Okay.

It’s time to get started. I’m Robert Dubrow. I’m the faculty director of the Yale Center on Climate Change and Health. I know most of you, but maybe not everyone. And it’s a great pleasure today to introduce Jose Siri, who is speaking to us from London. And since 2019, he’s been the senior science lead for Cities, Urbanization and Health for the Wellcome Trust’s Our planet, Our Health Programme. Some of his previous positions have included being a research fellow in Urban Health for the UN University International Institute for Global Health. He’s been a research scholar for the International Institute for Applied Systems Analysis, and he got his PhD in Epidemiology with a concentration in infectious disease epidemiology from the University of Michigan. So without further ado, I’ll let Jose start his talk. Great!

Many thanks, Robert. Can you hear me? Thumbs up?

Great, great.

So it’s great to be with you today. Thanks again to Robert.

Thanks to the Yale Center on Climate Change and Health.

and thank you to you all for joining.

Today, I’m gonna talk about the central role that cities play
in climate change and health and how systems-based research can contribute to the solutions. And I hope that you’ll see or you’ll agree with me why we need this type of approach to compliment traditional public health research. So I want to start with a few concrete examples. Just this past month, we saw one of the most intense heat events in history in the Western North American heat wave. So starting in late June, the Pacific Northwest and Western Canada saw maximum temperatures up to 19 degrees Celsius above normal, lasting through early July. This is a map showing temperature anomalies on June 27th, compared to the typical average for the same day in different years. The heat caused power outages, it destroyed infrastructure, it buckled roads across the region, it spoiled crops, and damaged trees, some places saw major water quality declines because of fish kills, and of course, it sparked wildfires. Some places even saw serious flooding from snow melt. So the drought, excuse me, the fire had a whole range, excuse me, the heatwave, had a whole range of complex consequences. And we still don’t know the full health impacts,
but there’ve been estimated 700 plus excess deaths so far.

There was a significant rise in hospitalizations, and there was morbidity, not just from the heat, but also from cascading events like smoke inhalation from wildfires, major mental health impacts, of course, for those effects.

In this context, impacts were much worse because this region has a low uptake of air conditioning, and it hadn’t prepared in other ways for this level of heat. So in other words, they’re not adapted.

A preliminary attribution study has estimated that this is about a one in 1,000 year event in today’s climate, but that it would have been 150 times rarer without human-induced climate change. Under two degrees Celsius warming, an event of this magnitude might happen every five to 10 years.

Of course, we know that cities amplify heat waves because of urban heat island effects. Cities can be significantly hotter than surrounding areas, especially at night.

In the left figure below, you see how climate change might shift the distribution of hot days. Now, to the right.

In the right, you see the additional shifts
0:03:48.59 –> 0:03:50.3 from urban heat islands.
0:03:50.3 –> 0:03:52.44 And the message from from this figure is that
0:03:52.44 –> 0:03:54.8 even small rises in average heat
0:03:54.8 –> 0:03:57.25 can lead to large increases in extreme heat
0:03:57.25 –> 0:03:59.28 at the leading edge of the distribution,
0:03:59.28 –> 0:04:00.79 especially in cities where you have
0:04:00.79 –> 0:04:02.49 the additional amplifying effects.
0:04:03.81 –> 0:04:07.07 So let’s cross the world to South Africa,
0:04:07.07 –> 0:04:09.3 and three years earlier.
0:04:09.3 –> 0:04:13.1 In 2018, after three consecutive years of low rainfall,
0:04:13.1 –> 0:04:15.21 Cape Town had one of the worst water crises
0:04:15.21 –> 0:04:16.81 ever recorded in the major city.
0:04:17.75 –> 0:04:20.72 Early that year, officials estimated that the water system
0:04:20.72 –> 0:04:24.56 would actually fail on a so-called “day zero” in April.
0:04:24.56 –> 0:04:26.17 In other words, they projected that water levels
0:04:26.17 –> 0:04:28.29 would be too low for any withdrawals
0:04:28.29 –> 0:04:31.273 and the city would essentially have to shut the system
0:04:32.12 –> 0:04:34.92 down.
0:04:34.92 –> 0:04:37.36 The chart you see here is a measure of water storage
0:04:37.36 –> 0:04:38.52 for the city over the five proceeding years.
0:04:38.52 –> 0:04:41.88 The black lines at the bottom
0:04:41.88 –> 0:04:43.26 now show have the minimum levels needed to allow withdrawals.
0:04:43.26 –> 0:04:45.66 in this case, the city averted the crisis,
0:04:45.66 –> 0:04:47.64 but not before it drew up security plans
0:04:47.64 –> 0:04:50.4 to protect emergency water supplies.
0:04:50.4 –> 0:04:52.47 Water was severely rationed.
0:04:52.47 –> 0:04:55.57 Citizens were challenged and in some cases, even shamed,
0:04:55.57 –> 0:04:58.02 into conserving and consumption was reduced
0:04:58.02 –> 0:05:00.41 by more than half, which allowed the city to survive
0:05:00.41 –> 0:05:01.46 until the rains came.

