, and therefore, conference speakers will lead us from research to practice.

Image 1: Over 500 people from over 30 different countries registered for this conference, which was held in a hybrid setting online and in Burke Auditorium at YSE. (Source: Julian Macrone '21 MEM.)

Keynote by Ko Barrett

Dr. Seto introduced keynote speaker Ko Barrett, the first senior advisor for climate for the National Oceanic and Atmospheric Administration (NOAA) and IPCC vice chair. Barrett has been representing the United States to the United Nations on climate change for over 20 years and as described by Seto, guides NOAA's strategies by asking "What kind of data do we need? How do we actually provide better and more accurate forecasts about climate?"

In this keynote address, Barrett started with background on the IPCC, the world's leading scientific authority on climate change that produces a report on all the known science around climate change every six to seven years. Barrett confirmed it is "indisputable that humans are causing climate change and causing more extreme events…and some of the severe impacts will be irreparable in our lifetimes." Barrett laid bare the facts: that limiting warming to 1.5° C requires global greenhouse gas (GHG) emissions to peak by 2025 at the latest and to be significantly reduced by 2030. Climate change is already affecting every region on earth, she explained, "and places that have not even seen a human footprint are feeling the effects of humanity's carbon footprint." Exposing the immensity of the issue, Barrett explained: "This conversation makes people feel like the problem is too big and too hard, and it often makes them feel hopeless." Barrett turned to cities – where two-thirds of GHGs are emitted through production and consumption – as an opportunity for transformation, a point for major reduction in carbon emissions. She described "the importance of city and community level action as a magnifier of individual ambition." Barrett believes that cities and communities where we live and work are the right scale to put the groundswell of motivation and concern into action because we can make and see a tangible difference that is not dependent on the swing of federal and international policies and administrations. With that, Barrett set the stage for the conference and led us to our first panel.

Image 2: Moderator Dr. Narasimha Rao (right) facilitates the "Net-Zero Carbon Cities and Electrification" panel with Dr. Şiir Kılkış (left), Dr. Angel Hsu (center), and Dr. Benjamin Sovacool (virtual). (Source: Julian Macrone '21 MEM.)

Net-Zero Carbon Cities and Electrification: The Next Global Agenda

Moderator Dr. Narasimha Rao, associate professor of energy systems at the Yale School of the Environment and IPCC Working Group III contributing author, introduced the first panel and the topic of energy transition (See Image 2). Dr. Rao described energy demand being concentrated in cities as an opportunity and overviewed aspects relating to cultural shifts and reducing social inequalities. As urban populations grow, Dr. Rao explained that scientists and practitioners are looking into ways to preempt the lock-in of carbon intensive infrastructure and to transform energy use. In this panel, Dr. Rao set the scene to review the most recent IPCC report that covers these topics and asked the speakers about their most exciting findings.

Dr. Benjamin Sovacool, professor and director of the Institute for Sustainable Energy at Boston University and IPCC Working Group III lead author, proposed that reducing atmospheric carbon dioxide is an intergenerational problem to achieving net-zero. Encouraged, Dr. Sovacool estimated that the amount of wind and power energy will quadruple by 2030 and the number of electric vehicles (EVs) could grow from 1 million to 1 billion by the middle of this century. Given these examples, he demonstrated that there is not just one type of technology to create this transition but rather a portfolio of options from banning conventional cars in cities to shifting toward mass transit and walking. Dr. Sovacool looked to policies "to stimulate what you want—sustainable transport—disincentivize what you don't want—fossil fuel transport—and invest in innovation." He also challenged conference participants to imagine how cities could look different in the future with otherworldly ideas, such as creating a $1 trillion USD solar shield and floating cities.

Dr. Şiir Kılkış, senior researcher at the Scientific and Technological Research Council of Turkey (TÜBİTAK) and IPCC Working Group III lead author, followed Dr. Sovacool with the warning that CO_2 emissions need to be cut in half by 2030 to avoid triggering tipping points. How do we obtain sustained reductions at the necessary levels? Dr. Kılkış focused on bringing together electrification—how we power buildings, transport, and district—and urban planning—how we plan for positive cascading effects for mitigation. She touched upon the synergies of reducing energy demand through walkable urban areas and increasing demand flexibility to absorb greater shares of variable renewable energy, underlining the key strategy areas across different types of urban growth as focused in the most recent, Sixth Assessment Report of the IPCC (AR6) (See Figure 1). Dr. Kılkış

