Weather Whiplash

https://www.climateone.org/audio/weather-whiplash
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Greg Dalton: I'm Greg Dalton and today on Climate One we're talking about the weather. All across the country the weather lately has been crazy weird. While the East was slammed this winter with massive snowstorms and biting cold temperatures, the West experienced searing draughts and was unseasonably warm. The weather is running hot and cold. Is this just freakish spell, or is it a sign of climate change driven by burning fossil fuels? On the show today we will explore the link between weather, climate fossil fuels and more with our audience here at the Commonwealth Club in San Francisco. We will also talk about what people and governments can do to understand and prepare for weather whiplash. We're joined by three guests; Louise Bedsworth is deputy director at Governor Brown's office of planning and research. She has a PhD in energy and resources from U.C. Berkeley; Hunter Cutting is director of strategic communications at Climate Nexus, a nonprofit communications firm focused on climate; and Kathy Sullivan runs the weather for President Obama as administrator of the National Oceanic and Atmospheric Administration. She holds a PhD in geology from Dalhousie University in Canada. Dr. Sullivan was one of the first of six women selected to be an astronaut in 1978 and holds the distinction of being the first American woman to walk in space. Please welcome them to Climate One.

[Applause]

Kathy Sullivan, let's look back at the last say 10 years or so of weather. We know that 2014 was the hottest year on record. Put us in perspective -- what's going on with all this really hot and really cold?

Kathryn Sullivan: Well, the big picture is that the chemistry of the atmosphere is clearly changing, carbon dioxide is rising. That's been an actual physical measurement -- grab some air from the top of a big volcano Mauna Loa, take it to the lab, measure it, that goes back decades. So that's just an actual measured curve of carbon dioxide concentration in the atmosphere. The physics of what that will result in are very clear and they've been known for 60 or 70 years. Carbon dioxide is one of the heat trapping gases that accentuates -- heightens the greenhouse effect that makes our planet livable. So the atmosphere is getting warmer, more heat stored in the atmosphere. And those physics are pretty clear too when you put more heat in the atmosphere, you can bring in more moisture, you have more power, more latent power in the atmosphere. And the bell curve of what we would consider normal weather for any given place shifts to a warmer -- the average shifts to a warmer point. That means a couple of things, you see more extreme weather -- a category of weather that's what you consider extreme is more abundant. There are more frequent events and there are more intense events. So, the physics that you would expect would predict you'll see higher hot temperatures, you'll see more persistent hot periods. You'll see fewer extreme cold temperatures and indeed the statistics show that. You'll see warmer nighttime lows and indeed the statistics show that, and onward and onward. So, in part what you're seeing is patterns we've been used to don't match up anymore with what the new normal in this hotter than before atmosphere and it reeks a little bit of havoc with our nice, easy expectations of, you know, October -- March is always likes so and so in San Francisco in the cooler atmosphere before but it's going to be different with more heat trapping capability in the atmosphere.

Greg Dalton: And you're one of the few Americans who have actually been up in that atmosphere, so how does having walked in space influence the way you look at this as your one of the few people

who have actually -- the famous Earthrise photograph that really changed the way humans looked at earth came from astronauts in the late ‘60s.

Kathryn Sullivan: In the ‘60s and ‘70s, yeah. I'm just a lowly space shuttle astronaut, so unfortunately we didn't get as far away as the guys that got the great Earthrise pictures. The shuttle orbits the earth in the 200 or 300 mile altitude range. It’s above most of what we consider to be the atmosphere. Two things I would say, one is, you know, down here walking around on the dirt we tend to see the atmosphere and the sky is immense, the atmosphere seems huge. Think of the metaphors in literature, the ocean of air above us. When you get even a couple hundred miles away and look back the planet you get a really different sense of proportion. And the atmosphere that everything alive on earth depends upon looks a lot more like the fuzz on the tennis ball than it does look like some thick rind on a grapefruit or something. It's remarkably thin. And you can see very elegant stratification within it as you watch the sunrise or set behind it. So I got very different sense of the thin little membrane of air, it’s a little fluid membrane that envelops this ball of dirt and makes it habitable. It's very elegantly and finely structured. It's got a sort of precision to how it all works and clearly that the chemistry of, at least, is being altered.

The second impact on me really was just a personal motivation one. It was so incredible to get to see that myself and have that view and take those pictures. And I just found it was never going to be enough for me to just come home and be able show cool vacation pictures from space. I somehow wanted to take that power, that perspective and how it lets us understand this planet and center my professional life around trying to make that capability that we have actually matter and translate into information that we can use every day to conduct our lives more safely or run our businesses more effectively.

I would make just one final point because it's a very profound one and I think it's worth remembering. We are the first generation of human beings ever in the history of humankind that has the ability to comprehend and measure our planet the way we currently do with satellites and other instrumentation. We can essentially take a snapshot of global conditions, oceanic conditions, atmospheric conditions, and this has what’s made it possible for us to have the kind of forecasting we have in weather forecasting and longer range outlooks. Human beings have always craved foresight about what's coming ahead for them and they should be prepared of and were the first generation that is any capacity to develop that kind of foresight in substantive scientifically sound actionable ways and we’re babies in terms of learning how to factor that into our decision making.

Greg Dalton: Aren’t we also the first generation to change the biochemistry of the planet on a global scale? And so when someone says how do I know that this huge snowstorm in Boston is related to climate change or is the California drought related to climate change, what do you say Kathy Sullivan?

Kathryn Sullivan: Well, it’s an exceedingly complex system. My best metaphor for this is, it’s little bit like dissecting what happened in an airline accident.