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But even though the crisis was averted, it sort of highlighted some of the severe inequities and conflicts related to water in the city. Now for example, informal settlements in Cape Town received less than 4% of the water supply, even though they represent 20% of the population. There were conflicts over the use of water for public health versus for agricultural priorities. And again, this is a situation where the systems that the city of Cape Town had put into place just weren’t designed for the conditions they encountered. They weren’t well adapted.

As for the Western American heat wave, this was a quite rare event, perhaps 0.7% per year in today’s climate, but made five and a half times more likely because of human-induced climate change. In an intermediate warming scenario, the probability of a drought as bad as this or worse could rise to 25% per year by the end of the century. In a high warming scenario, it could rise to 80%.

So you would see this kind of drought most years, essentially. Again, cities amplified drought risks because they concentrate massive amounts of people in a small area, they impact health directly, but also through loss of livelihoods.
impacts on agriculture, and sometimes even increased infectious disease risks. So for example, where hygiene suffers because of lack of water. As with almost all climate risks, the greatest impacts are on the poor and marginalized. So coming back to the U.S. now, one year earlier than that. In 2017, Hurricane Harvey dumped as much as five feet of water on parts of Texas. Over a hundred people died, 30,000 people were displaced, and the storm caused $125 billion worth of damage. Aside again, from the direct health impacts and environmental exposures, many, many people suffered mental trauma from the disaster and from the losses of their homes or their livelihoods. Again, impacts felt disproportionately on Black and poor residents. This was another extremely rare event, perhaps one in 2,000 years in today’s climate, I’ve seen as low as one in 9,000 years. But again, the rainfall totals were made more than three times as likely, like human-induced climate change, and the risk might increase to one in 100 by the end of the century. In Houston itself, within the city, modeling suggests that the urban environment not only exacerbated the flooding,
because of impervious services and channeling the water, but the urban environment actually increased local rainfall, through interactions with meteorological system, making the observed flooding, the observed water levels 21 times more likely. So, it’s not hard to find material unfortunately for climate and health. There are hundreds of other examples that I could have used here. All of these have connections to adaptation because they speak to the need to plan for such impacts, but they’re also intimately linked to mitigation because all of them were made much more likely by human greenhouse gas emissions. So these events really illustrate that climate change is not just the concern for the future, we’re already seeing serious impacts today. They show how cities mediate and modify both overall climate impacts and the distribution of impacts across society. They show how much human-induced climate change has already increased health risks, and how these health risks may increase in the future. And they tell us or they show us really, the cities are critical part of solutions for climate mitigation, adaptation, resilience. So for the rest of my talk, I’m gonna be discussing why cities are critical for climate and health impacts and solutions,
what challenges we face in implementing healthy climate action in cities and beyond, why we should see many climate and health challenges in cities as systems problems, and how a systems-based research agenda can help catalyze solutions.