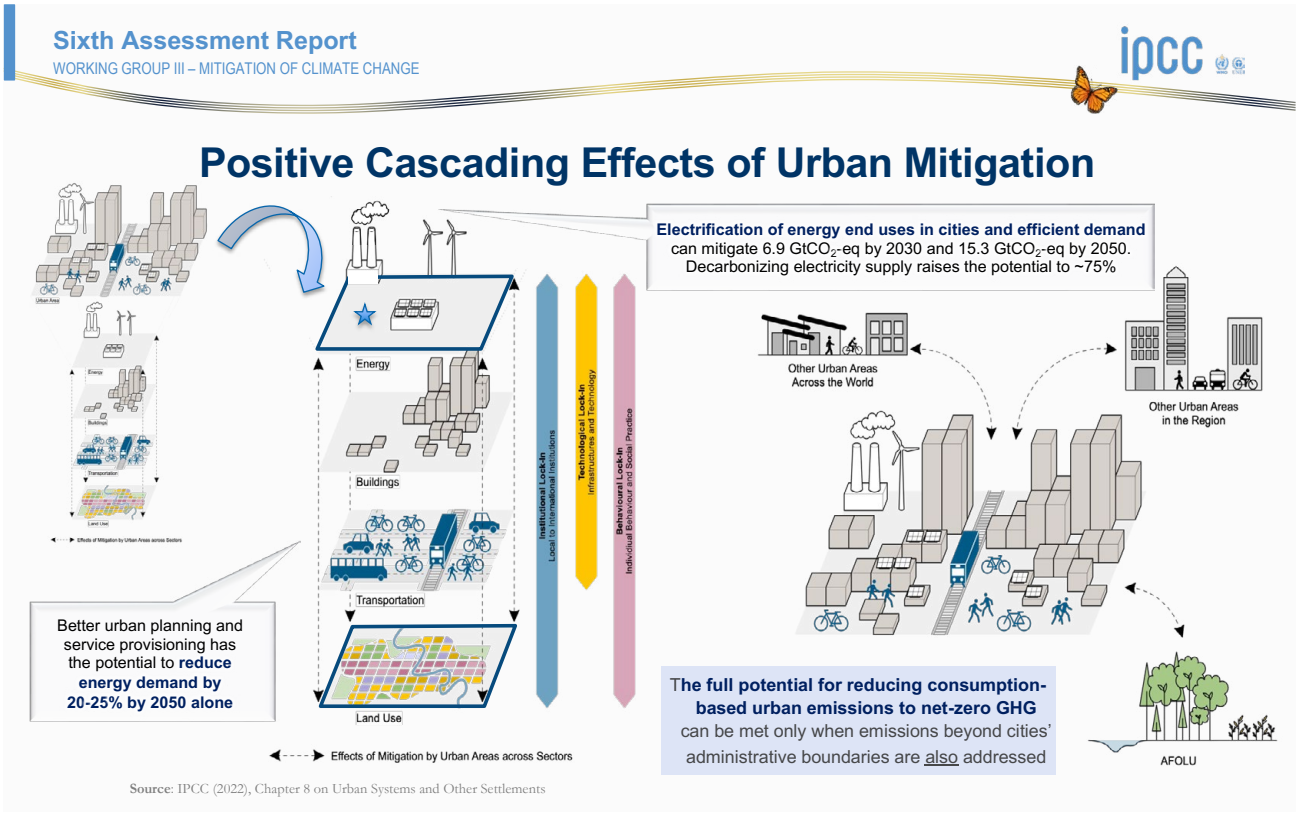

Figure 1: Dr. Kılkış provided the "Positive Cascading Effects of Urban Mitigation" when planning for a reduction in urban GHG emissions from energy, buildings, transportation, and land use. (Source: IPCC (2022), Chapter 8 on Urban Systems and Other Settlements.)

said urban systems are a key part of the solution through reducing and changing energy and material use, increasing electrification, and enhancing carbon uptake. After providing examples from emissions scenarios at the urban level, she highlighted the co-benefits for urban inhabitants across energy, health, and climate. Her takeaways made clear that: 1) urban systems have a key role in bringing the world to net-zero through enhancing carbon uptake, 2) electrification requires integrated strategies to be most effective, and 3) better urban planning accelerates progress for decarbonization. She quantified the opportunity space for integrated mitigation efforts in urban areas as reducing 9.8 $GtCO_2eq$ (gigatons of global carbon emissions) in 2030 and concluded by emphasizing that "collective action across urban systems can support making a world of a difference."