There's always a chain of events that led up to the accident and the temptation to want to say “well if that one had been a little different, if that one had,” the outcome is a consequence of the whole chain of events. That’s just being metaphorical but to take any given storm or any single event and say that specifically because of just the chemistry, it’s because the dynamics the atmosphere. The odds of severe events, the odds of intense events, the odds of higher temperatures, warmer overnight lows; those odds unequivocally all go up globally as you put extra heat into the atmosphere and how that will translate out by latitude and by region, by proximity to the ocean, by microclimate topography, that’s going to continue to be very complex. So, to take some event in the Russian River drainage and some event in Santa Cruz and say “bingo, that's one for one” -- it's not

that linear a system. That's our linear thinking but that's not how the planet behaves.

Greg Dalton: Sometimes people use the metaphor of baseball players and steroids and homeruns. We know that, you know, you can't say that that Barry Bonds homerun was because of steroids but we know that over some of those 700 and so home runs there was some juicing going on there that had an influence. Louise Bedsworth, what can we expect in California? You work statewide for Governor Brown. What is the state looking for in terms of impact on climate in California now and going forward?

Louise Bedsworth: I think we know several things from the projections that we've been able to do. We know temperatures are going to warm and it depends on the path that emissions take and how sensitive the atmosphere is to those emissions. But even under the best case scenario where globally we successfully reduce emissions we're gonna see some amount of warming in California. We know we'll see more warming in the summer months and I think probably one of our biggest impacts of concern is going to be the effect on the State's water supply. We know the precipitation patterns. We are less clear on the amount of precipitation but we know that the form of that precipitation is going to change.

We'll have more precipitation as rain than as snow, so that is going to really impact the state's water supply. We also know that we'll see more extreme events, more large destructive wildfires, severe droughts and heat waves, and we've experienced all of those recently and I think we just know we're going to see more of them in the future.

Greg Dalton: And Hunter Cutting is weird weather, is a teachable moment to people when something happens unusual; their garden blossoms differently or there's some unusual weather, does that cause people to say, hmm, global warming is happening or is it just like, not so much?

Hunter Cutting: Well it seems to be. Science is not something that engages a lot of people a lot of time, surprise, surprise. But weather is something that everybody contends with and so when you try to have a conversation with people about global warming in the abstract, unless they're a political advocate of some stripe you just not going to a of traction with everyday people. But if you're having conversation people when they're contending with the drought or contending with the heat wave, a natural question comes up with like why is this? You know, why is this the third once in 500 year storm we're having in the East Coast of the United States within 10 years? So, they do seem be teachable moments and some of polling data suggest that as well.

Greg Dalton: But how long do those teachable moments last, sometimes it snows and people, "ahhh, it's global warming ha-ha-ha," you know. Kathy Sullivan, it's getting cold and sometimes that people have trouble sort of squaring cold weather and snowing and even some new record lows with global warming. Isn't that supposed to be linear in one direction?

Kathryn Sullivan: This planet is not linear. This very complex set of interlocking dynamic systems and it's natural human -- we're linear. We make simple linear mental models to deal with the world around us and we all have a penchant to try to apply those and fit what we're experiencing in the world into nice simple linear models.

So that instinct is there and that habit pattern is certainly there. But, you know, a cold day, you know, a down day in the stock market does not belie a net bull market trends, if you look far enough back. We know it at the shore, when you see some low waves you know there's a little longer surf beat coming in. You have to watch over -- observe over the right interval of time to really get the full picture of the phenomena that you're looking at. Your comment about, you know, there are more really cold days statistically actually isn't true there are increasingly the number of extremely cold

days as you would expect from what the physics tell you to expect. The number of extremely deep lows -- low temperatures is going down as the heat of the atmosphere builds up.

Greg Dalton: So explain for us hot air hold more moisture, so what does that mean for more moisture circulating and how does that manifest in storms?

Kathryn Sullivan: So the energy that drives weather in our planet is the heat coming in from the sun, the moisture content of the atmosphere, and obviously the rotation of the earth all of the swirling that that introduces. So we're dialing up the extra heat in the atmosphere. This is kitchen table science, right? This is stovetop science. When you heat up the water the relative humidity in a hot atmosphere can be much higher than in the cooler and drier atmosphere, so it's kitchen -- it's really stovetop science working on the planetary scale. The energy content of the atmosphere, what makes our weather systems dynamic, is the heat and moisture content of the atmosphere. Dial one up you're going to have a more energetic atmosphere.

Greg Dalton: We have all these terms that have come into the common language recently with the polar vortex, atmospheric rivers, the ridiculously resistant ridge which is pushing rain up to Canada and stopping rain from coming into California. Hunter Cutting, how does that play out in terms of this new vernacular, this new language of weather in terms of popular realization of what's happening?

Hunter Cutting: As we were just talking about earlier, it is an entry point to the conversation, right. It's a way that people enter the climate change conversation that they don't get into otherwise. We have the weather channel naming winter storms now and it builds a story. If you give something a name, it's a character in the story and we're a tribal species, we communicate by telling stories. Scientists work with numbers and formulas. Average folks tell stories. So they need a name for that storm so they can tell a story about that storm and then that story can be expanded talk about what causes storm, what changed the odds of the storm happening, and that's how you can bring climate change into the conversation.

Greg Dalton: So, Kathy Sullivan is there now a business incentive for promoting severe weather. Are people making money off of this? Is there like ratings involved and sort of -- I heard the term the other day "weather porn," which is like the idea of like what happens after a disaster, hurricane, etc. Is there now sort of a business incentive to exaggerate perhaps severe weather? CNN has a severe weather center, right, that tells you something.

