

# Climate Winners and Losers

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**Announcer:** This is Climate One, changing the conversation about energy, economy and the environment.

Is a hotter planet necessarily all bad news?

**Solomon Hsiang:** We do spend a lot of resources trying to cope with the cold. And so there are many parts of the world where if you get a little bit warmer, or if you get a little bit more rainfall, a little less rainfall you actually can take those resources that you were spending on, you know, shoveling your driveway or paying someone to plow it. And you can invest those in something much more productive.

**Announcer:** But will any benefit from a changing climate be offset by the social costs?

**Katherine Mach:** Will we create winners and losers in terms of the big companies able to shift their supply chains readily at the same time that people on the ground in small communities in Africa or small rural communities in the southeast in the U.S. for example, can't as readily make those types of rather dramatic fast adjustments.

**Announcer:** Winners and Losers in a warmer world. Up next on Climate One.

**Announcer:** Do you live somewhere that might actually benefit from climate change? Welcome to Climate One - changing the conversation about energy, economy and the environment. Climate One conversations - with oil companies and environmentalists, Republicans and Democrats - are recorded before a live audience, and hosted by Greg Dalton.

I'm Devon Strolovitch. Rising temperatures and seas will produce losers and winners. Some parts of the world will see more moderate weather and economic gains. Others are already seeing sagging property prices and economic losses. So who will come out ahead?

**Katharine Mach:** Going into the future I think a real question on who wins who loses is how much climate change occurs.

**Announcer:** That's Katharine Mach, a Senior Research Scientist at Stanford University. For five years she co-directed the IPCC working group on climate impacts, adaptation and vulnerability.

Greg Dalton spoke to her at a recent Climate One event, along with one of the authors of a 2017 paper in the journal *Science* that outlines the impacts of a warmer world on human health and migration, violent crime, food production and wealth distribution.

**Solomon Hsiang:** It's like taking from the poor giving to the rich and that's only within the U.S. If you use the amount and you go international that pattern is only magnified.

**Announcer:** Solomon Hsiang is Chancellor's Associate Professor of Public Policy at the University of California, Berkeley. Here's our conversation about winners and losers in a warmer world.

**Greg Dalton:** Solomon Hsiang let's begin with you. *Romeo and Juliet* begins there's a brawl in Verona and it happens on a warm day. So tell us how heat and brawls and violence are related.

**Solomon Hsiang:** Yes, so *Romeo and Juliet* is a story we know. It's a conflict between two families. The opening scene is Mercutio and his buddy are out and they say we should go to a bar and his friends say what do we do we're gonna get a fight because it's so hot today. And we're gonna go anyway. And they go and they get a fight and that's the whole story is about. And so, you know, this is an intuition this idea that the temperature affects our judgment and our ability and willingness to engage in violence that's something that we studied a lot in our research. And we see this over and over and again when we look at the data just around the world throughout the United States hot days, hot weeks, hot months are associated with higher rates of violent crime. All types of crime. Sexual assault, regular assault, murder.

**Greg Dalton:** Fights at baseball game.

**Solomon Hsiang:** Yeah, fights at baseball games, road rage. It's like one of the most incredibly robust statistical findings I've ever seen. You can go anywhere in the world and you can see this in the data. So it's most clear and strongest at sort of the social level throughout the tropics and parts of the world where institutions tend to be weak households have fewer resources to cope. And so you know, we think that part of the mechanism is that people's crops might fail. And so they look for other types of opportunities and someone in my country or community say you can join my rebellion and if we capture the oil fields then, you know, we get to pull in a lot of dough after that. And that becomes more appealing if your normal source of revenue is starting to break down, right. And so we think that might be one of the channels the population is also just moving around trying to cope, you know, it's never that great to have a lot of guys who aren't finding work in the fields and so they come into the city and they're just hang around unemployed. That's kind of like a recipe for mischief. You know if someone is trying to create mischief that's a great environment for them. So, you know, we see these patterns everywhere. We haven't connected all the dots we're still doing a lot of research to understand what's going on. But if you take the things we see today and we think societies in the future couple decades from now are more or less gonna be fundamentally similar to the way people today think, I would be concerned.

**Greg Dalton:** Just think of the movie *Dog Day Afternoon*. You know think about the dramatic movies we've seen where it's a really hot day, even *12 Angry Men*. You also done research about the cost of a hot day. It's like lighting money on fire. Tell us something about that.

**Solomon Hsiang:** Yeah. So a lot of our work focus is on trying to understand the economic consequences of these types of extreme events or not so extreme events and thinking about how is the range of events that our experience shifts in the future. How is that gonna affect, you know, our pocketbooks. And so one thing we've done is we've looked in the United States and followed actual U.S. counties over time and asked if I take a county and I heat up a little bit more than it normally gets heated up what happens to the people in that county. Do they earn more money, are they

suffering economically in some way. And what we found is that a hot day, over the whole 24-hour cycle is above 85 Fahrenheit. We see that people earn roughly \$20 less at the end of the year, okay. Now that's just from the temperature there's nothing else, that's not related to anything else and that's per man, woman and child. So the analogy is okay every time it's a hot day I take 20 bucks and I just throw it away right because I'm just not gonna earn that money at the end of the year it starts to accumulate. And then you say okay well next year is gonna be just hotter and hotter and hotter and all that money that you could've been putting in the piggy bank, right and accumulating interest over time is all gone.