Dr. Angel Hsu, assistant professor of public policy & environment at the University of North Carolina at Chapel Hill and IPCC Working Group III contributing author, focused on the potential and excitement of cities moving toward a net-zero pathway, now that we have the science to back-up urban efforts to take on climate change. Dr. Hsu identified three main gaps: emissions, implementation, and ambition. She estimated the emissions gap, which is the difference between pledges and targets and the total emissions reductions needed for a 1.5° C target, as 25-28 $GtCO_2e$ (gigatons of carbon emitted) per year. The implementation gap of 4-7 $GtCO_2e/yr$ between the current policies and actions versus pledges is another gap that illustrates the ease of developing policies and pledges versus the difficulty of implementing them, relatively speaking. Finally, the ambition gap shows that despite the most optimistic net-zero pledges, there is still an 18 $GtCO_2e$ gap to get to 1.5° C. Dr. Hsu's research focuses on closing these gaps through subnational, nonstate, and city actors; she asked: "do all of these measures actually add up?" Dr. Hsu claimed the Paris Agreement added excitement and motivation when it recognized that all levels of society and governments can make contributions. Her research finds

that, depending on the initiative, sub-actors can create 16-66% of the contributions to net-zero goals.

During the panel discussion, Dr. Kılkış confirmed that net-zero is not happening overnight and planning is required; Dr. Sovacool urged that these plans need to be enforceable. Dr. Hsu warned to be mindful of greenwashing because cities cannot be net-zero if they are still embedded in fossil fuel systems and grids. In that light, Dr. Kılkış encouraged that "cities shouldn't race individually but collectively" toward net-zero, and Dr. Sovacool and Dr. Hsu discussed whether cities in countries that signed onto the Kyoto Protocol are making more progress. Touching upon equity and justice, the panelists discussed complexity in cities and yet again opportunities within them. Dr. Kılkış characterized cities as multidimensional with various starting points to net-zero, where equity can accelerate progress around the world. Dr. Sovacool broke inequity into three lenses: spatial inequity (e.g., EV charging points), interspecies inequity (e.g., anthropogenic harm of air, water, and land), intertemporal inequity (e.g., creating burdens for the future). They all agreed that urban planning is an important tool in applying research, and Dr. Kılkış pointed to Chapter 8 on urban systems in the AR6 for a roadmap for different types of cities and options of mitigation strategies (See Figure 2).*

In the closing remarks, moderator Dr. Rao sought the views of the researchers on areas that can make the most important contributions for progress on the ground, giving examples from the social sciences, and theoretically asked the researchers, if you received a new grant, where would you apply its resources? Dr. Sovacool noted social movement building, Dr. Kılkış identified continued advances in the urban sciences to guide integrated approaches and upscaling of ambitious urban mitigation efforts, and Dr. Hsu offered exploring how to incorporate sub-state and non-state actors into integrated assessment models and scenarios for the IPCC.