Kathryn Sullivan: Yeah, you know we the total business of whether communication in a pretty unique way in the United States. NOAA's responsibility is to gather the foundational observations. No one can make a forecast without then. We actually gather them from countries all around the planet, because you cannot make a forecast for anywhere in the United States that's more than two days long unless you've got measurements from the entire globe. So there's a tremendous international exchange of that foundational information so global forecasts are possible, and we put a certain set of basic forecast products out and then we stop. We work directly with the public sector managers; folks like governors' offices, state emergency managers.

But the rest of carrying out information to all of you as viewers of the general public on providing to the agribusiness firms in the Central Valley or to the winegrowers in Russian River or to the airline companies, that's an entrepreneurial space. In our country that's a private sector enterprise and we think of the weather enterprise as being both public and private elements together.

So the short answer with that backdrop is yes, you've got commercial companies vying for market share; you have broadcasters vying for viewer loyalty. And they know from their polling and

audience studies that the weather broadcasters is one of the loyalty points because just what Hunter said, this is natural tie point. Everyone's got this kind of interest point. So yeah they want to draw your attention. They want to make sure you look back again frequently, keep it being in the news, keep it coming back. Nate Silver has pointed out if you look at the way they express the weather to you they actually slant the results if it's generally benign weather and low probability occurrences, the broadcast community will slant results in way they think helps you better manage your expectations. You're going to be madder at them if they didn't tell you to take your umbrella and you got wet than if they you told it would be a good idea to take your umbrella and you didn't get wet. You'd be happy that they had you prepared and grateful that you didn't get wet. So they'll give you, whereas we might put out 25% chance of rain, they'll put out 30 or 35 to manage those expectations. When the consequence of the weather gets more severe; tornado outbreak or hurricanes or the probabilities get high enough, then their broadcast come right back to holding true to what the NOAA data are saying. Yeah, there's definitely managing expectations of ratings.

Greg Dalton: Speaking of sort of bias towards being cautious or conservative, we saw recently that in the Northeast some big storms came in, Louise Bedsworth, and the governor said, "well we didn't warn people enough last time, we're really going to warn them this time" and then if the storm wasn't as bad as people predicted it, then people are all mad at the governor, "you hyped it,. I could've gone driving," etc. So how does California deal with sort of managing that in terms of how much to alarm people but also being prudent?

Louise Bedsworth: Right, well when it comes to day-to-day weather a lot of that will often end up at a local level. I mean, I think we had large storms in December and we saw a lot of reaction in California preparing for that atmospheric river event. And, you know, I think where we come in at the state level is really helping communities to prepare for events that are coming, either in the very near term or over the long term as we look over the climate change horizon. And then of course working on recovery and response after an event and thinking about of course getting immediately back on your feet afterwards and also the long-term, building resilience into your recovery and you moving forward. And so I think that's a lot where we at the state level come in which is really how to get the tools out help you prepare, guidance, information, technical assistance and then, you know, to help after the fact as well.

Greg Dalton: One of the biggest events -- severe weather events in California recently was the Rim Fire, you know, the electricity in San Francisco was at risk, a lot of damage. Louise Bedsworth, what has California learned from the Rim Fire and how is it in terms of planning for the future and how's it affecting the people still up there?

Louise Bedsworth: Right, so the Rim Fire happened in 2013. It started right before Labor Day weekend and it burned over 250,000 acres. It's the third largest wildfire in history of the State and it burned for two months, so you can imagine the impacts from that were tremendous in terms of loss to tourism and recreation, businesses up in the region right near Yosemite National Park, to the schools closed a number of days because of smoke impact. Smoke impacts were felt as far away as Montana. So the event itself was amazingly damaging to the economy and the environment up there, and if you go up there now you can see just these barren hillsides that used to be covered in trees.

And so we've been working very closely with the community up in Tuolumne County where the fire occurred to think about how do we build a partnership to recover from that fire but that also joins together -- much the land that burned was owned by the U.S. Forest Service and National Park Service and then a little bit of private land, but most it was federal land. So how do build a partnership that can create economic resilience in that community, help their businesses withstand those types of events, can help us manage our forests in a more sustainable way, to minimize the

risk of the large destructive fires, that can also help us capture more water in our watersheds, prevent downstream impacts to water quality and other things. And so we've been working very closely with them. And it's tremendous the work that's going on up there already on its own and then, you know, the State is able to be working with them to try to bring it to fruition actually in response to a federal program which is the National Disaster Resilience Competition. And so it's really interesting, I think it has really spurred putting into action things we've known we need to do for decades. People have known need to manage our forests in certain ways to maximize the benefits that we have received from them, particularly in California water, critical. So, what we're actually doing now is let's figure out how we do this. How do we put it into play on the ground. Working with our private companies, with local businesses, with the Forest Service, the Park Service, the California Department of Forestry and Fire Protection, California Environmental Protection Agency, the Resources Agency, the local government. I mean, you name it people are involved and engaged.

Greg Dalton: One of the consequences is it's hard for homeowners to get property insurance up there and I want to talk about that and then get to other parts of the country where the insurance industry is starting to say, hey -- sort of sound the alarm on the risk of living the American dream if it means a nice cabin in the woods or a beachfront property. But first in Tuolumne, what is the experience with people having difficulty getting property insurance?