**Greg Dalton:** Katharine Mach, tell us how hot it is today, 2018 and how hot is it going to get because that's, you know, how many \$20 bills are we gonna be burning?

**Katharine Mach:** Great. So since pre-industrial time when we really started turbocharging our emission of heat trapping gases in the atmosphere. It's warmed globally in terms of the thin surface of the earth, 1°C. Going into the future I think a real question on who wins who loses is how much climate change occurs. So with continued high emissions of heat trapping gases we're looking at the potential for 4°C temperature increase globally within this century. The key feature is that type of warming puts humanity at risk of impacts that are severe, pervasive, and irreversible at global scale. So this question of winners or losers it really matter how much climate change we're talking as compared to reining and our emissions and limiting warming to 2°C, under 4°F.

**Greg Dalton:** And so can you tell us, can science tell us regionally which parts of the United States, we all see these maps with those different colors of, you know, scorching red and purples, et cetera. Can science tell us what places are gonna heat more than others?

**Katharine Mach:** I think the spatial geographies of risk are really, really important and Sol's work has been pivotal on taking that not just from the climate change indicator whether it's temperature or temperature in combination with humidity to what that means for people. I think in terms of uneven risk it's not just what the overall unevenness or unfairness looks like through space we need to be thinking also about the most affected systems whether that's coral reefs or archaeological remains being uncovered in indigenous villages in the Arctic or small islands going under. We have to think about extremes which are unpredictable kind of except that there are these profound patterns. And if we think about the \$300 billion in losses in the last year there was unevenness there comparing Puerto Rico to Houston for example.

**Greg Dalton:** We'll get to some of that. Sol Hsiang, is temperature were the biggest driver of like people are thinking well I wonder I'm gonna be a winner or a loser. What's the key determinant of that?

**Solomon Hsiang:** So there's a couple factors. When you're thinking about temperature what we found and it's kind of surprising I think 10 years ago we didn't know this. But over and over when we look at the data temperature is just really important factor in looking at the economic productivity of agriculture looking at crime rate. So, you know, many people think oh it's just the temperature but actually temperature affects everything. Now the ways in which temperature affects things tend to have a shape that looks like a U. So, you know, we're looking at people getting ill maybe getting, you know, going to hospital. We see more people getting ill when it's very, very cold and then also when it's very, very hot. Okay, so being in the middle and like being Goldilocks is great that's the sweet spot. So what happens is the thing that really matters whether you're a winner or a loser regarding temperature is what is your temperature today. If you live in an environment where it's like pretty comfortable, you're probably in the middle and you won't be affected that much. But if you live in a place that's pretty hot, okay. So you live on, you know, if you live in the South for example, Southern United States already quite hot getting hotter days really

harms you. If you live in the North, so you live in the Pacific Northwest or the Dakotas, then getting more warm days actually benefits you because you'll actually have fewer people getting sick, okay. And so what you have is about redistribution everyone sort of shifts to the right on this U shape and if you're coming down you benefit, if you're going up you get harmed. And so that ends up being basically a redistribution from the people who are hot today to the people who are cold today in the future. Does that make sense?

**Greg Dalton:** Sure. And then we'll get into some of those impacts in a minute. First I want to talk a little bit about rising seas and other change. Some neighborhoods on Staten Island, New York were almost wiped off the map by superstorm Sandy. Afterward, Joe Tyrone Junior helped organize a mass buyout of the Oakwood Beach community.

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**Joe Tyrone Junior:** Oakwood Beach is an area on the east shore of Staten Island. Many have described it as the epicenter of the storm of superstorm Sandy. The wave height was measured at around 15 feet. I had an investment property there. I had a one-family bungalow. I could've rebuilt again at my own pocket but I didn't want to do that because the devastation was just incredible. The Governor of the state address, announced that he was going to he chose us as a pilot program for the buyout. What he did was he created an enhanced areas and we were enhanced because we're right on the shore and he felt that if he had a large participation that that would protect the inner portions of our neighborhood near the inland portions. And so that we would act as a sponge which is really basically what nature intended from the beginning that we would be a sponge. After Sandy they weren't talking about climate change. They were just tired of their areas flooding constantly for whatever reason whether it's climate change or not. Ultimately the decision to leave was because they knew it was gonna continue to happen.

[End Clip]

**Greg Dalton:** That was Joe Tyrone Junior of Staten Island, New York. Katharine Mach, talk to us about that buyout program. Is that smart policy and is it scalable to buyout homes in harm's way?

**Katharine Mach:** So what is a buyout? You know, the basic idea is that in a changing climate, people are on the move, right. And that can either happen automatically or we can be strategic. We can manage it we can buyout properties. It's actually a surprising number of people who have retreated in a managed way globally given natural hazard rest to date is over a million. Here in the U.S. we got two categories. Number one the buyout program, 45,000 properties approximately have been purchased at their pre-disaster value to this program to date. We're also just beginning community relocation with the Louisiana tribe for example. And so some of the real questions around our buyout program is that it has been in the U.S. the major way that we have gotten out of the way with what is called sometimes severe repetitive loss properties instead of cashing them in with flood insurance yet again, you just buyout the property. It's worked in that it has certainly been a way to reduce risk by getting assets out of a floodplain for example. But it's not necessarily incredibly strategic in terms of how we might deal with 4 to 13 million Americans inundated through this century. For example, it is patchy so if you have a floodplain that now has houses in half of the different locations, well do you protect those houses with a seawall which is actually what is underway in Staten Island in some dimensions of planning right now. Or do you actually recognize that to truly reduce risk by creating room for the river, creating room for the sea that we have to be more sweeping, recognizing that there are a whole lot of challenges and also opportunities around this type of adaptation.