*https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter_08.pdf

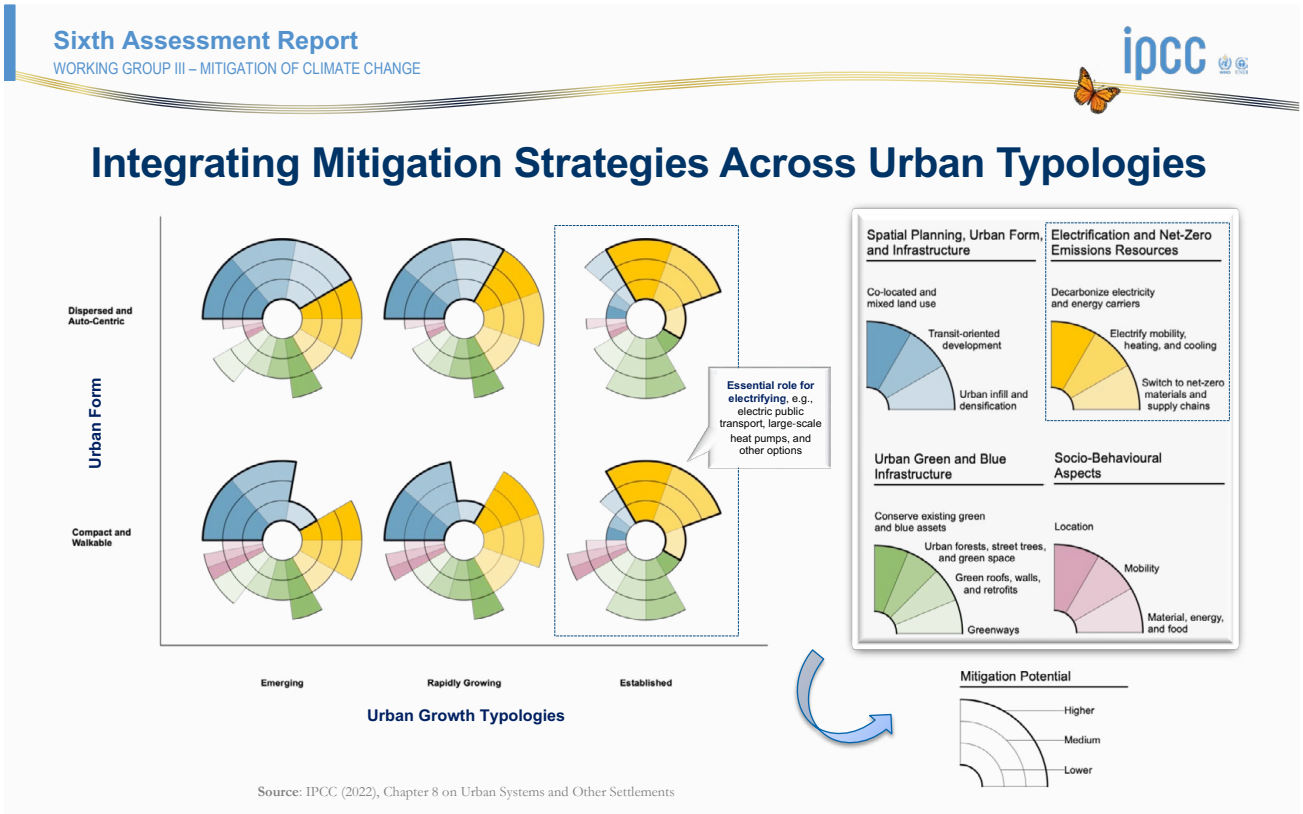

Figure 2: The IPCC offers roadmaps with a variety of mitigation strategies that are most appropriate for different city types. (Source: IPCC (2022), Chapter 8 on Urban Systems and Other Settlements.)

Passive Home Design: The Future of Architecture

Dr. Diana Ürge-Vorsatz, professor and director of the Center for Climate Change & Sustainable Energy Policy at the Central European University and IPCC Working Group III regional vice chair, delivered the afternoon keynote address about carbon-zero architecture. With the latest IPCC report showing that net-zero energy buildings are "feasible" in all climates and environments, she showcased the potential of such architectural designs to make an impact. By minimizing temperature loss with advanced insulation and windows, these passive houses require no energy for heating or cooling. Many of these homes can even be retrofitted from existing structures and often at costs on par with conventional construction methods. Sometimes, changes do not even require significant architectural alterations. Structures like the Vienna Technical University building have managed to reach energy-positive territory by optimizing 9,300 different components—little details that "you can't put […] into assessment models."

For much of a world caught in a pressing energy crisis, passive homes also provide a path to energy independence. Dr. Ürge-Vorsatz showed that retrofitting existing homes with current methods would be "enough to eliminate Russian gas dependency by 2040." Capitalizing on current buildings and refitting them to prioritize durability could also "make a bigger difference" on the environment than our attempts to capture carbon. "Very often we are asked, 'What can I do?'" Ürge-Vorsatz said. Adopting passive design would be a step closer to accomplishing "systemic change."

Spatial Planning to Create Walkable Cities and Change Demand

Climate researchers and city planners came together in the second panel to envision the role of urban spaces in sustainability efforts. Dr. Eric Masanet, the Duncan and Suzanne Mellichamp chair in sustainability science for emerging technologies at the University of California, Santa Barbara, started the discussion by sharing IPCC report findings on low-demand energy pathways. He and his IPCC co-authors analyzed hundreds of case studies and concluded that lowering our current energy and resource demands—even while meeting decent living standards—might be enough to "reduce global greenhouse emissions by 40-70%." When folded into policy regimes at the urban level, Dr. Masanet noted