Louise Bedsworth: It has become more difficult. I don't think it's unique to Tuolumne County I should say. I mean the Rim Fire that occurred all up and down the Sierra Nevada in California. Just the next year in 2014 we had the King fire, wasn't as large but incredibly destructive fire. I mean, the damage to soils there was tremendous. And so we really have a whole region of our State that's critical watershed, critical for our State water supply, that is at risk. And so, you know, as we look at those communities and what we can do to try to boost resilience, insurance is a huge problem in all of those communities, of how do take on that risk. And I think there's programs in place that are helping homeowners to take action to build defensible space, to build a fire safe ways, to work together, to assist people who don't have the resources to do it themselves. But it's an ongoing challenge and one I don't think we currently have an answer to, but we'll certainly be working on.

Greg Dalton: We're talking about weather and climate change at Climate One, I'm Greg Dalton. You just heard from Louise Bedsworth, an adviser to California Governor Jerry Brown. We also have Kathy Sullivan, the administrator of NOAA and Hunter Cutting with Climate Nexus, a PR firm.

Kathy Sullivan, the number of billion-dollar severe weather events has increased. Critics might say well that's obvious, because just like a box office records the ticket prices of the cinema go up over time, so there's more property it's worth more. But how do we know that there's more economic impact from severe weather?

Kathryn Sullivan: Well true, I mean the value at risk if you will is higher. As the population grows, as our cities grow we build and develop more areas, any given natural event has more in harm's way, so you do expect the numerical value to go up over time just even because those factors. To tease out underneath that whether the statistics of the events, the frequency of certain events, is actually going up or the intensity of certain events is going up is a more subtle and challenging task. We maintain at NOAA an analysis called the Climate Extremes Index that aims to do that, and it takes a basket of indicators that get at percentage occurrences of precipitation in certain patterns, temperatures in certain patterns, and try to look across all of those to try to get underneath the symptomology of the insurance dollars and really understand and foresee what degree of frequency of change were seeing in the natural events. Again, everything about the physics of a warming atmosphere tells us we should be expecting to see more events and more extreme events. And things like the Rim Fire, our Forest Service colleagues back in D.C. are working this problem really

assiduously. They're funded and equipped to deal with a certain amount of wildfire per year and we're seeing now like seven times that sort of acreage burning fairly consistently. If you look at the thirty-year trailing average, the last couple years have been 5 to 7 times as much acreage per year burned. So that swamps the response capability of the federal government and then you get the 1% fires, like the Rim Fire or the ones in Colorado a year or so back as well. It's rare for a fire to reach that scale, the biggest fire ever on record in the State of California. But when it does the tale of the consequences are so huge.

This is another new dimension of the challenges. How we deal with those infrequent, low likelihood of occurrence but when they happen the consequence is so large because the normal preparation and insurance space is about the more likely to occur events. That's valid. But we're seeing we're exposed to more prospect of long tail events that have maybe a, you know, 1 in 20 chance of occurring. By the way you all are twice as likely to get -- that's twice as likely as any of you have a likelihood getting melanoma as Americans. So it's not that distant event. How much attention are we all paying to sun exposure and avoiding melanomas? The 1 in 20 events are twice as likely as that and we're struggling to figure out how to bring them in to our planning and preparation and our insurance calculations.

Greg Dalton: Great, more to worry about. Aren't you glad you came today?

Kathryn Sullivan: Downer alert.

Greg Dalton: Right. We're going to go to our lightning round and ask some quick questions with either yes or no answers or a fill in the blank. Kathy Sullivan, if you owned a beachfront condo in Florida you would hold it until when?

Kathryn Sullivan: Tomorrow.

Greg Dalton: Call your broker. Okay. Louise Bedsworth, if you owned a ski-in-ski-out condo in Lake Tahoe you would hold it until when?

Louise Bedsworth: Couple more decades.

Greg Dalton: Couple more decades, okay. Kathy Sullivan global warming critics are correct when they say the climate has always been changing?

Kathryn Sullivan: True. We live on a dynamic and variable planet.

Greg Dalton: Louise Bedsworth, California will be one of the best States to live as the climate gets weirder?

Louise Bedsworth: True.

Greg Dalton: Grapes of Wrath climate edition, okay. Hunter Cutting, as California's Central Valley becomes painfully hot the State should relax its rules restricting land development along the coast?

Hunter Cutting: That's a political question.

Greg Dalton: Personal value question, you're an environmentalist.

Hunter Cutting: That just seems to be borrowing from Peter to pay Paul, no.

Greg Dalton: Kathy Sullivan, if you wanted to buy a haven to protect your family from climate

disruption, where in the United States would it be?

Kathryn Sullivan: I would not focus on where I bought the haven so much as how I designed and built the haven.

Greg Dalton: I think there's some "prepper" reality TV shows for that. Hunter Cutting, where in the world would you escape from severe weather? Anywhere in the world, where would you go? Is there a safe haven somewhere that you travel internationally?

Hunter Cutting: That's a bit of a science question, but my understanding is that the further north you go, the greater the changes, so -- south but you need to -- it's so complicated! You need to avoid the expansion of the Hadley cells where we're having more drought around the mid-latitude. So I don't know if there is a good place, I think --

Kathryn Sullivan: International space station.

Hunter Cutting: There you go, exactly.

Greg Dalton: Get on the list to go to space.

Hunter Cutting: Mars. Mars.

Kathryn Sullivan: Mars comes to mind.

Greg Dalton: Get on the list to go to space with Elon Musk, SpaceX, that sort of thing. Louise Bedsworth, if you wanted to buy a haven to protect your family from climate disruption, where in California would it be?

Louise Bedsworth: Wow, I think I'm going to go -- I'm going to cop out with that answer too, and say it's going the about design and how you built it.

Greg Dalton: Some people would say it's also about the community that you're with and there is no safe place, it's what you need is functioning systems and neighbors who care about you and it's really more about community than any sort of magical place. Kathy Sullivan?

