

Joan Kjaer: Hello, I'm Joan Kjaer from International Programs, and we're happy to have you with us for tonight's world canvas on climate science and the environment. We hope during this discussion to get a better understanding of what science has to say about the impact of climate change on the environment and what a safe, clean, sustainable planet means to the people who inhabit it.

Joan Kjaer: We're coming to you from Merge in downtown Iowa City, and thank you all for joining us. I'd like to thank our colleagues also in the Office of Outreach and Engagement, the Office of Sustainability, the College of Engineering, and the Public Policy Center for helping us promote the event.

Joan Kjaer: Environmental challenges come in all shapes and sizes. Some seem far away and intangible, while others touch us in our homes, on our farmland, in the air we breathe, and in the water we drink. We hope to learn a lot tonight, and I'm grateful to have an exceptional panel of experts, beginning with my first two guests. They are just next to me. Greg Carmichael, professor in the UI college of Engineering and co-director of the Center for Global and Regional Environmental Research. Thanks for being here today.

Greg Carmichael: Thanks Joan.

Joan Kjaer: Mm-hmm (affirmative). And at the far end, we have Gabriele Villarini, who's an associate professor in the University of Iowa College of Engineering, also the director of IIHR Hydrosience and Engineering. So, thank you Gabriele.

Gabriele Villar: Thank you.

Joan Kjaer: Mm-hmm (affirmative). Greg, could I go to you first? I'm gonna start with a very big question, just ask you to give us a big picture overview of where we are in terms of air quality globally. And then, regionally. However you'd like to get us into that.

Greg Carmichael: Well, air quality remains a tremendous problem around the world. The current estimates are about seven million avoidable deaths occur each year due to air pollution. Many of those are in the developing world, but as we learn more and more, even in Iowa city we have health impacts from air quality and any negative changes in air pollution levels has a health impact. But certainly around the world... I'm doing a lot of work these days in China and India cities, and tremendous problems. They're facing it in a very aggressive manner, and I think that bodes... It's good news. It's a hard problem, but they are taking actions to be more sustainable and, I think, trying to find solutions that are both gonna help the air quality, but also help reduce greenhouse gas emissions.

Joan Kjaer: Can you give us a little bit of an idea of some the sort of policy approaches that both India and China are taking?

Greg Carmichael: Well, I think one point I'd like to make about dealing with air quality in cities like Delhi and Beijing, there's also this aim for reducing greenhouse gas emissions. There's no silver bullet. I mean, they... India now has a national clean air program that they're just launching, and I was there last week to help think about implementation. There's 30 strategies that are all coming to be put into play and need to be put into play to make changes, and the changes are gonna take decades to see the final results from.

Joan Kjaer: Well, a moment ago you mentioned pollution, tracking pollution. If you could take us back 25, 30 years, and tell us where we were then in understanding who the polluters were, where the pollution was going, what it was doing generally to the global environment, what kind of progress have we made?

Greg Carmichael: So, we have a better understanding of the sources of pollution, and both the source of pollutions and their greenhouse gas implications. We have a much better understanding, I think, of the strategies. We have better techniques to detect pollution levels, so we don't have to rely on the measurements from a local measurement that may or may not be accurately... on purpose. Or disguised on purpose. Now we can detect from space. And so we have a lot more ways of controlling. I do think, though, that one lesson learned is... We go back to Los Angeles, you know, in the 1960's, we had higher pollution levels than any of the cities that exist today.

Joan Kjaer: Really?

Greg Carmichael: And, you know, it's taken them 60 years, and they're still in violation of our air quality standards. So, it takes time, but I think what we are seeing is that we can learn and transfer ideas more quickly. And so, it won't take Delhi 50 years, it may take them 20 years.

Joan Kjaer: Yeah, so what can you tell us about the rising temperatures on the globe? If we call it global warming, or, you know. Some of the research indicates that it seems to be just a couple of degrees. And that doesn't sound like anything to an average person, but-

Greg Carmichael: It's already... We've increased global temperatures by one degree celsius. By most projections right now, with the path we're on, we're headed about two degrees. The Paris Accord that was put into... you know, discussed as to try to limit us to two degrees? But the actions being taken won't get us there yet, but it's a step in the right direction. And what we're learning more and more is that that's the global temperature. The real science in climate change is what's happening at the regional scale now. And we're getting much better about understanding, down scaling, what will happen to the Midwest versus the global change. And in many of those regions, we're finding that right now we're on paths that might be as high as four or five degrees.