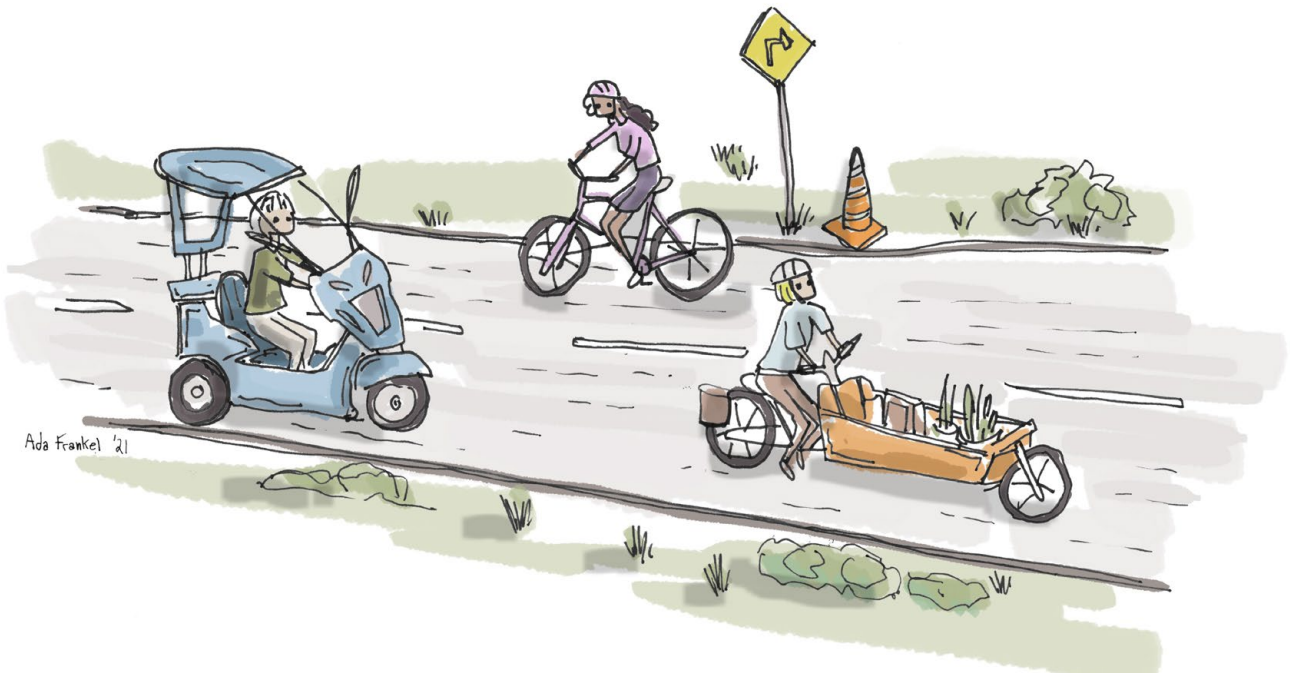

Image 3: Dr. Krizek advocates for smaller modes of individual transport. (Source: Ada Frankel '21.)

that low-demand pathways would "[empower] many more stakeholders" without over-relying on supply-side technologies, such as carbon-capture and storage (CCS).

Nonetheless, Dr. Masanet suggested that the greatest challenge to meeting current climate goals might be changing behavior. Data from the United States showed that increasing energy efficiency alone wasn't enough to reach climate goals. The average U.S. home—though 25% more energy efficient—had also expanded its floor area. The average fuel economy of U.S. passenger vehicles has increased, but growing rates of travel have likely "[negated] all the efficiency gains," Dr. Masanet concluded. He proposed that some of the most tangible pathways at hand might include reduced home sizes, more materials-efficient building designs, and minimized food waste. Many of our current consumption patterns and structures have "a lot of waste in them," which, when properly addressed, would be capable of delivering "gigaton-scale savings" at the global level.

Dr. Kevin Krizek extended these findings to transportation infrastructure. Dr. Krizek, a professor of environmental design at the University of Colorado Boulder, raised important questions for both policymakers and environmentalists to consider. "In times of high uncertainty […] how can we design for change and resilience?" he asked. While Dr. Krizek highlighted the problems of America's automotive-oriented infrastructure, he also pushed urban planners to make use of the existing space around them. With almost one-third of all urban land area devoted to the public right-of-way, he stressed the need to "[see] street space as solution space." COVID revealed how much our street infrastructure was available—how street space is one of the strongest assets cities have to combat climate change and improve their character. Streets can change and he urged the public to lean into the power of thinking in terms of smaller vehicles that are scaled around humans (See Image 3). Krizek pointed to Congress Avenue in Austin, Texas—a bustling main road that had converted half its lanes for bike use—as a prime example of an urban street being

Image 4: Monon Boulevard, Carmel Indiana. (Plan by Speck & Associates and Gehl.)

reformed. He argued that repurposing current street space to significantly accommodate bikes and pedestrians isn't incompatible with existing code and policy. To make green living a reality, cities have a rich opportunity to prioritize smaller modes of individual transport and foster a mindset of collective ownership over the land.