Kathryn Sullivan: So can we just put a tack on that point because we've all used the word resilience a little bit, and at least one amplification on that is really valuable to make: that always has to be three strands woven together. It's societal, it's economic and its ecological resilience. You've got to be looking at all three, you got to be weaving all three or the notion is meaningless.

Greg Dalton: Our guests today are Kathy Sullivan, the administrator of NOAA; Hunter Cutting with Climate Nexus; and Louise Bedsworth is the advisor to California Governor Jerry Brown.

I would like to talk about migration. Kathy Sullivan, do we know how weather patterns may affect migration? I interviewed someone who used to work at the Center for Disease Control; he predicted that people would move from Arizona back to Michigan, that this migration we've seen to the Sun Belt in recent decades would be reversed as Americans move towards cooler temperatures. Is that something that's on your radar at NOAA?

Kathryn Sullivan: You know a number of migration patterns are on, let me say, the national radar screen in this regard. Disease patterns are migrating. The hay fever seasons have already expanded by up to 26 days through the central and northern tier and up into the Canadian provinces. Anyone who's a gardener has watched the plant hardiness zones march north year over

year as the annual planting guides came out. A wildlife biologist can walk through a list of species that are arriving sooner, leaving later, shortened seasons. That's being observed all around the globe. Human migrations are also being observed and are very much a concern of national security officials in many, many, many countries.

There is a study just out, reported in Eclipse today, in the proceedings of the National Academy of Sciences that makes a very compelling case. It's probably the clearest case -- and this goes back to my airline accident analogy of earlier -- that the unrest we're seeing in Syria and the Middle East is at least in part -- I emphasize at least in part -- fostered or catalyzed by climate change. You have severe drought for a number of years in the rural area with increasing food security, a flood of people to cities, government cities not able to handle them and provide the basic security and well-being, weak government responses, erosion of confidence. It's a slow unraveling and climate drought is not the only factor but it contributes to that. And in the last five years there have been at least a half a dozen different studies, out of Europe, out of the Defense Science Board, out of the Marine and Military Advisory board, out of the Asean nations, raising the point that next consequence that the countries of the world need to take care of is the destabilizing of populations and the movement of people both climate refugees in large populations but also triggering kind of humanitarian responses the we maybe see after a big typhoon but having them sort of chronically happening.

Greg Dalton: And the U.S. Marines are preparing for those sorts of things. They're often the first ones in. Closer to home, American taxpayers paid about $60 billion after Hurricane Sandy. I've interviewed a couple governors who said that that cannot continue indefinitely. At some point Uncle Sam's not going to be able to bail out States after some really big storms. Kathy Sullivan, then let's hear it from Louise about California's response, but first can you anticipate these things getting so big that they break the bank?

Kathryn Sullivan: You know, it's partly -- it's a little bit how big do they get, it's a little bit how frequent. What the intensity and frequency hurricanes will be under warming is sort of right on the edge of what the science can give us insight about. But it's still that value at risk that is the net thing Americans and globally humans are concentrating coastal zones. More than 40% of the global population and a similar number of Americans live in our coastal zones, so there's more of us at risk, there's more built infrastructure, there's more economic infrastructure at risk. I think the current number of the United States is something like $39 trillion of asset value in coastal zones. Mike Bloomberg and Hank Paulson Tom Steyer in the Risky Business Project report that came out recently run the curves on out. They did their own empirical work about the economic consequence. They said by 2060 - by 2050, excuse me -- the value at risk in American coastal zones could be between 66 billion and $106 billion of asset value at risk. There's a 1 in 20 chance, again you're twice as likely get melanoma as this --

Greg Dalton: Thanks for reminding us of that.

Kathryn Sullivan: -- 1 in 20 chance that that could be $700 billion asset value at risk. A Sandy, a Katrina moving through an inopportune swath of our coastal zone could really wipe out -- I mean Andrew wiped out insurance companies in Florida. So, the reinsurance companies, the guys that insure the insurance companies, they're the guys you transfer your risk to -- they're among the folks really raising the warning signs here and trying to find ways to push on governments to price this risk more accurately and take account of it.

Greg Dalton: There's a perception that California doesn't have to worry about things so bad. We don't have hurricanes. Louise Bedsworth, are we okay in California? Maybe fires, but we don't have those bad hurricanes back east. And is California planning on a bailout from Uncle Sam if it does

happen? We've got a Governor who doesn't like taxes.

Louise Bedsworth: Right. No, I mean I don't think anyone is counting on a bailout. I think California certainly has risks. We have the rising sea levels, a tremendous amount of infrastructure along the coast in California too and in the Bay Area. You know, you can look at the maps and see our major airports at risk, our port, so we have a tremendous -- we have a lot of assets along the coast as well. We have a lot of areas at risk from wildfire, extreme heat. I think what we're really trying to do is think about how do we build and design and prepare for the risk that we face. And I think California has a good example and that we also have all these assets in the high risk seismic zones. I mean, San Francisco, Los Angeles, you know we live with risk.

And so I think we have to start thinking more about how we build future climate risk and these other risks into our planning and development. And so thinking about ensuring that you're protected from rising sea levels, you're energy efficient, you're water efficient, you're building in compact patterns that reduce stresses on the environment and that are also more resilient.

These are the types of things that we are starting to really and have been focusing on, I think, for a long time to help us mitigate that risk.

Kathryn Sullivan: Greg can I touch in one other point?

Greg Dalton: Sure, Kathy Sullivan.