So, first of all, why are cities critical for climate and health impacts? First of all, cities are where we mostly live. And this is a fairly new situation. Most of us tend to think of, for example, the Industrial Revolution as the time of massive urbanization as I do. But the population of England in 1800 was maybe just 10 to 20\% urban. Urban population growth began to overtake rural about half a century ago. And according to the UN, we became majority urban around 2007, where you see these two curves cross. Today, the UN estimates that we’re about 55\%, and by 2050, two-thirds of us will live in cities. Now it’s worth mentioning that these numbers are quite uncertain. We actually can’t measure who lives in city and how many people live in city directly. We’ve tended to use national definitions for urban, whatever they are. But in Norway or Sweden, a city with 200 people is considered urban.
In Japan, you have to have 50,000 people to be considered urban. So cross country comparisons are quite difficult. There have been a few efforts to apply a single standard everywhere. One effort using a construct called degree of urbanization, puts the global urban share of the population at about 75 to 80%. Most of the increase coming from Asia and Africa. There’s some controversy over that definition. There’s other efforts, but whatever method you use, the take home message is that we’re mostly urban and we’ll be adding billions of more city dwellers over the course of the century. So, given that we’re mostly urban species today from the standpoint of an ecologist, cities are our dominant habitat and they’ve profoundly affect our health. And I like to think of the analogy of a fish tank. So if you buy a fish tank, you have to supply it with fresh or salt water, depending on the kind of fish, you need to add light and heat, gravel, hiding places for the fish, you have to regularly add food, you need a filter, and so on and so forth. If you imagine building an ideal habitat for a human being, it probably wouldn’t look too much like modern cities, that some are better than others.
This list here is from Stephen Boyden’s seminal work on human ecology in Hong Kong. And I love that this includes not just physical, but psychosocial needs. So, of course, cities should supply clean air, water and food, but it’s equally important that they supply emotional support, and variety, and a sense of purpose. But again, the key is that cities, in many ways, determine the health of the human species. Virtually, every urban system affects health in familiar ways, but also along pathways that we may not be aware of, or when we think about, excuse me. Urban transport systems affect physical activity, they affect the air pollution and exposure to air pollution, and mental health and opportunities for social interaction. For women, in some contexts, they also can seriously affect safety or perceptions of safety. Housing affects exposure to extreme temperatures, infectious vectors, toxic pollutants, but it can also influence a sense of belonging and variety and daily experience. Cultural systems have impacts on creativity, of course, but also on loneliness, and even on infectious disease transmission. As we’ve seen in lots of examples during COVID-19. And I’m sure I’ve left relevant systems off this list. I won’t go through them all, but I just really want to emphasize the point that cities,
through their complex integrated dynamic systems, are among the main drivers of our health and wellbeing. Now, importantly, for what we’re discussing today, cities affect virtually all the pathways along which climate change affects health. So you have direct impacts, for example, through storms, drought, flooding, and heat. And as we’ve seen, these are all modified and sometimes amplified by cities in urban systems. You have indirect impacts, might mediated through ecological systems. These are also affected by cities. So for example, cities drive deforestation, increasing the likelihood of zoonotic disease transmission when previously separated species come into contact. They can cause food system disruptions when they grow over or expand over productive agricultural land, which is quite common. Indirect impacts can also be mediated through social processes like migration or trade. And of course, cities are the primary driver and destination of those processes as well. Cities are also where most mitigation and adaptation actions either are implemented or are the driving force behind it. Perhaps most importantly, cities emit about three-quarters of all greenhouse gases from final energy use.
They use more than three quarters of all natural resources. They produce about half of all the waste that humanity produces. And the graph on the left shows global greenhouse gas emissions by economic sector. Electricity and heat production, transportation, buildings, and to some extent, industry, are important sources of urban emissions as you might imagine. But even emissions that happen in rural or undeveloped areas, so for example, from agriculture or forestry, are mostly the result of urban demand for goods and services. On the right, the figure shows two common ways of accounting for emissions and the bluer circle towards the top, shows all emissions arising from goods and services produced within the city, whether they’re consumed there or exported somewhere else. That’s the usual way that we measure emissions. The greener circle shows all emissions arising from goods and services consumed by the city, wherever they’re produced. And in fact, especially in wealthy cities, a high percentage of emissions are from imported goods and services. So, you buy your iPhone,
and you don’t have any emissions from that, but emissions are produced in China or somewhere else or where that phone is produced. We’ve done a lot less well at documenting so-called consumption-based emissions. For example, they’re not generally included in net-zero commitments, which are pledges to reach a state of carbon neutrality by a certain date. There are efforts underway to change that, led by groups like C40 Cities, which is a network of the world’s largest and most influential cities. So, just as urban populations are growing, so too our urban extents. The amount of land that we devote to cities is projected to increase dramatically over the century. In fact, many analysts suggest that we’re more than double total urban land extents. I believe Karen Seto, who I think is with us here, has estimated that 60% of all of the urban infrastructure we’re going to need has yet to be built. Under some scenarios of fossil fuel development, models have projected that we could have as much as six times as much urban land by the end of the century as we have now. More than two-thirds of the expansion in urban land will happen in Africa and Asia. And so,
you can imagine that this is a tremendous opportunity
to rethink how we design our fish tank,
how we make our cities healthier places,
both for people and for the planet.
So,
I've highlighted some troubling trends and statistics here,
but I really want to emphasize that
cities can be forces for good.
It’s really important to remember that.
These two pictures are before and after shots of a place
in Seoul, South Korea,
called Chonggyecheon.
I’m positive, I’m butchering the pronunciation, but I try.
From the late 1950s to the mid-1970s,
this was a site of major industrialization and really a perfect example of car dependency.
You can see in the upper picture that the site included an elevated highway.
This was constructed over the bed of a former river.
In 2003, the then mayor of Seoul initiated a project to remove the highway and restore the river.
It was highly controversial.
It was expected to lead to terrible congestion
and other consequences,
but actually it’s become a showcase for the city.
The new watercourse, which you see in the lower picture,
led to locally cooler temperatures,
by some measures an increase in biodiversity,
less traffic congestion,
less pollution,
more tourism, and cultural and economic revitalization. And cities everywhere are taking actions like this, and trying experiments like this. Now, we saw a host of new experiments in public space and infrastructure, and working in mobility during COVID-19. Cities are also taking the lead on net-zero commitments, and adaptation matters, and on integrating all these activities under one-governance structure. So the city of Amsterdam, I believe, is taking an explicit Doughnut Economics Approach to their development, where they both mitigate the excesses of growth, but also provide all the social needs for the population. So really important that we see cities not as problematic, but as a source of solutions. So now, I want to talk a little bit about some of the challenges to implementing healthy climate action in cities. Many of these things that I’ll talk about, of course, apply to climate and health more broadly. One challenge is that we just don’t know where we’re going in terms of emissions pathways. This figure shows annual growth, global greenhouse gas emissions under different scenarios. If we do nothing, we’re up in this pink gray area, and we’re probably looking at
more than four degrees Celsius of warming, which would be catastrophic. But fortunately, we are already doing something, and under current policies, we’re probably in this tan space in the middle and looking about three degrees of warming, which would still be extremely serious. Our current pledges and targets under the Paris Agreement get us down to about 2.4, and if we were able to take the urgent massive action that we need to take, we might still be able to hold a warming to two degrees or even 1.5. But it’s important to remember that all the climate impacts that we’re seeing today are just 1.1 or 1.2 degrees of warming. So even 1.5, even if we meet the goals of the Paris Agreement, we’re looking at significantly more serious health impacts and other impacts. Now, of course, not knowing what to adapt to, makes it quite difficult for cities to plan effectively. It also makes it quite difficult and challenging to project impacts. So, a second issue is that we don’t know enough about tipping points. A tipping point is a set of conditions where small changes can lead to abrupt shifts.
0:20:30.61 –> 0:20:33.06 in the state of a complex system.
0:20:33.06 –> 0:20:36.64 Most often, we hear about climate change tipping points.
0:20:36.64 –> 0:20:37.83 So for example,
0:20:37.83 –> 0:20:40.6 there’s a hypothesis that if the Greenland ice sheet melts
0:20:40.6 –> 0:20:41.68 too quickly,
0:20:41.68 –> 0:20:43.97 the influx of cold water could shut down
0:20:43.97 –> 0:20:46.65 the circulation of the North Atlantic Ocean currents
0:20:46.65 –> 0:20:49.55 and that would cause a very rapid shift in global climate.
0:20:50.5 –> 0:20:53.06 So that’s one climate tipping point.
0:20:53.06 –> 0:20:55.34 There are many other potential climates tipping points,
0:20:55.34 –> 0:20:58.44 but tipping points aren’t limited to climate systems.
0:20:58.44 –> 0:21:00.57 So you can have ecological tipping points,
0:21:00.57 –> 0:21:03.263 and socio-economic tipping points as well.
0:21:04.22 –> 0:21:07.09 So to give an example of an ecological tipping point,
0:21:07.09 –> 0:21:10.25 drier conditions can cause less vegetation growth,
0:21:10.25 –> 0:21:14.05 which leads to less evapotranspiration, even less rain,
0:21:14.05 –> 0:21:17.35 and eventually leads to rapid desertification.
0:21:17.35 –> 0:21:19.52 And there’s evidence that that may have
0:21:19.52 –> 0:21:21.52 already started happening in some areas.
0:21:23.38 –> 0:21:25.54 In terms of socioeconomic tipping points,
0:21:25.54 –> 0:21:27.36 sea-level rise, or sustained drought
0:21:27.36 –> 0:21:29.54 can lead to sudden abandonment of settlements
0:21:29.54 –> 0:21:30.543 and out-migration.
0:21:31.38 –> 0:21:33.07 Imagine if the Cape Town drought
0:21:33.07 –> 0:21:34.733 had gone on a couple more years.
0:21:36.17 –> 0:21:39.18 Importantly, tipping points can also be positive.
0:21:39.18 –> 0:21:42.36 We might see a sudden transition to renewable energy
0:21:42.36 –> 0:21:44.42 when a critical mass and cheaper technology
0:21:44.42 –> 0:21:46.1 leads to universal adaption.
0:21:46.1 –> 0:21:49.03 We’ve seen that kind of rapid spread for mobile phones
and social media, for example. But deep uncertainty about the likelihood, magnitude, and timing of tipping points is another factor that complicates city planning and even global climate planning.