City planner and author Jeff Speck added crucial, firsthand perspective to the discussion. Some of his past work has included plans for Transit-Oriented Developments in Long Island and the Boston area. Like the other panelists, he attributed challenges in achieving low-demand pathways to the American condition. Cars—one of the prime culprits he identified—initiate feedback loops that support wasteful infrastructure and urban sprawl—they allow us to structure our lives around environmentally inefficient commutes. As a result, Speck pressed city governments to adopt designs that would encourage new modes of travel (See Image 4). He pointed to his recent project in downtown Oklahoma City, which removed nearly 1/3 of all driving lanes through the addition of better facilities for walking and biking. A greener future is well within every city's reach—allocating space for new bike lanes, for instance, is a matter of simply "re-striping" the streets (See Images 5 & 6). Speck concluded his talk with a plea for immediate infrastructure reform, cautioning against any further roadbuilding. "Every new lane is a commitment to greater global heating," he urged. Expanding roadways will only increase America's demand for cars.

The panel ended with an open discussion that identified challenges to re-green cities. All three speakers acknowledged that undoing America's reliance on

Images 5 & 6: Image 5 shows Cedar Rapids traffic flow before restriping and Image 6 shows traffic flow after restriping. (Plan by Speck & Associates.)

automotive infrastructure will be easier said than done. "People think that their access is going to be jeopardized," Krizek said. He, like Dr. Masanet, admitted that changing popular perceptions of more sustainable lifestyles—smaller homes, fewer cars, more bikes—will take time.

The panelists also voiced concern for the current direction of American development. Krizek mentioned that "there are real costs" to the way American cities approach their urban spaces. He drew attention to the "epidemic of pedestrian deaths," criticizing our continued dependence on oversized vehicles. Electric Hummers and Ford F-150s—many of them weighing over 3-tons—would only perpetuate America's car-based infrastructure. Speck expressed similar urgency. He noted that even the smallest of infrastructure policies, such as on-site parking spaces, would continue allowing people to "drive more cars." Basic lifestyle choices—such as adjusting the thermostat, throwing away food, and consuming meat—all add to the crisis of growing emissions. "A lot of us aren't acting," Dr. Masanet observed.

New Haven Mayor Justin Elicker '10 MEM/MBA responded to the perceived lack of action in cities. "Our team is sold on this. I'm sold on this […] I would love to close down more streets like we've done in East Rock [neighborhood]." He goes on to clarify the need for residents to voice their desire for change in transportation and city planning. "Not a lot of folks are calling for those sorts of things […] We need to have a larger constituency advocating for these things. It is not just the mayor, although we very much want and are working on these things, but it's about community advocating for these things."

Dr. Karen Seto closed the panel with the topic of developing countries, where an area of "20,000 American football fields" gets paved every single day (See Image 7). "One of the most valuable things we can do is encourage [the developing countries] to leapfrog past us," Krizek concluded. Rather than imitating American infrastructure failures, they should implement green designs directly into their development and sidestep the transition from fossil fuels altogether. The parting message from all three speakers, though, was simple: "if you live a lower carbon lifestyle […] your life is better," Speck said.

Image 7: Dr. Karen Seto (right) facilitates a dynamic discussion with Jeff Speck (left), Dr. Eric Masanet, and Dr. Kevin Krizek. (Source: Julian Macrone '21 MEM)

Carbon Uptake and Storage in Cities and Buildings

YSE's Senior Associate Dean of Research and Professor of Ecosystem Ecology Peter Raymond has dedicated his career to carbon budgeting. As moderator of the conference's third panel, Dr. Raymond introduced the carbon cycle with three main messages. The first is the *scale* of emissions that is anthropogenically caused and that only half of emissions leads to atmospheric CO_2 growth because land and ocean sinks are currently taking up CO_2. Second, *urgency* is high because nothing is given about these sinks. We do not know that the land and oceans will continue to act as sinks in the future. Third, there is *opportunity* when consumption causes 60% of total emissions. Dr. Raymond noted that when he was a graduate student 20 years ago, there was less urgency. The 20-year time period to bring down emissions seemed like a long stretch, but now, the AR6 says that lag time is gone. We need to bend the curve immediately.