Kathryn Sullivan: The acute risk, the storm, the earthquake, again those are easier for us all to focus on. In a warming atmosphere, and the National Climate Assessment as well as the Risky Business Project show that projections of temperature variations we expect to see in the Southwest for example -- many regions the American Southwest that now see days, tens of days of temperatures above 95 degrees can expect by midcentury to conceivably be seeing months -- months out of the year which temperatures remain above 95 degrees and the nighttime lows don't get so low anymore. And so there's a creeping factor to think about here too, that if you get very high daytime temperatures and not much relief at night, just labor productivity losses. Again, the Risky Business Report, you know, the Hank Paulsons and Mike Bloombergs of the world, their analysis suggests that in parts of the Midwest and the Southwest the productivity loss -- labor productivity loss and hit on our economy just from the chronic backdrop of heat could rival the productivity slowdown that was seen in the 1970's. So, you know, could we get punched in the face with a bad enough that really got a devastating economic blow, yeah; but what about also just sucking the air out of the balloon as the effectiveness of our workforce and our economy winds down because of progressive heat stress.

Greg Dalton: Hunter Cutting, bring us out of this funk, what's the upside?

Hunter Cutting: Well, one of the very interesting things I think about this whole issue is, it's actually not a scientific problem. Thanks to work of scientists we're actually pretty clear what causes global warming. I mean, they've got it down to -- I mean there's a little tiny fuzz about exactly how sensitive the atmosphere is but there's no big mysteries, so it's not a scientific problem. I'm going to think is very interesting that's also sort of become very clear in the last five years or so -- it's not an economic problem. What we're really talking about is moving our economy from a fossil fuel economy to renewable energy economy. And the cost to that is marginal at best.

What it does mean is that we're going to have to change the direction of investment in a radically new direction. But were not have to have a radically increasing scale, the amount of investment, right? In many places of this country solar power is already cost competitive at utility scale level,

and better than cost competitive, it's cheaper if you put it on your rooftop. So it's just not a huge economic challenge. But changing the direction of those investments is a huge political challenge. And so I think when we talk about it being the greatest challenge mankind has ever faced, you keep hearing that phrase all time, it's not a scientific challenge. It's not the greatest scientific challenge. It's not the greatest economic challenge. But it is a pretty significant political challenge. But one of the very interesting things I think about political challenges -- and this is actually another line that I borrowed from the scientists -- politics is what you call nonlinear, it can change on a dime. I just think recently in our own political history in the United States, I can remember it was unthinkable that we would elect an African-American as president, just wasn't even politically viable. And that happened overnight. And so I think our ability to change the politics I'm very confident about, especially when it's in our economic interest. Not just to avoid the cost of climate change but to reap that the fact that clean energy is actually the cheaper road forward. But we have to change the politics to get there. And I feel a lot more confident in our ability to do that than to solve scientific mysteries or overcome huge economic challenges, for its worth.

Greg Dalton: Kathy Sullivan, one of the episodes of the current house of cards show on HBO or actually it's on Netflix, there's a hurricane called Hurricane Faith that changes the politics in Washington D.C. So whether it's real or on TV do you see the politics prospect for changing the politics on climate in Washington?

Kathryn Sullivan: I think over time. And yes punctuation kinds of events can really speed up, really accelerate change. I do think over time it will change. I think the mounting events, mounting evidence, more and more clamor for more and more people who are experiencing different trends and changes in their home environment and their business, that are hungry for information about what's coming ahead, I think were slowly seeing that beginning to happen. I think some of the polling data even shows a shift in the general public view across the country since even 5 or 10 years ago.

Greg Dalton: One of the things that we might need to do to rise to this climate opportunity is to get more women involved in STEM -- science, technology, engineering, math. So I would like to ask the two women PhD's up here, Louise Bedsworth, how to get more women in science to work on solutions to these things.

Louise Bedsworth: Well, I think when I was an undergraduate, and I was studying this actually, and I was at MIT and one third of my class was women, in environmental engineering 50% of us were women. I take that as a good sign that were moving in the right direction.

Greg Dalton: Kathy Sullivan?

Kathryn Sullivan: I would agree that they're slow trends but very encouraging trends. And I would jump on what Hunter said. Yes we need a good scientific cadre in this country; we're a science and technology society. But to move this needle we really need a wider range of participation of science attuned and science informed people in the policy and the economic and the business arena as well.

You're not going to solve this by enriching the ghetto of science. You're going to solve this by changing the national equation on multiple fronts.

Louise Bedsworth: I would also say I think California has a very good story in terms of we have invested and it started before climate change when we started addressing air pollution ahead of -- leading the country on it. California has a really good story to show the success you can have on cleaning the environment, we have a strong economy. When we look at clean technology

investments and given all the different ways people define it, California leads on that on patenting activity. And so I do think we have very low emissions per unit of GDP and energy use per unit GDP in California. And so I think there are very positive stories that you can tell and it doesn't have to be an either/or. And I think California has shown over the last several decades you can do both. And I think as we look forward to continuing to reduce emissions to 2030 and 2050 that's the path we want to stay on in California and that's really what we're trying to drive towards as we look over the next several decades.

Greg Dalton: Louise Bedsworth is advisor to California Governor Jerry Brown. Our other guests today at Climate One Kathy Sullivan, the administrator of NOAA and Hunter Cutting with Climate Nexus, a nonprofit PR firm, I'm Greg Dalton. You can join the conversation on Twitter using our handle @climateone. We're going to take a brief break and we will be right back.

Announcer: *And now, here's a Climate One Minute.*

Hurricane Sandy was one of the most destructive of US weather events in recent years. But the rest of the country is also dealing with costly devastation, in the form of floods, drought and other weather extremes.