**Greg Dalton:** And Sol Hsiang, seems like there's certain parts the New York Times did a big report

recently about three states. I think it's Texas, Louisiana, Florida where storms hit again and again and again and taxpayers are sending tens of billions of dollars to the same states over and over again. How long can that go on and is that a form of wealth transfer from other parts of the country?

**Solomon Hsiang:** Oh absolutely. I mean, the question how long it goes on is the question of how long people will keep buying our treasury bonds. It all relies on the credibility of the federal government to pay money back. And so it's completely unsustainable in the sense that like if I were a startup and I just said like oh, we just screwed up I'm sorry I just I like lost password to the bank account so can we just have some more money please. And then the VC says, okay here's more money and then we do it again, again and again after a while you cut me off. You'd be like this is ridiculous. We don't have that kind of market economy when we're thinking about interregional transfers that's arranged through an electoral system and politics. And a lot of politics is about redistributing wealth and so we often think that when some community is harmed we ought to go and help them and that is for sure I think a core value in our society. I think we also have core values about sort of everybody pulling their weight and I think what is challenging is to keep track of how many times one community has been sort of the beneficiaries and how many times other communities have been sort of paying for that to go in. And some people say, well, we should subsidize, you know, flood insurance because some people just like they had this property they didn't know there was such high risk. And we have in the past actually tried to increase the premiums to make them fair so that people were paying for their fair share of the risk and there was a lot of political blowback from trying to do that.

And what is really striking I think is that the regions that are gonna be harmed tend to be parts of the country that have benefited a lot less from economic growth over the last several decades. And so the southeast parts of the U.S. are struggling in many places. Whereas out here on the West Coast in the Pacific Northwest there's been booming economies through technology and other industries and those are the regions that are gonna benefit. So it's like taking from the poor giving to the rich and that's only within the U.S. If you use the amount and you go international that pattern is only magnified. So the places on this turning globe that are the most in danger is Africa. I mean Africa is the place that has the fewest resources to cope and the weakest institution to organize any type of adaptation. And so, you know, thinking about what's gonna happen throughout the global tropics is the type of thing that really keeps me up at night.

**Announcer:** You're listening to a Climate One conversation about winners and losers in a warmer world. Coming up, Greg Dalton asks how well can predict who wins and who loses.

**Katherine Mach:** What a lot of social scientists like to say is that not all poor people are vulnerable and not all vulnerable people are poor. And the flipside of that is that wealth is not necessarily protection.

**Announcer:** That's up next, when Climate One continues.

**Announcer:** We continue now with Climate One. Greg Dalton is talking about climate winners and losers with Solomon Hsiang, Chancellor's Associate Professor of Public Policy at the University of California, Berkeley; and Katharine Mach, Senior Research Scientist at Stanford University.

Here's your host, Greg Dalton.

**Greg Dalton:** Katharine Mach, we're talking about the social cost of carbon so tell us about you've done a lot of work on the impacts. Speak more to that inequity that's happening where the poor who contributed least are getting hit first and worst.

**Katharine Mach:** Yeah. So this question who's most at risk it comes down to a lot of different factors. And I think one really important feature is that risk in a changing climate is not just about the climate that human side of the picture is unbelievably important. So this inequity dimension plays out across scales. So number one, the huge inequities among countries of the world and the way that impacts that are happening in terms of impacts for food security or water insecurity or extremes, will mean different things when you're in a low income country context without the state support capacity there on the ground or the level of economic development to keep things chugging ahead. But I think this question of inequity is also really, really important. What a lot of social scientists like to say is that first of all, not all poor people are vulnerable and not all vulnerable people are poor. And the flipside of that is that wealth is not necessarily protection. So if we think about what's unfolded here in the U.S. whether it's the fires in Northern California, Sandy in 2012 in New York City or all of the cyclones striking the gulf coast over the past year, even within the city going block to block. You can have very different outcomes depending on are the elderly and infirm are the people who are most marginalized able to access resources from cooling centers to medical attention when systems start to fail in tandem.

**Greg Dalton:** And some of those systems to the point of breaking down, Katharine Mach, we've seen it's so hot in Phoenix that airplanes could not take off. It gets so hot that train tracks subways have to slow down. At what point we're gonna get to infrastructure just literally melting?

**Katharine Mach:** Melting or collapsing I think there are many profound ways where we have built our societies for stasis and stability and now we're in an environment of change. So what is that look like across the U.S. in Alaska for example, the ground is melting, right. The permafrost is thawing and whether it's pipelines or roads or buildings literally the ground is collapsing. And that's something we can see already there are astounding pictures of buildings tipping into the sea as you have the Arctic sea ice thawing, waste coming on shore. I think this question of heat is a really important one and that we certainly haven't designed everything for 118°F in Arizona come July, what have you. And that plays out in many profound different ways in particular in these environments where we've got transport and tight interconnection with electricity and tight interconnection with communications. And when you get a failure in one of those oftentimes it reverberates.