Dr. Galina Churkina, professor of urban ecosystem sciences and IPCC Working Group III contributing author, continued this specific focus on the carbon cycle. While climate mitigation strategies of the past have focused on lowering carbon emissions, Dr. Churkina said that so much carbon has been emitted into the atmosphere that it will be staying there—unless it is removed. Instead, she offered an expanded view on effective mitigation strategies: lowering carbon emissions + carbon uptake + carbon storage (in a place where carbon can be stored safely over the long-term). Cities offer solutions to each part of this equation at various levels where vegetation and soils, lakes and rivers, infrastructure and buildings, and landfills can all serve as carbon sinks. Dr. Churkina focused on infrastructure as a key sink, while stating

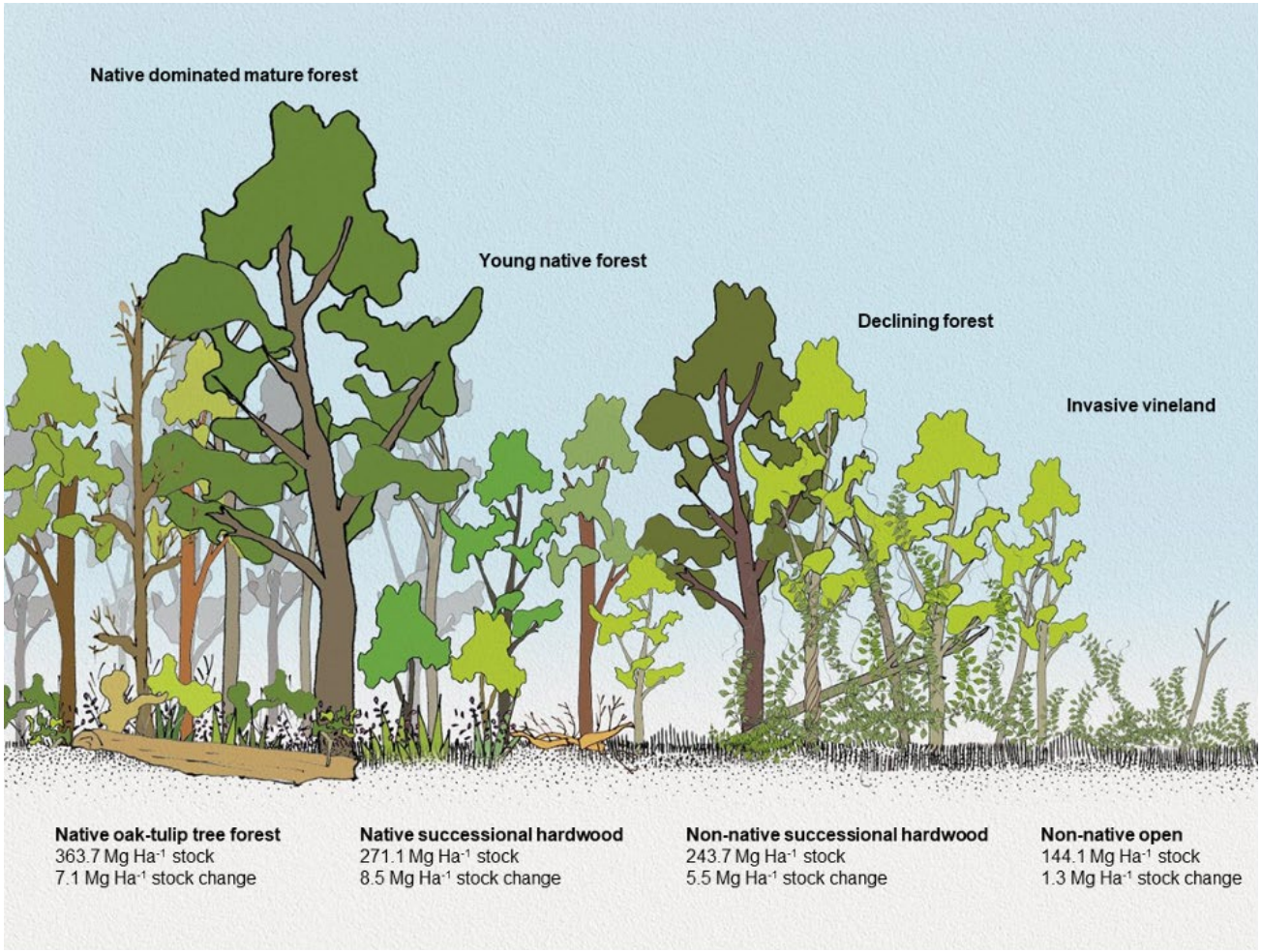

Figure 3: Healthier, intact forests and soils with native tree cover absorb and hold more carbon. (Source: Natural Areas Conservancy.)

that cities are not self-sufficient, closed entities; urban footprints expand beyond the urban boundary to food produced on farms, imported energy, and fiber harvested from land beyond the city's edge.