We don’t have enough information about the limits of adaptation or its effectiveness. The figure here shows frequency of adverse impacts from some event on the Y-axis and intensity of adverse impacts on the X-axis. When frequency or intensity are very low, when they’re in the blue, we don’t worry about them. They’re acceptable risks. Beyond some limit of acceptable risk, which is shown here by the curve line at the lower left, we adapt to the risk, but there are limits to what’s possible or feasible. A limit to adaptation is a point at which an actor can no longer secure valued objectives from intolerable risk through adaptive action. So the point at which your adaptive action can’t secure what you need to secure.

Above the limits of adaptation, which is the second curve line in this figure, to the upper right, risks are so severe that we have to try to avoid them or mitigate them. And you may have heard the phrase, “Adapt to what you can’t avoid, avoid what you can’t adapt.” Barriers to adaptation can be physiological.
So for example, where heat and humidity go beyond the human body’s capacity to cool itself, they can also be ecological, social, cultural, physical infrastructural, or technological. I’m sure there are other things that they can be. So we need to have a much better understanding of the limits to adaptation.

In terms of effectiveness, we have lots of projections and sort of modeled estimates of the effectiveness of potential actions, but far fewer measurements of performance of adaptation in reducing health or climate impacts or risks. So, as things become more and more implemented in the world, we need evaluations of those projects. Even when we know adaptation has been effective, it’s hard to separate out the effects of personal behavioral change, changing contextual factors, and specific interventions. So we need a theory that helps us disentangle those patterns. Another challenge, and this is a really important one, from my perspective, is that existing research doesn’t reflect non-patterns of risk. The figure above is from a preprint of a new review. They used machine learning approaches to evaluate about 16,000 climate and health studies.
And if you notice the scale, there is a log scale, so keep that in mind.

Notice where the studies are concentrated.

The second figure below shows the locations of heat wave and health research over close to half a century. It’s even a starker pattern, and that’s for one specific risk, but you can do that for any different climate analysis.

In both cases, there’s a significant lack of research in countries and cities that will experience serious climate and health impacts.

That includes Latin America, Africa, the Middle East, Central Asia and Oceania. And lots of research in the U.S. and Europe, India and China, but much of the rest of the world needs a lot more.