**Greg Dalton:** Sol, let's talk about some of the winners. Canada, Russia, who are the winners?

**Solomon Hsiang:** Yeah, I mean there are a lot of countries where we see that their economic growth would accelerate if they're a little bit warmer. I don't know how many people here like spend a lot of time shoveling their driveway. But we do spend a lot of resources trying to cope with the cold as well. And so there are many parts of the world where if you get a little bit warmer, or if you get a little bit more rainfall, a little less rainfall you actually can take those resources that you were spending on, you know, shoveling your driveway or paying someone to plow it. And you can invest those in something much more productive. So there are people who are gonna benefit so -

**Greg Dalton:** That is productive if you're the guy shoveling the snow.

**Solomon Hsiang:** Yeah. And so, you know, we see places in Northern Europe, Russia as you say, Northern and Central Eurasia and Canada. These are the types of countries that could actually benefit from some amount of warming in terms of sort of increasing economic growth and economic productivity. The U.S. is really split down the middle. So basically half of the U.S. is harmed, a

quarter of the U.S. benefits. And so the U.S. on net kind of is harmed but not as dramatically as places further south than us.

**Greg Dalton:** Any indication that people are moving yet in anticipation of this are people moving out of the South or may be hard to say that is because of heat or climate but boy 118° in Phoenix sure makes you wonder how long that can go on. Sol.

**Solomon Hsiang:** So actually when we look at the data historically we've seen a lot of people moving around and migrating in response to climatic events that they're experiencing. Now whether or not it's human caused climate change is a different question that's sometimes harder to detect, but I think everyone in the United States is very familiar with the Dust Bowl and what happened in this country. We had a huge part of this country basically evacuated and people pushed into the cities, the labor markets became flooded with a lot of extra people at the same time we had an economic downturn. That was a very difficult situation to cope with and having lots of people moving is very difficult. It puts a strain on society and the structure of different markets. So we've seen similar patterns we've done research in Indonesia where we see the same thing. When there's communities that have been exposed to long sequence of hot years and a lot of crop failures, the families pick up and they move to the city. So the question is, as you repeat this over and over what do we end up seeing? You know, there's a lot of movement out of Northern Africa right now and across the Mediterranean into Europe. And when we talked to policy folks in Europe they're very concerned about this. This part of the world is very heavily exposed to warming temperatures they don't have a lot of water resources and when people start moving it's very hard to say no and it's also very hard to support them. So neither option is great. It'd be great if people were just able to take care of themselves at the standards we would hope.

**Greg Dalton:** Katharine Mach, you know, migration climate refugees is that something you've encountered with your IPCC working group is that something that is notable because other people we've actually had David Miliband head of the International Rescue Committee on this stage saying it's not a big deal. There are no climate refugees yet.

**Katharine Mach:** So on the climate issue there has been increasing attention to all these different dimensions of human security. And I think migration is a particularly interesting one in there you start with conflict. But migration first of all is interesting because we see tons of migration throughout the world today sometimes it's politically driven sometimes it's economically driven. If it is economically driven, it is usually good for the people who are moving. It's good for the host populations who are the recipients and oftentimes there's money going back home as well. So in general moving can be a really good way to deal with hard times. And some of the real questions moving forward is A, how much faster and bigger will these migration flows get. If it is North Africa cruising into Europe do we have the institutions of the global scale to deal with that? Second there's actually really important question around trapped population. So if migration is a good way to get to that place in the U.S. where you could be better off economically but you are too poor to be able to implement that move for your family, there are really important questions of equity that come into play, not just in terms of who is forced to move but who is not able to move and would like to.

**Greg Dalton:** If you're just joining us we're talking about climate winners and losers at Climate One. I'm Greg Dalton. Our guests are Katharine Mach, a Senior Research Scientist at Stanford University and Sol Hsiang, a Professor at the University of California at Berkeley. We're gonna go to our lightning round and ask quick questions for our two guests. The first is association. I'm gonna mention a phrase or a noun and just get the first thing that pops into your mind unfiltered with complete disregard and reckless professional abandoned for what is coming into your mind. So Katharine Mach, what comes to mind when I say South Florida?

**Katharine Mach:** Flooding.

**Greg Dalton:** New Zealand.

**Katharine Mach:** Earthquakes.

**Greg Dalton:** Sol Hsiang. People buying waterfront condos in Miami today.

**Solomon Hsiang:** Gambling.

**Greg Dalton:** Sol Hsiang. People selling waterfront condos in Miami today.

**Solomon Hsiang:** Risk-averse.

[Laughter]

**Greg Dalton:** True or false. Katharine Mach, warmer temperatures and less dense air may be related to a surge in home runs in major league baseball?