When former New Jersey Governor Christine Todd Whitman joined us in 2013, she talked about what lessons other states can learn from Sandy and its aftermath.

[Clip]

Christine Todd Whitman: *Even for people who want to argue over 'is it climate change' or 'do humans have an impact on it' -- at least they've got to start thinking about well, something is happening, and we've got to start preparing for it. Because part of what drives up the cost of the forest fires and of things like the floods and Superstorm Sandy is the fact that we're building in places, where we haven't built before. Particularly in states like Colorado in the west, but also along the shore, we're rebuilding in communities. They've been there for a long time. I understand how difficult it is to take on this issue, but we're going to have to look at 'should we be rebuilding in some of the places that we're rebuilding?' And if so, 'do we do it in a different way?' And that is something we're seeing the towns start to take on. The local people get it. And that's why the states are the laboratories of democracy, because governors have to deliver, and we see it happening; we have to pay for it. And so governors tend to step up where the federal government doesn't and say, "This is how we're going to address this issue.*"

Announcer: *That was former New Jersey Governor Christine Todd Whitman, speaking with Climate One in 2013. This has been a Climate One Minute – now back to Greg Dalton and his guests at The Commonwealth Club.*

Greg Dalton: We're back at Climate One, we're talking about weather and climate. Let's go to audience questions. Welcome.

Male Participant: Thank you. My name is Gary Ladshaw. I come from Cupertino which is south of here in Santa Clara Valley. Right now, the question is what can the Governor's office do to get our public servants to understand both the severity and how far we have to go. So going through should we widen this highway, put in golf courses? I mean, it's absurd in the contexts we've been talking about.

Greg Dalton: When's your boss, Louise Bedsworth, going to crack the whip on the local governments?

Louise Bedsworth: Well, I think what we're really trying to do is work to provide guidance and tools with up-to-date information to local governments. Most of those decisions fall to the city or county, a land-use decision. We've developed tools that can provide climate change information at a local level. I think more importantly -- and this is getting probably more into the weeds than most people would like -- is very soon doing a comprehensive update to the general plan guidelines, which is the guidelines every city and county follows to develop their long-term plan. They haven't been updated comprehensively in over a decade. And that's going to be coming down to cities and counties and climate change is integrated throughout that. We been working closely with other state agencies on it, you know, it's a long process of both working across our state agencies and then trying to provide information down to the local level.

Greg Dalton: So I think it's the citizens maybe more than the governor that's going to prod those local agencies. Let's go to our next question. Welcome to Climate One. Thank you for that question.

Male Participant: I have a question about adaptation versus mitigation. I know we have to adapt, but is it somewhat misleading to imagine that we can, and how far ahead are we projecting in this conversation? And I'm curious what projections NOAA's using and is there -- how much climate change is already baked into the equation? And is it -- maybe it's akin to the duck and cover of the early Cold War to tell people that we can adapt.

Greg Dalton: Kathy Sullivan?

Kathryn Sullivan: Thanks. So, the conventional usage in Washington is that mitigation speaks to mitigating or reducing CO2 emissions and slow the warming, and the aim would be avert certain temperature extremes. Adaptation, yes, I mean there's already enough shifting of the patterns and the norms that we're accustomed to in the climate sense that we have to look at adapting business practices, land use practices, to a different set of normals. I wouldn't relegate it to duck and cover status, because I think adapting and a sense of learning how to make our designs, our societies, more resilient better able to weather, better able to withstand disruptions whatever may induce them has a good prospect of mitigating the consequence of whatever we might face. So, I think it is valid to work on adaptation. At NOAA we oversee the synthesis of research that becomes the every four years national climate assessment. The last one just came out last year. And we rely on those scenarios, and globally we check those against the international scenarios that are done by the IPCC Panel. That is the best synthesis of the scientific data and the models. It's a critical synthesis. It's not a roll up your friend's science kind of thing. It really is a very demanding challenging process to confirm and vet the quality and the caliber of the science underlying these projections. They're the best we've got.

Greg Dalton: And Hunter Cutting, you think that Californians of Americans and humans are very adaptive and we are good at this?

Hunter Cutting: We are good at change. It's one of the signature characteristics of our species. It's definitely part of the American fabric and the culture is that we are very adaptable. American ingenuity is not just a buzzword it's -- you can watched the last 200 years of our history and see it in action. So I think, you know, it's a bit of a balancing act, right. We're going to have to mitigate, we have to reduce emissions to avoid catastrophic changes, and they're catastrophic. The temperature increase that we will see may not sound like much, like eight degrees may not sound like much. But that's about the amount of temperature change that we saw that ended the last Ice Age and would have crocodiles live in the Arctic. I mean, so we really don't want to go there, you know, two degrees of temperature change -- a lot of people have put that out there as safe, although you could talk to the residents of Sandy Hook and ask them if they felt it was already safe. But that we can do. We can adapt to that much. So I think we have to do both. We have to mitigate to avoid the

catastrophic and adapt to what we can't avoid. Adaptation is just going to be part of what we do now going forward in the future.

Louise Bedsworth: And I would say there are things -- it's not an either/or. There a lot of things you can do that do both, and that's really important. I mean, in California in particular water efficiency, energy efficiency, a lot of natural lands management, things like that you know. All of these activities don't fall into one column of the other and I think really focusing on trying to do these ones that will both is really important.

Greg Dalton: Geo-engineering is one idea that if this gets so bad that we ought to run for the switch on the wall, break the glass and pull the lever, and Kathy Sullivan recently the National Academies said that research should be done into possibly doing this with tampering on a global scale with the atmosphere to buy some time to deflect some heat. Your view on that?