We still don’t have nearly enough evidence on how cities interact with modify and mediate climate health relationships. And because we haven’t done the research, we especially have limited information about how these interactions are already affecting residents of informal settlements, secondary cities, cities in the Global South, or how they’ll affect in the future.

We don’t have enough evidence on impacts on marginalized groups or intersectional impacts, even in high-income countries.

And we don’t have enough evidence on impacts mediated via complex indirect pathways.
which I’ll talk a little bit more about later. And of course we’ve seen the climate change will push our infrastructure beyond the tolerances it was designed for. That was something in several of the examples that I gave. We need much more information on how our infrastructure would respond to and what we do to fix it. So another issue is that we have systematically incomplete information on how to catalyze climate action. And some of you may be familiar with this picture. This picture represents a story from World War II. Bombers were being regularly shot down when they went out on raids, and the U.S. Military was trying to figure out what to do about it. So when the bombers came back, they systematically mapped the bullet holes in planes returning from combat, and they proposed to add armor to the parts that had the most holes. But a statistician named Abraham Wald, pointed out the solution was the exact opposite because these were the planes that had survived. So the military should armor the parts with no bullet holes, because any plane that got hit in those places didn’t make it back. This type of effect has been called survivorship bias, and it’s really common. In the context of climate change, we’re beginning to have many collections of implemented
mitigation adaptation and co-benefits actions. And often these collections try to pull out and identify the salient shared features of success. But we have far less information on interventions that failed during implementation. Almost no information at all on actions that were rejected during ideation or planning. Actions that were proved and never implemented. In this context, survivorship bias can arise to drawing conclusions only from successful climate action. So we need to look at the failures. Another challenge is that research policy and practice tend to operate in silos. In other words, people tend to engage, primarily, with the concepts, people, problems and actions that relate to their own specific area of work or interest. Obviously, this challenges effective communication, the challenges are believed to integrate research policy and practice, and it challenges the coherence of the actions that we implement. One thing that I and many others have observed is that health has actually, often particularly, separated from other sectors. And maybe this is because of deference to the health sector, maybe it has something to do with specialization, maybe it’s because health is life and death, and so occupies a sort of a different place. But the result is that in many cities,
just to give one example, urban and transport planners have little or no contact with the health department, even though their actions have huge implications for health and wellbeing, and obviously for climate. Another challenge is that the pace of the required change of what we have to do is getting faster and faster. Every year that we delay action, the climate challenge becomes greater. As of 2019, we would have had to cut emissions by 7.6% each year, globally, to meet the goals of the Paris Agreement. And just for perspective, in 2020 with COVID-19, we had just a 6.4% drop in emissions. So that starts to give you a sense of the scale of what we need to do every year. The figure here shows how the pace and trajectory of the needed emissions reductions changes with the year when they begin. So if they had started in 2000, it would have been a much shallower reduction that we would have had to have. Now it’s much deeper. Not only do we have to move faster than ever, but we have to do more than ever before. So our goal can’t be just to reduce emissions, but we also have to meet all the other goals to sustainable development. We have to end poverty and hunger,
provide education and equality,
and all of the other SDGs.
The figure on the left just shows how health is intimately linked with all of those goals. And on the right, we have countries plotted, excuse me, on the right we have countries plotted with respect to their ecological footprint per capita on the Y-axis, and their human development index on the X-axis. So the further to the right on this chart, the better your standards of living. The shaded square at the bottom right defines the space within which countries have high human development and live within the world’s limits. And you can see that there are very few countries in that space, and we need to get everyone there quite quickly. So one last challenge is that we have lots of commitments, but actual implementation lags far behind. Here, we see cities and regions that have pledged a net-zero emissions target, and we also have the percentage of national populations that are covered by these targets. As of 2020, 126 countries and 51% of global emissions, of the global population had net-zero goals, either formerly adopted, announced, or under consideration.
But pledging and implementing are far different things, politically and practically. So we need to keep an eye on this and we need mechanisms for accountability.

So I want to shift gears here and talk about the systemic nature of many urban challenges, including those related to climate and health, and why we should think of them as systems problems.

First of all, what do I mean by systems problems? Systems problems arise from the interactions of networks of interconnected elements or systems. They tend to have various features, detailed complexity, so they have lots of variables, there’s lots of things going on.

Dynamic complexity. Cause and effect can be hard to define in these systems. The outcomes of interventions aren’t obvious. They usually have multiple stakeholders acting on incomplete information, often with conflicting motives. They operate across multiple scales and sectors. They’re often resistant to change or sometimes they’ll change very suddenly and unexpectedly. And they’re usually related to other problems.

So the defining feature of systems problems is feedback, which can be reinforcing or balancing. Reinforcing feedbacks lead to exponential growth decline, balancing feedbacks lead to stable values.