**Katharine Mach:** True.

**Greg Dalton:** Very interesting debate online if you're a sports fan. Check that out. About home runs and air density and warmer temperatures. True or false. Sol Hsiang, Wall Street banks are figuring out ways to make money on climate driven volatility? (0:34:02)

**Solomon Hsiang:** Definitely true.

**Greg Dalton:** True or false. Katharine Mach, many natural scientists need to learn how to speak plain English?

**Katharine Mach:** True.

[Laughter]

**Greg Dalton:** Sol Hsiang, so do many economists?

**Solomon Hsiang:** For sure.

**Greg Dalton:** Also for Sol. True or false. Economists are people who don't have the personality to be accountants?

[Laughter]

**Solomon Hsiang:** True.

**Greg Dalton:** Alright that ends our lightning round. Let's give them a round for getting through the gauntlet there.

[Applause]

Sol, I wanna ask you to drill a little bit into the human health consequences of a warmer world. What are we looking at in terms of human health, what's happening there?

**Solomon Hsiang:** So there's a huge number of researchers in public health who thought about this



for a long time. I think there's so many ways in which the environment affects people's health. There's obviously people who are, you know, hit by storms. There's also people who suffer from heat stroke when it gets hotter out. And the diseases that are carried by other organisms. Malaria, dengue these sorts of diseases end up propagating through communities much faster when the species that carry the disease between individuals in this case mosquitoes are doing better. So in the U.S. right now we're concerned about Lyme disease because ticks are taking off. And it doesn't ever helps to make things a lot hotter. The one case in which it does benefit some communities as you have the communities where place where people are really cold. And so elderly folks often will get the flu or the pneumonia in the winter and that can be fatal. So we see fewer people dying of those types of deaths in the colder parts of the country. And then there's all sorts of risky behavior we observe. So there's been a lot of research for example, in Africa in communities when they're facing drought conditions. We observe a lot of women engaging in much higher rates of transactional sex and that leads to higher rates of HIV transmission. So these types of sort of social dynamics interacting with the health environment interacting with the physical environment make it a really complicated challenge for the healthcare system to cope with.

**Greg Dalton:** I've heard lots of climate connections that's the first time I've heard the climate-AIDS connection. Katharine Mach, pick us up here. Where's the bright spots, what are some good things that are happening?

**Katharine Mach:** Well, I think on this theme of winners and losers we need to talk about responses and that we're seeing profound wins in that space in the world right now. You can take Sol's maps of what's happening county by county in the U.S. and plop on top of that where we're seeing bigger deployments of renewables for example, and the Great Plains regions running from Texas to North Dakota. Some of the biggest production of wind energy is happening and that belt. Here in California obviously we love talking about how ambitious we are in all the progress we're seeing. Maybe the last point I'll emphasize on the adaptation side of the equation is that all of these risks tied to everything we care about so oftentimes there were real win-win entry points where yes it's about developing and making people well off economically. Yes, it's about directing our attention to the climate dimension of that and we get wins across them in ways that our investments can mean more in total.

**Greg Dalton:** It's also food production, is it true that, you know, that the corn belt is gonna move up into Canada, Katharine Mach, you know, food production will there be some winners where some crops can grow in certain areas where they didn't grow before or is it more complicated the balance of food production?

**Katharine Mach:** So we're already seeing impacts on agricultural production globally and certainly in the U.S. and I think what Sol's work what others work in the agricultural impact space has really driven home is that the bands of temperature as they shift as also there's precipitation changes, changes in ozone all these other things that affect production. The major places where we may be most able to be productive agriculturally likely will be shifting. I think there have been some interesting ways where we already see early winners, or at least people with good foresight in terms of wine moving North. There is a great example of transformational adaptation that's moving peanuts in Australia. But I think some of the real questions are how fast we'll be able to move these industries. Will we create winners and losers in terms of the big companies able to shift their supply chains readily at the same time that people on the ground in small communities in Africa or small rural communities in the Southeast. In the U.S. for example, can't as readily make those types of rather dramatic fast adjustments.

**Greg Dalton:** And Sol Hsiang, I was recently in Walla Walla, Washington, where grapes are moving up there from California it's like Napa was 30 years ago. And I thought well, you know, the big

companies can buy grapes from wherever but it's the farmers who are stuck with the land. So I wanna get to the corporate adaptation and corporate supply chains if they're kind of seeing these trends they kind of moving ahead and either moving operations or adapting their supply chains to these changes.

**Solomon Hsiang:** I think they do that right now. I mean when we have a hurricane striking parts of the country and they're moving resources around trying to cope. I think strong firms will often do that, and we see that the firms that are also diversify geographically in such a way that they can actually move resources between regions are much more robust. You know local mom-and-pop stores in New Orleans a lot of them are gone and they've never come back. So I think, you know, the diversification and the ability to cope sort of is a really strong predictor of firm performance in the long run, just in general, under all sorts of types of volatility. And then thinking about risk as a dimension of volatility that they have to cope with is something that's really pervading I think a lot of leadership in firms right now. There's a lot of organizations that are trying to understand what is their exposure and what do they need to do to prepare so that they can be resilient in that way.

**Greg Dalton:** Another example of how those with wealth and resources are better such situated to adapt to this. But what happens after hurricanes tell us there's some myth and realities Sol Hsiang about what happens after a big hurricane. Who moves out, who stays what happens to the economy after a Katrina or a Maria or a Harvey?

**Solomon Hsiang:** We see a lot of things happen, you know, the most obvious thing is a lot of stuff gets broken gets destroyed. Sometimes people will move out sometimes because it's not as nice of a living environment property prices actually fall and we see lower income communities move in.