Joan Kjaer: Really?

Greg Carmichael: Changes in those regions and, you know, when get above about two degrees, you get very large changes in climate, and faster changes in climate that we can deal with. I think we'll be facing extremely difficult challenges for sustainability if we go much beyond the two degrees.

Joan Kjaer: Well, in your work with the Center for Global and Regional Environmental Research, is a lot of your work focused on the Midwest and on Iowa?

Greg Carmichael: We do have a lot of our work... A lot of our work is regional with an Iowa focus, because we live here. And we like to see impacts. But I think it's also important to point out that a lot of the research is international. And it's important for us to do that international research. I would say that we might be in the mode right now where we discount the international activities and want to take a very local view of things. And, in the case of climate and most environmental problems, that in and of itself is not enough. We really need a local, regional, and global perspective.

Joan Kjaer: Well, thanks for getting us started. I'm gonna go down to you now, Gabriele, and I ask you to tell us a little bit about your work, and then we'll focus more specifically on something called atmospheric rivers that I know you can tell us about. So, please tell us about your research.

Gabriele Villar: Yeah, my research focuses on extreme events and trying to look at extreme events as a way of understanding what causes them, so that if we understand what the drivers are, and if we can predict what the drivers are, then we're better positioned to be able to tell you what, in the future, the situation might look like. In terms of extremes, we, in my group, we focus on hard meteorological extremes. So floods, hurricanes, heavy precipitation, and atmospheric rivers.

Joan Kjaer: And, so there are some interesting articles about your work with atmospheric rivers. They look beautiful when you can kind of look at them.

Gabriele Villar: They're pretty amazing, yes, if you look at them.

Joan Kjaer: Yes, pretty amazing, but tell us what they actually are because we can't see them with the naked eye, right?

Gabriele Villar: Well, you can't just from the ground. You need some light, as Greg mentioned, in terms of air pollution. They're beautiful features of the atmosphere. So imagine, like, a hose that... Concentrated floods of water that is basically focused on specific locations. So, you have a lot of moisture, a lot of water that is dropped over very regional part of the country. Some of the work that we have done revolves around the Western, the Western U.S., the West Coast of the United States. Some of you may have heard them described in terms of the pineapple express, which basically features this element that originates in tropics close to Hawaii. And there is this moisture that is transported, the water

that is transported, from the tropics up to the mid latitudes, California, Oregon, Washington.

Gabriele Villar: They're called atmospheric rivers because, if you look at them, they look like rivers in the sky, literally. The amount of moisture that they transport is huge. Several hundred times the Mississippi River that's in Louisiana, just to give you an order of magnitude of how big they are. They're good and they're bad. You know, like with any of these kinds of events, there are positive features associated with them and negative features. The positive feature is that they are a key component of the water budget, water cycle, water resources for the Western U.S. When we hear about the snow pack and how the snow pack in much of the Sierra, much of the West Coast, has been using, it's tied to the lack of this event. They are tied to heavy rainfall events, mudslides, floods. And so that's, in a sense, a negative side, the negative implications of these events. The positive implications are the water resources, the negative are the mudslides, floods, and all the effects, all the negative effects. They're also called drought busters. So, if you think about the West Coast drought that we just are getting out of, we have been able to get out of that kind of situation because there has been a much larger frequency of these events. And so they alleviated the drought conditions.

Gabriele Villar: And Joan, just to bring it home a little bit, it's not just the West Coast, but it's also a much more Central U.S. issue as well. Most of the attention in the literature has been focused on the West Coast. They are big, and they have received a lot of attention. In the Central U.S., it's an area where we have been focusing on quite a bit. And so, if we go back to the 2008 flood event that affected all of us here, that kind of flood event was driven by the currents of multiple atmospheric rivers that transported moisture from the Gulf of Mexico into the Central U.S. That's why it's...

Joan Kjaer: Yeah. And so, I take it these rivers don't have one path. What you study is the fact that they move around... The storms land in different places, and by understanding what's happening up there, we might be able to do a better job of planning for emergencies and disasters.