So remember the example of desertification before, where less rain went to less vegetation, went the less rain and so on, that’s a reinforcing feedback loop.
Your thermostat in your house operates on the principle of balancing feedback. When the gap between the room temperature and your thermostat setting gets large, it turns on the furnace and the room heats up. When the gap becomes smaller, it turns off the furnace so the temperature stays close to the desired temperature. So an important observation here is that you can have a valid causal relationship between A and B, perfectly valid, but still see all sorts of different behavior in the real world, depending on other connections in the system. System behavior can be explained endogenously in terms of feedbacks, delays, stocks, flows, and parameters within the system. That means that the way the system behaves depends on the way the elements of the system are connected. Simple system structures, or combinations of feedback loops and delays, give rise to characteristic patterns of behavior. Sometimes, we see these called systems archetypes. So seeing a certain pattern suggests a certain relationship between the elements in a system. So just to give a couple of examples, the top example here, you have a balancing feedback loop with a delay and that gives dampening oscillations. So if your thermostat is slow to react, you’d see this kind of pattern.
The second example, a reinforcing loop tied to a balancing loop can give you a typical logistic growth curve. So, in the second diagram, we have population growth with an ecological carrying capacity. At low populations, the reinforcing loop dominates and growth is exponential, and at high populations, the balancing loop dominates, so growth slows until the population equals the carrying capacity.

There are many other well-established systems archetypes, and of course, these relationships can be expressed mathematically and modeled. Simple systems structures combined into broader systems in constant dynamic flux.

And this is where conventional approaches really struggle. So when you have health needs and risk factors and diseases and health resources that are all fluctuating constantly over time, it’s hard to develop valid conclusions.

Earlier, I mentioned silos, here’s where they really become relevant. So when dealing with a system virtually, everyone sees the part most related to their own work, or their own ideas, or their own community. So climate scientists tend to look at climate variables, city planners look at urban variables,
health professionals tend to look at direct health relationships.
Now, of course, there’s intentional reaching across the boundaries. 
Health scientists certainly look at the impacts of variables in other parts of the system, but it’s rare that anyone is able to perceive the whole system and the way things co-vary and interact at the same time.

So an important guideline and systems thinking is that you can’t understand the behavior of that whole system by understanding the behavior of individual parts. This is especially true in critical feedback loops, especially if feedback loops that have delayed action when they cross silo boundaries.
And under those circumstances, it’s very common for decision-makers to be surprised by the counter-intuitive outcomes or the failure of policies or interventions. Now, practitioners of systems analysis and systems thinking have developed heuristics about when and how to intervene in a system to have greatest impact. These are so-called leverage points, and some of them are more effective than others. So the lowest value leverage points are parameters. For example, the rates of flow into or out of stocks. Higher up on leverage scale are physical system structures.
like buffers and material stocks and flows.

Even higher are control structures. The structures that control the working
system, feedback loops,
information flows and rules.

The highest leverage points are those that allow
the system structure or the goals to change,
so you can add feedback loops or remove them.
And if you look at the very peak are interventions to
change the paradigm out of which systems arise.
In a real sense, that’s what we’re trying to do
in the context of climate change
and sustainable development.
We want to shift our shared understanding of the goal
of the human system, of humanity’s place in the world.
In the meantime,
systems thinkers tell us
that most of what we do to solve problems
do not rely on low value leverage points,
and that we often, after we’ve identified them,
push them in the wrong direction.
So the systems approaches offer an opportunity
to identify higher quality actions.
Many urban climate and health challenges have features
or show behaviors that we associate with systems
problems.
There are processes that we see replicated again and
again in cities around the world.
Urban sprawl, traffic congestion, gentrification,
slum formation, air pollution, patterns of consumption growth. All of these are processes that resist change, that involve multiple stakeholders, and so on. We also see persistent why they replicated social patterns like prejudice and denialism. And this should be no surprise. Cities are the most complex systems that human beings have ever created. And all of this suggests that we need a systems-based research agenda to address these and other climate and health issues. Now, what I mean by a systems-based research agenda is not a replacement of traditional epidemiological or public health approaches. I think those are absolutely critical. And we have to make sure that we don’t disrupt traditional science. What I rather mean is a program of work that complements traditional methods, that frames them within a systems context, and that draws on them to map complex problems, and identify solutions. A systems agenda would include components that apply methods to understand complexity and that engage broadly across disciplines, and especially beyond science. Now, this could be more or less expensive, but I’ve mapped out some of the components that I think are necessary. And these include conceptual mapping,
0:38:52.63 –> 0:38:54.61 systems-based case studies,
0:38:54.61 –> 0:38:56.19 simulation modeling,
0:38:56.19 –> 0:38:59.24 systemic analysis of governance planning and policy,
0:38:59.24 –> 0:39:00.89 and transdisciplinary research.
0:39:00.89 –> 0:39:03.24 And I’ll talk about each of these just briefly.
0:39:05.58 –> 0:39:07.23 At the most basic level,
0:39:07.23 –> 0:39:10.03 concepts mapping can help organize information.
0:39:10.03 –> 0:39:12.13 I know this doesn’t look very organized to you,
0:39:12.13 –> 0:39:14.9 but it actually helps a lot.
0:39:14.9 –> 0:39:17.663 It allows for exploration and hypothesis generation.
0:39:18.58 –> 0:39:21.5 This particular diagram is a causal process diagram
0:39:21.5 –> 0:39:24.87 for droughts and mental health from a systematic review.
0:39:24.87 –> 0:39:26.91 Now, the numbers that you see in brackets
0:39:26.91 –> 0:39:30.36 are the number of papers meeting the search criteria.
0:39:30.36 –> 0:39:32.08 So, you can see that this gives a sense of the state
0:39:32.08 –> 0:39:33.75 of knowledge across the system,
0:39:33.75 –> 0:39:36.83 and suggests where more research may be needed.
0:39:36.83 –> 0:39:40.6 And then there’s the area of the shaded in green here,
0:39:40.6 –> 0:39:43.32 gives a sense of how this whole system diagram can be used
0:39:43.32 –> 0:39:46.01 to identify subsystems of interest.
0:39:46.01 –> 0:39:48.81 In this case, between drought, agricultural productivity,
0:39:48.81 –> 0:39:51.72 workloads and the health of the economy.
0:39:51.72 –> 0:39:54.92 Conceptual diagramming of this sort can also help identify
0:39:54.92 –> 0:39:58.513 potential co-benefits or co-risks between climate actions.
0:40:00.73 –> 0:40:02.72 On a more applied level,
0:40:02.72 –> 0:40:05.61 place-based, systems-based case studies can help,
0:40:05.61 –> 0:40:07.65 can also help with hypothesis generation
0:40:07.65 –> 0:40:09.6 and problem diagnosis.
0:40:09.6 –> 0:40:11.93 They can also play an important role in communication
and advocacy because they provide a common language that cuts across silos, the language of feedback and stocks and flows. This is a case study series from a research project that I led a few years ago at UNU, it was called, Systems Thinking in Place-Based Methods for Healthier Malaysian Cities, SCHEMA for short. Don’t ask me about the acronym. The case studies were produced in iterative cycles of engagement between a systems thinker, who provided technical knowledge and encourage thinking about dynamic processes, and a set of urban stakeholders who supplied local relevant knowledge, and evaluated the options, the structural options that were given to them by the system figure. In the end, the local stakeholders made all the decisions about the final model. This particular model explores how to assure safe food in school cafeterias, but the series covered a wide range of sustainability and health issues. There’s lots of different methodologies for producing this kind of study and it could be done quite easily, so I think it’s actually also a really useful tool for education and systems they need. On an even more applied level, of course, you have simulation models. Treat these with caution, absolute prediction is difficult,
but they can provide useful insights to the system behavior,