Families moving in taking advantage of the lower prices. Often people say oh well we should, you know, buy stock in Home Depot or something because there's gonna be a construction boom there is often benefits in the construction sector, but the losses in other sectors of the economy overall outweigh the benefits in construction. So local economies do tend to suffer and in many cases they suffer for over a decade. So, you know, after a storm hits you often hear America announce we're gonna build back better, stronger than we were before. Now that may be true, but they don't usually tell you on what timeline, right. So it is -

**Greg Dalton:** In their term while they're in --

**Solomon Hsiang:** Right. I mean San Francisco today looks a lot better than we did right after the earthquake, but it took decades to get where we are, right. And so what happens is you have a community in there on some sort of economic trajectory they get hit by a storm and they get knocked down to a lower trajectory. And so they do continue to grow eventually do continue to benefit but it takes them a lot longer and they never get to where they would've been, you know. I think, you know, we asked question people say, oh New Orleans is doing great today, but a question you can ask is what would New Orleans look like today if Katrina had never hit. And that's just it's a world that's so different from the one we're in that's even hard to imagine but it would have been a very different place I promise you that for sure. So we also see a lot of losses because people lose their jobs. We see higher rates of unemployment in these communities and then they end up calling on benefits from the government. So a lot of people have unemployment insurance payouts and so we as taxpayers end up paying for these storms much, much more than the bill you see coming from FEMA because we actually pay more in unemployment benefits than to the direct disaster relief right afterward.

**Announcer:** You're listening to a conversation about winners and losers in a warmer world. This is Climate One. Coming up, Greg Dalton asks what it even means to be a winner amidst a changing and more hostile climate.

**Katharine Mach:** This question of when do we have limits where we just can't cope biologically is unbelievably important to consider both in terms of kind of a fine scale winners and losers question and also broad patterns.

**Announcer:** That's up next, when Climate One continues.

**Announcer:** You're listening to Climate One. Greg Dalton is talking about winners and losers on a hotter planet with Solomon Hsiang, Chancellor's Associate Professor of Public Policy at the University of California, Berkeley; and Katharine Mach, Senior Research Scientist at Stanford University.

Here's Greg.

**Greg Dalton:** Katharine Mach, isn't a warmer climate gonna make oil and gas resources much more accessible in certain areas and therefore benefit oil drilling in the Arctic, Northern Canada, et cetera?

**Katharine Mach:** There are really interesting questions about what happens to the nature of extraction as the Arctic warms. So the Arctic in general is changing very fast, very profoundly in terms of sea ice that is melting, permafrost that is thawing and temperature deviations that are just astounding. Part of that is now water that used to be frozen over all the time in terms of sea ice almost year-round or for much of the year is now passable in almost every season. So we're starting to have questions arise of what does that mean for shipping. What does that mean for oil and gas extraction including around Greenland which is so susceptible to massive loss over centuries of emissions of heat trapping gases. And that's all in juxtaposition with these ecosystems that are so sensitive to change and indigenous communities dependent on them is this question of what happens to the Arctic. Is it really wide open and we have some really important questions not only about do we extract but what about all these pipelines that are on permafrost that is melting.

**Greg Dalton:** If you're interested in more about that we did a podcast from the Arctic. I was up there on a ship and spoke with the former prime minister of Greenland. It's called the Deep Dive Into the Arctic and they talk about the Northwest passage and what that means. They're torn because there's economic opportunity, but they're also worried about the cultural impacts and what it means to have that Northwest passage. Sol Hsiang, air-conditioning, you know, changed America that's now available to the most people in the middle class. How is that gonna help seems like one answer to this is more air-conditioning, right, you know, put in bigger air-conditioners. How is that gonna be a positive feedback loop, and where else could that energy go?

**Solomon Hsiang:** We're concerned about that. And I think many people are thinking trying to understand how increasing energy demand might actually accelerate things. There are, you know, many parts of the world I mean San Francisco is one of them where there's not a lot of air-conditioning. But there are many parts of the world that are very, very hot locations where there's not much air-conditioning and it is really important that those communities do eventually get access to air conditioning. Air-conditioning saves people's lives it dramatically increases the productivity of people who are working, it increases cognitive function it increases the quality of life. So it's really important that people get access. It's also important that we find ways to power air-conditioning

systems around the world that don't necessarily involve just sort of combusting fossil fuels. I do think that sometimes when I talk to people and we talk about air-conditioning is thought of as a way to adapt to the climate and people often say well, we're just gonna come up with awesome technologies like we came up with air-conditioning. I engage people and that I often point out, you know, we actually know how to keep people alive in space. Like we can actually keep that's a very hostile environment much harder than you know California with a few degrees warming. So we can keep people alive in intense environments but it's absurdly expensive. And so we could in the future, you know, all walk around in spacesuits if the environment becomes really hazardous but we're not gonna have any resources left over to do anything else when we're in the spacesuit, right. So we can adapt for sure. But the question is whether or not that's the way we want to spend our money or do we want to do other things besides adapt.

**Greg Dalton:** Katharine Mach, the climate conversation grew out of chemistry and physics, you know, the natural world in this sort of alarm systems red lights flashing. And increasingly the social sciences have become more part of the conversation. Why isn't the human brain responding to these flashing red lights, why isn't society doing more? I'd like to hear your thoughts on the social scientist coming to this climate conversation that was for so long has been chemistry and physics.