Kathryn Sullivan: I have to disagree with the Academy on that one. I think certainly continuing to do research to understand the inter-linkages of our planetary systems yes, but I would say right now we have so little understanding of what dominos we would be knocking over as we did any of those things, and talk about spiritual and moral and other quandaries there. So I find it inconvenient to have a hurricane bearing down on Florida, I'm going to figure out a way to quash the hurricane. Hurricanes exist on the planet as a means of distributing heat and moisture through the entire atmosphere so that the atmosphere works the way it does and creates the increase the vegetation and other patterns that societies through all the latitudes and all the continents presume upon and depend upon.

So am I really entitled? Am I really entitled to turn that switch off and just glibly not care about what that does the mid-latitude water balances and mid-latitude crop production and the food security of people depending on all that? The dominos may not fall for 5 or 10 or many, many years after. Is it just, I got mine I was protected from the hurricane, I'm really happy and it doesn't matter?

Greg Dalton: There's some also some very serious governance questions about what group of humans would you trust to kind of have their hands on that kind of switch of that technology. Climate One will be doing a program coming up this spring with Ken Caldeira from Stanford and some other experts looking at hacking the climate, and that scenario and that research.

Before we wrap up here I want to ask about something we haven't touched on which is the food impacts. And Louise Bedsworth, the things we've talking about water, stress and changing temperatures can affect California's food production. What's the future of the fruit and salad bowl of the country?

Louise Bedsworth: Well certainly we have already observed changes in the climate that are affecting chill hours which is an important metric for certain tree crops that we have in California. We're seeing decline in those chill hours in the Central Valley.

Greg Dalton: Important for wine.

Louise Bedsworth: Yes. Obviously the drought has had a huge impact on agriculture as well. We see projections that show where certain grapes will move to grow in the future. So certainly without a doubt there's going to be impacts. And I think there's a lot of conversation that's been happening that's been coordinated by the Department of Food and Agriculture in California that's been very productive, engaging specialty crop farmers on this topic and a lot of investment that is going into getting a better handle on and understanding the changes and helping to create tools to support

decision making and, you how, we need to move forward to preserve that industry in California.

Greg Dalton: Kathy Sullivan, food trends in America. Are we going see corn grown up in the Arctic or Canada?

Kathryn Sullivan: The prospect is certainly there. As I said, flowering plants everybody's garden realm; we've certainly seen the plan hardiness zones grow. I'll harken back again to the Risky Business Project which just about a week ago put a second volume out focused on the Midwest and looks at the what the potential impact on crop yields might be. And again it's the disruption factor. My hometown is actually in Ohio and farmers there are already seeing rainfall pattern changes that are affecting the viability of certain crops that have long grown there. Several generations of a family could count on that location for their crop and their farming and the pattern shifting. So it's at least a disruption for that family business and concern. Maybe it helps the guys further north in Michigan. But we should not underestimate -- not underestimate the challenge of a nation, of a body politic, of a people navigating through these disruptions that touch on things like the security and reliability of your water supply, the security and reliability of your food supply. Even if numerically the economic consequence should wash out quickly, the human and social consequence, and the challenge that poses to the fabric of society I think we should just bear in mind.

Greg Dalton: As we wrap up here, we're going to end by asking each of you two things. One is what are you doing to reduce your carbon footprint yourself, it might include water in there. And also, what gives you hope? Hunter Cutting, what are you doing to reduce your carbon and what gives you hope?

Hunter Cutting: Well, I want to put solar panels on my house.

Greg Dalton: What took you so long?

Hunter Cutting: You know, it's a good question. They've gotten cheap. They've gotten dirt cheap. That's the thing. And also, quite frankly -- I know wouldn't say anything political but I just feel like the energy industry in the United States is not helping us with the changes that we need to make and so if I'm going to take some power and put the panels on my roof and produce my own power, maybe that will help change the politics from the energy sector as well.

Greg Dalton: You want to stick it to the utility, okay. And hope?

Hunter Cutting: It's cheap.

Greg Dalton: Kathy Sullivan?

Kathryn Sullivan: Both related. There are really easy victories out there. Personal energy use efficiency is a really easy victory. There's a lot of low hanging fruit, easy to gain, good practical payback terms and things like that. What gives me hope, I think the passion so many people have for earth and preserving it and the ingenuity of humankind.

Greg Dalton: Louise Bedsworth?

Louise Bedsworth: Well, I guess I'll take advantage of the good weather we have. I've really been wanting to ride my bike more than, instead of driving so do that and taking transit more than I do. In terms of hope I would say similar -- I think I've had opportunity be around a lot of California over the last year, and there's just amazing things happening in almost every community. It's very diverse and every community is unique but I was excited to see so many cool things happening. And I think just the people that are working on this topic have great ideas and a lot of enthusiasm, so

that gives me hope.

Greg Dalton: I'm Greg Dalton, I get hope when I listen to a San Francisco Giants baseball games on AM radio and I hear advertising for solar rooftop solar, which means that Joe Sixpack is getting it on solar and that's a good sign for shaping the culture. It's even better when the Giants are winning. We have to end it there. Our thanks to Louise Bedsworth, Deputy Director of the California Governor's Office of Planning and Research; Kathy Sullivan is administrator of the National Oceanic and Atmospheric Administration; and Hunter Cutting is director of Strategic Communication at Climate Nexus. You can follow the conversation on Twitter and listen to a podcast of this and other Climate One programs in the iTunes store. I would like to thank your audience here at the Commonwealth Club and on-air and online. Thanks for coming and joining us.

[Applause]

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