the probable outcomes of different scenarios, and potential unintended consequences.

Simulation models can also be used to design and assess interventions, which is especially important for interventions with long time horizons.

This particular model is of climate population and water supply. The agents here, which include households, and the water utility manager, make decisions based on their own attributes and rules for behavior, but also based on the current state of water system.

Agent-based models are especially useful for looking at issues with distributional impacts, but there are many other classes of simulation model.

Analysis of urban governance policy and planning is another really crucial element just because these are the information and control structures for urban systems. So these are potentially high leverage points.

This particular chart maps different modes of urban climate governance against mitigation sectors. So for example, for transport, it distinguishes self-governing like procuring energy-efficient vehicles for the government fleet,
governing through enabling like educational campaigns,
governing by provisions, such as the provision of public transport,
and governing by regulation such as road user charges.
I don’t want to go through this in detail,
but just to make the point that understanding how each of these modes functions and practice,
and how they themselves are connected in feedback systems
and hierarchies.
It again offers opportunities for problem diagnosis,
hypothesis generation, and advocacy.
One of the things that this kind of mapping does is it allows for documentation of the early stages
of policy and planning to reduce the survivorship bias
that I talked about earlier.
And finally,
transdisciplinary research is increasingly recognized
as an important modality for resolving complex societal challenges.
This is an OECD report that I helped coordinate in 2020,
because recommendations for universities,
research funders, researchers,
and international organizations,
are looking to foster this kind of work.
Transdisciplinary research,
which is across the boundary between science and society.
That’s the defining characteristic.
It involves non-stained stakeholders and co-design,
blending knowledge and creating new theory.
in search of common goals.

It generally involves cycles of conceptualization,
implementation and evaluation.

It takes longer.

It’s usually more difficult.

It’s almost always more messy than traditional research,
but well-designed and this is where research can generate
scientific breakthroughs and local solutions
at the same time.

And that’s something that’s really important at this moment
when we have to act at the same time as we learn.

And just to give an example of transdisciplinary research,
through my program at Wellcome,
we fund a research partnership called RISE,
Revitalizing Informal Settlements and their Environments.
And this is a randomized control trial,
The complex, nature-based water and sanitation
and intervention in informal settlements
in Indonesia and Fiji.
The intervention itself has core features.
It’s based on a nature-based approach to sanitation,
but ultimately an intervention is tailored
to each community.
Community stakeholders make the final design decisions.
RISE measures a wide range of health
and environmental outcomes,
and scientifically, its generated knowledge,
not only about the intervention,
but about community engagement,
and the capacity involving the informal settlements.
So for the study communities, it’s generated livelihoods, ownership and agency beyond the benefits of the intervention. And I think that we need much more of this type of research to tackle the challenges of climate and health in cities and beyond. So that brings me to the end of my presentation. I think that we’re at a time when we need to harness the brilliance and the exuberance of cities to meet the needs of people in the planet. And I think that systems thinking is critical to that effort. So thank you for listening. I’m glad to take any questions.