**Katharine Mach:** Yeah. So if they were as easy as understanding the physics we definitely would've solve this challenge already. The first estimates of climate sensitivity how much warmer the planet gets for doubling CO<sub>2</sub> in the atmosphere were made in 1895 approximately. So we haven't solved it yet. So why is it hard? There are a lot of different entry points. I think first of all we have to recognize that climate touches everything we do. So oftentimes people will point to the Montréal protocol and it's chugging along with quite a lot of progress in terms of solving the ozone depletion challenge. But climate change is harder, right because it comes down to this question of how do we develop in every low-income country around the world. If we were to say let's drop our emissions to zero tomorrow well we need to turn off these mics, those TVs you'd all need to get rid of your iPhones luckily mine is off stage is not something that is an easy challenge to solve because energy and land use are so embedded in our human experience. So some of the solutions are first of all from the social science angle of psychology and how people interact with risk and how to communicate effectively. I think there are lots of themes that are simple as hope not fear, unexpected messengers, driving connections to the issue, not just having it be abstract, often long-term, and all about the doom of humanity. There are a lot of other dimensions of the social science perspective that have been all about understanding what is vulnerability what is susceptibility to harm and all of the different ways we construct that ourselves, recognizing that this is a fabulously rich issue and basically no discipline is left behind in terms of understanding how all of the different pieces come together.

**Greg Dalton:** So how do you personally, Katharine Mach, deal with that hope and doom because you're in the business of looking at some pretty dark models and sometimes scientists can kind of go to the dark side staring at the, you know, the doom. How do you manage your own personal balance between that hope and fear?

**Katharine Mach:** So the dorky introvert answer would be that I love the complexity of this issue that being engaged really passionately with something that involves understanding so many features of the human experience is riveting on a daily basis. I think the response of a citizen and how I think about the long-term persistence of humanity I guess I have faith in the fact that we're really good at muddling through and I think at some point we're gonna start to see things in terms of innovation things getting easier as we start to decarbonize. So I think there are a lot of reasons to have hope at the same time that you can't get around the fact that the risks are serious and that means something to me even as a scientist in my dorkiest, most introverted moments.

**Greg Dalton:** We're talking about climate winners and losers with Solomon Hsiang, Professor at UC Berkeley and Katharine Mach from Stanford. I'm Greg Dalton. We're gonna go to audience questions, welcome to Climate One.

**Male Participant:** Hi, Targo Makecha. So you both discussed the developing nations potentially suffering from climate change. I'm curious what actions do you propose developed nations take and what role do you think climate change has on international security and geopolitical stability?

**Solomon Hsiang:** It's definitely not gonna make things more stable. I mean it's true and I think like it's very hard to predict exactly what will happen. If you look in the historical record, there are a lot of old political institutions, civilizations, communities that collapsed during periods of major climatic shifts. So Angkor Wat in Cambodia, the Akkadian Empire in modern-day Syria. The Mayan Empire in Central America, almost every Chinese dynasty throughout Imperial China collapsed during periods of drought. So we have a lot of records of institutions breaking down in these periods. And I think that's the thing that I'm most worried about. It is when political institutions, governments fail we know that failed states are some of the most difficult things to put back together. It takes decades. And so if we're doing anything even if it's only incrementally increasing risk of failure for a dozen states by 10% that is a tremendous cost to humanity I think. And so that's the type of thing that is the most concerning to many of us in the research community.

**Greg Dalton:** Especially in these times. Let's go to our next question. Welcome.

**Male Participant:** Hi. My name is Tom McCone. I'm from UC Berkeley also School of Public Health. But the question is in the IPCC there was discussion about reaching physiological limits in many areas of the world particularly for workers. And if you think about it's not just airplanes can't function but we have situations where whole working populations can't even work outdoors for a large amount of time because they're at the physiological limits that basically you alluded to this that we're gonna have to wear spacesuits or some other thing just to function. So what are some of the economic or even cultural implications and when that starts happening and we're not very far from seeing that happen right now.

**Greg Dalton:** They're starting to harvest crops in California at night because it's too hot in some places in the day. Who'd like to tackle that, Katharine Mach.

**Katharine Mach:** Both probably could. So I think this question of when do we have limits where we just can't cope biologically is unbelievably important to consider both in terms of kind of a fine scale winners and losers question and also broad patterns. So in terms of this fine scale question indeed, outdoor workers are particularly susceptible to the impacts of heat in particular in combination with humidity. Those are not just people picking fields it's also how do we maintain our infrastructure including infrastructure in the midst of a heat wave for example, where if we have electricity outage we need to get out there. It may be a future where we have to do that in spacesuits but that's unbelievably expensive compared to the way things work right now. There are also these questions of what happened to some of the dynamics of the atmosphere change and shift regional patterns for example, in the Middle East there have been some really profound studies of just how hot and uninhabitable some of those regions could be. They're already incredibly reliant on air conditioning of course, but that's also in combination with increasing desertification so essentially more dust in the air, air quality impacts that will be exacerbating in tandem. A lot of these things come down to real questions of how can we deal with this in terms of our health in terms of our hearts, our lungs and also just our physiology so that we don't get heart attacks and heat strokes.