Continuing the focus on infrastructure, Dr. Diana Ürge-Vorsatz specifically directed attention to closing the emissions gap through infrastructure. Dr. Ürge-Vorsatz claimed that "human-made mass exceeds biomass on earth" and "concrete is the single most human-used substance after water." With that in mind, her research laid out eight strategies focusing on durability and longevity of buildings and infrastructure: encourage retrofitting over new construction, minimize material demands, use bio-based materials in construction, use bio-based materials for carbon capture and storage, preserve live soil, integrate mini and micro ecosystems, improve material production processes, and cultivate a circular economy and carbon capture. Dr. Ürge-Vorsatz promoted embodying carbon in construction materials—which is not always straightforward, but timber provides a pathway to storing large amounts of carbon and perhaps achieving negative-emissions in infrastructure.

On the topic of timber, Dr. Clara Pregitzer, forester and deputy director of conservation science for the Natural Areas Conservancy and IPCC Working Group III contributing author, turned the panel's attention to the role of blue and green infrastructure—not as a silver bullet but as one piece of reducing emissions. Cities face magnified impacts of climate change, from severe storms to hurricanes to flooding to drought. Therefore, Dr. Pregitzer highlighted the importance of healthy blue (e.g., coastal tidal marshes) and green (e.g., green roofs, street trees, and natural areas) infrastructure to absorb and mitigate climate impacts. Dr. Pretgitzer's work pays special attention to natural areas in cities with New York City as a major case study, where she and her colleagues have found that most of the carbon in urban natural areas is stored in trees and soil like it is in rural areas (See Figure 3). Her research, therefore, calls for more forest management and interventions to promote healthier tree cover and more street trees in urban spaces. Reflecting on the fact that cities can move more quickly than federal governments, Dr. Pregitzer pointed to opportunities to fill in knowledge and data gaps on blue and green spaces, looking for their inequitable distribution, and influencing political will and policy.

In the panel discussion, Dr. Raymond reminded us that Connecticut has faced its second drought in six years. He asked the panelists: "What worries you? Of that, what is being incorporated into solutions?" Diving into uncertainty, Dr. Pregitzer noted that thinking about forest succession over time and thinking through impacts is important because pests, rain, and wind kill and knock down trees. Dr. Ürge-Vorsatz followed by stating young trees are finding it harder to tap groundwater and survive, so we must cherish our older and more mature trees. Yet, she reminded us that there are huge opportunities, such as making pavements and surfaces more permeable to help mitigate droughty conditions. Dr. Churkina reflected on cities becoming increasingly hotter and becoming heat islands, which can serve as laboratories for future conditions.

Dr. Raymond prompted the panelists on two more sets of uncertainty: 1) the durability and impermanence of these solutions (i.e., the risk of reversal and losing carbon stocks) and 2) monitoring and verification. He asked: "What does or doesn't concern you about those?" Dr. Pregitzer jumped in to say that forests are not a permanent element for carbon; once a tree dies, it is emitting CO_2. On monitoring and verification, trees will grow if given the opportunity, though tree mortality is high so monitoring will be a key part of her upcoming 2024 research. Dr. Ürge-Vorsatz was "not concerned about the permanence because if a tree dies in a city, we will plant another one." She dismissed the strong focus on monitoring and verification saying she "doesn't think it makes sense to keep counting" when current accounting of offset projects shows 2% of them resulting in real reduction, 8% in temporary reduction. "If we need to get to zero, I don't see a lot of sense in the cost of counting." Dr. Churkina questioned the expected lifetime of wood and urged that wood is a material that if designed smartly can be reused easily. Permanence is relative, she seemed to convey, as buildings can be built and renovated with used materials, providing a long life for infrastructure and carbon storage.

Closing Remarks

Dr. Karen Seto remarked that the seven hours of information throughout the conference offered a buffet of mitigation strategies for cities. She asked, "How can we take ideas and plan our cities with these options that show enormous opportunities but also challenges?" Dr. Seto synthesized the talks into three major take-aways. First, there is opportunity in the scale of the challenge. "Are there other ways to think about our landscape?" she prompted. Second, she reflected on urgency; Barrett informed us that we have three years left to hit peak emissions. "We have the knowledge and the know how to actually do it—but we're not doing it!" Dr. Seto explained. Third, Dr. Seto connected with each attendee: "We are the folks living in cities and towns. We comprise part of the 55% of the world's population living in cities, and we create more than 60% of emissions. We can't wait on the private sector and nation states but need to think about what we can do as individuals now."

Acknowledgements

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