I could start with a question to get things started. So you gave a number of examples of conceptual diagrams of systems models that, you know, were hard, obviously hard to digest deeply, you know, given the timeframe, which, but my question is, do you see a role for more quantitative systems models in doing this kind of work? Yeah, I absolutely do. And I, when I was talking about simulation modeling, I was more talking about quantitative models. I think that you do get into difficulties when you try and get into that exact prediction. We’ve seen, for example, with COVID-19, how difficult it is to predict the exact behavior of a system,
but we are actually quite good at predicting the general shape. So we may not be able to say that the people come now, but we can say that there will be a peak. Certainly, all sorts of climate and health questions in cities and beyond are amenable to that kind of quantitative model, yeah.

Thank you for a very insightful presentation, Jose. And my question is about, first of all, realizing through your presentation and the work that some of us are doing with food systems, how it is important to not fear complexity, that at the end of the day, we have to deal with it the way it is in reality on the one hand, and we can come up with very wonderful spaghetti-like diagrams, like some of the ones you showed us to all the innumerable factors and subsystems all the interconnected, explaining the problem that we have. But then, I think for decision making, for policy making, the secret sauce is in actually breaking down those systems into subsystems, that we can really understand in a reasonable way,
and that we can actually come up with very specific policies or interventions to address them versus trying to do everything at the same time.

So, what is your take with regards to not fearing complexity, but at the same time embracing simplicity to try to address the humongous problems that we face?

Yeah. So first of all, I think that you’re right about spaghetti diagrams. There’s a diagram, a famous diagram on obesity and the factors that lead to obesity, and called, I think the framework shift model, which is so crazy that I decided I didn’t want to show it.

And those sorts of diagrams actually, I think can lead to paralysis.

So they’re not useful in that sense, but they are useful in constructing them to think about the subsystems and to learn about the things that were not, you know, you didn’t consider it to be related and actually are. But I agree with you, that pulling out the subsystems is really where you get more interesting and applicable results.

I did some work with a colleague at ANU that made the argument that low order systems models.
So five variables or less are really useful for influencing policy makers if you can get them to engage with the process. I have another talk. I remember where actually, I was at a meeting and there was a policy maker speaking. She had been, I think deputy director of the city of Lens in France, and someone asked her, you know, how do you get policy makers to engage with systems thinking? And she said, don’t ever use the word system. Once you’ve used the word system, they’ve checked out. So you do have to find ways to express these things in ways that are more palatable and more understandable for the audience. But I think that that’s part of the challenge. And I don’t think it’s, I don’t think, I mean, I don’t think it’s daunting. I think it’s actually really exciting that there’s this whole area of space that maybe we haven’t spent enough time thinking about, but that we can, especially sort of in mapping the government structures and the barriers that come about through the structure of governments. Thank you. Are there any other questions? Feel free to speak up. While you’re thinking, I’ll ask another question.
I guess the question is, what are the limitations of cities’ city-level policy in a context where you don’t have a coherent, you know, good national policy around climate change or climate change and health?

That’s a good question.

I think that, well, for one thing, it depends on the context. There’s some places where there will be more importance to have coherence or not depending on the climatic factors, depending on social factors.

I think that in general, cities are a good unit to use because they can, you know, they can take action at a large enough scale to affect people, and they’re close to people. National policy makers often have less understanding of the issues than city policy makers.

I think where you really do have to have coherence between cities and countries is in finance, because cities don’t have the finance to be able to take the kinds of actions that they need to take.

So for example, there’s a group called the Coalition for Urban Transitions, which I believe is funded by Bloomberg.

It’s sort of a partner to the C40 Cities program, which advocates and provides evidence for governments to fund climate action through cities. But, yeah, so in general, I think the cities are a good unit.
Obviously, it’s much better if you can coordinate city action with national action. And that’s something that we don’t see enough of. In the United States, you have huge disparities between city climate action and national climate action, but hopefully that’s changing for the better. So I see a question here. Why don’t I read it out? Based on your research, do you see a potential role for environmental lawyers in overcoming the silos you mentioned and perhaps addressing the need for accountability and meeting commitments pledged by national governments? So, first of all, I see a role for everybody. You know, we’re having the silos that I mentioned, so lawyers, architects, urban planners, engineers, public policy makers, civil society, everybody has a role. But specific to the role of law, that’s actually something that we’re thinking about at Wellcome, right now, because we’re designing a whole new strategy that includes climate and health as one of the three fundamental areas that we’ll fund for the next several decades. And one of the elements in there, is how do we design funding for, to produce the kind of research that lawyers will be able to use in holding governments and other players accountable. So you’ll have seen, or you may have seen that recently there was a judgment in Holland against
the Shell oil company that said, basically, it was liable for not having a policy that did enough to curb emissions. And we hope that we’re gonna see many, many more judgments like that. Not just against the oil companies, but really against all sorts of players that are not taking appropriate climate action. So I think the role of lawyers is actually quite critical in all of this. Okay. One last chance. Any other comments? Feel free to either put it in the chat or just speak right up. Okay, well, thank you very much, Jose, for a wonderful seminar, it was very comprehensive and... Thanks, Robert. It’s great to be here. And if anyone has any questions, I’m very glad to answer it so, you know, just write me. Okay. So, bye everyone.