**Greg Dalton:** Let's go to our next question. Welcome to Climate One.

**Female Participant:** Thank you and thanks for the conversation. I've been studying climate change for a while and I am a homeowner in Florida. So I've done a lot of study and the rate of change is local, your ability to cope is local, looking at the age of this population the next 20 years are gonna make a really big difference. There's drawdown technologies I'm a technical person myself and I've been looking at a lot of the hundred and one solutions and I'm just wondering what you think what you see on a global basis of the ability of the globe to become vegan and have less children and draw down technologies as opposed to massive oil drilling that's going on.

**Greg Dalton:** Who'd like to tackle that? Katharine Mach.

**Katharine Mach:** If we want to be really simple about the climate challenge we just say this is a question of can we have the same level of economic well-being that exists in high income countries in the world right now and not be reliant on heat trapping gases. So the easy entry point is that let's say that is in many ways is an engineering challenge by no means is it only an engineering challenge, but some of these questions are really just what is the next technology on the horizon in terms of piecing together cleaner energy with storage with dealing with the periods where the wind isn't blowing and the sun isn't shining. That said that certainly isn't the entire picture. And there are a lot of really easy places where we could just use a lot less heat trapping gas in our daily life. So what do we eat for example, that's incredibly important. For buildings, there are many places where we would save money if we had better insulation that can be hard to install if you got a beautiful old steady, but certainly where we're putting up new construction is easy win-win type of investment. And then the final piece of the equation I think is really getting to the drawdown point can we remove carbon dioxide from the atmosphere. That's a critical piece of our climate response equation one that I've been thinking about passionately in terms of the full spectrum of how that spans from biological to engineered approaches. But it's not one where we can rely on that in its entirety in particular, if we don't decarbonize our energy sector.

**Greg Dalton:** Let's go to our next question at Climate One.

**Female Participant:** Hi, thanks. My name is Jean Clinton. I think some of the adaptation we're gonna see is going to be sort of natural through markets and economics. But what are your thoughts on specific areas that you think congress or the president need to focus on in terms of intervention strategies to help mitigate or manage the adaptation be they agriculturally, economic development, social, you know, what would be the priorities for national attention to help manage this transition?

**Greg Dalton:** Sol Hsiang.

**Solomon Hsiang:** I mean, I'd say to cope with adaptation we should really think about the issue that was raised in the beginning, which is the question of whether we are going to subsidize environmental risk. I think right now there's just a lot of incentives for people to go and live in risky places and adopt risky attitudes. In economics we call that moral hazard it's like people sort of behaving more risky because they have great health insurance. So if I break my arm it's okay someone will fix it for me. We have that situation right now and that leads to a lot of additional risk-taking. If people have to face the risks and the consequences of the risk they take, then they're going to pull back. They're gonna drive their car a little slower they're gonna be a little more careful. And so I think that would be number one. Number two would actually be creating incentives to not use more hydrocarbons to put a tax on carbon. Because if you don't do that, there's a lot of ways we can adapt to the climate that involve just using more carbon using more energy. And so that's gonna come back the other issue we raised before the positive feedback of people just making the problem worse when trying to cope with it. So doing those two things, making the markets in greater alignment with public benefit would be the two things I would focus on.

**Greg Dalton:** Sol, as we wrap up what gives you hope about climate change? What give you hope that we can do this, get it done? Solomon Hsiang first.

**Solomon Hsiang:** I think that we and, you know, it's rough to be talking about violence and conflict and economic decline. But this I say to people I point out this is the first time in human history that we've had the types of scientific and analytical tools that we can actually have this dialogue before something happens. In the past, we talked about Angkor Wat or Mayan civilizations. They were leaders that were relying on fortune tellers or like rolling dice to try and figure out like should I make this call or a different call. Now we can actually use science and data talk to one another try to understand our values about the future and come to some consensus about what it is we want to change about the way we live. And this a revolution. This has never happened in human history before. So it's really great and incredible to be part of this discussion.

**Greg Dalton:** So data will prevent us from going off the cliff, or at least help us understand what's going on as we go off that cliff.

[Laughter]

Katharine Mach, what gives you hope?

**Katharine Mach:** So most people don't wake up in the morning and have the first thing that pops their mind be climate change, and that they care about climate change. Sol and I might be in the real minority on that issue, but I think the really compelling thing about the climate issue is that there are a whole bunch of different reasons why people are leading and why they will continue to lead. Those come down the things like leadership creating yourself as a winner as California is doing, as China is doing and actually paving the way for so many people who come in the path behind. It can be about air quality and human health it can also be just about immediate economic interests. Most states in the U.S. that are profoundly productive in terms of wind and solar energy are at this point doing it for the basis of economics, not necessarily because they're waking up in the morning and thinking about climate change.

**Announcer:** Greg Dalton has been talking about winners and losers in a warmer world with Solomon Hsiang, Chancellor's Associate Professor of Public Policy at the University of California, Berkeley; and Katharine Mach, Senior Research Scientist at Stanford University.

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[Applause]

**Greg Dalton:** Climate One is a special project of The Commonwealth Club of California. Kelli Pennington directs our audience engagement. Carlos Manuel and Tyler Reed are the producers. The audio engineer is Mark Kirschner. Anny Celsi and Devon Strolovitch edit the show The Commonwealth Club CEO is Dr. Gloria Duffy.

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