Gabriele Villar: Absolutely. So there are a couple of elements that... One is that they're not static features. And, as any atmospheric event, they tend to move across the area of interest. The problem becomes if they tend to get stuck in a certain area for an extended period of time, that's where you get the deluge. That's where you get the heavy rainfall, the flooding comes with them. One of the elements that we have looked at is, why do we treat these events as being the same? So, the events that are affecting Southern California, for instance, why do we try to look at them from the same point of view, from the same perspective, as events that might affect Oregon or Washington? And so, we do carry a little bit of broader perspective and we said, let's try and see if they are any different. And if they are, why do we expect that the same drivers are responsible for their occurrences? And it turns out that they are not, they are not all the same, and they're driven by the same atmospheric phenomenon, climate condition. And

so, being able to understand what has been driving the occurrence of these events from a climatic prospective, actually has led us to a path where we can be better positioned to predict the occurrence with all the implications from a water resources management perspective and disaster preparation.

Joan Kjaer: But, in terms of removing the threat, that's beyond our control unless we can get a handle on warming oceans and greenhouse emissions and all these kinds of things? Is there any... We can do a better job of planning for the disaster. Is there a way to kind of reduce the likelihood of severe storms?

Gabriele Villar: So from this perspective, as I mentioned, they are not all negative aspects associated with these events. So, if we were to... in a hypothetical future, we were able to get rid of these events, basically it would mean a perennial drought conditions in the West Coast.

Joan Kjaer: Oh, sure.

Gabriele Villar: So it's not necessarily the... getting rid of events. It's more how do we manage when they become so extreme that would overload our water infrastructure. If you know when they're coming or you have a sense, then you can be better prepared for them. The idea that we can, to a certain extent, engineer our way out of all extreme events... it's...

Joan Kjaer: Yeah, we can't do that. So, what do you think the future holds, for the next few years here in Iowa, in terms of drought conditions or rainy conditions. Do we see patterns that are likely to... Well, can we get an idea of what we're likely to face? Or are we just sort of reliant on the winds to give us whatever they give us?

Gabriele Villar: Yeah.

Joan Kjaer: Yeah.

Greg Carmichael: I think we are getting better. I think that climate science is advancing tremendously. Like I mentioned before, regional components, the models are getting better at the regional components. We're learning more about our capability to actually attribute extreme events to climate events or not. And so our understanding of that is increasing. And what we know is that if we can reduce greenhouse gas emissions over time, that when we warm the climate, we actually increase the probability of extreme events, and so we can expect fewer extreme events in the future, and things like heat waves and others that have tremendously negative components and not positive sides. We're also moving, in a way, we're moving much more towards climate services. And so, now the meteorological services around the world are developing climate services so that we can actually give seasonal and decade-al predictions of expectations about regional impacts. Growing seasons, extreme event... And so you can actually begin to adapt and plan for these in a much better way. That's

largely being produced by, I think, a tremendous interest in moving forward from a science perspective. It's both observations, it's understanding, it's computer resources, all of those things are expanding tremendously and it's leading to a much better understanding of the climate systems.

Joan Kjaer: Well, so then I have a question about the political world we live in, because the science may tell us one thing, and informed discussion may tell us one thing, but then someone will say, well, wait a minute, the weather's always been strange. We have a few pleasant years, a few disastrous years, that's weather. That's not climate. What do we say to people who don't understand that this is-

Greg Carmichael: I think the policy horizon is one that is quite serious. I mean, we can take lots of things locally, we can act individually, lots of good things are happening, but in my mind, the climate challenge and the continued growth in the greenhouse gases is such that we really need a sense of urgency. And without national programs... There's a role for that, and it's needed. It's not just us, but India, I'll come back, you know they have tremendous air pollution problems, but their natural energy strategy is, we're gonna burn all the coal we have. And their greenhouse gas emissions are increasing tremendously. You need national policies, you need international cooperation. We still need all the local and regional, but the lack of national attention and international cooperation in this area is a serious issue in my mind.

Joan Kjaer: And what do you think, Gabriele, do you feel that there are inroads being made in public understanding of really just how very serious this is?

Gabriele Villar: (Audience laughter...) Enough said, I guess, right?

Joan Kjaer: Yeah.

Gabriele Villar: So, you know, what Greg just said is exactly right. If you look at the evidence from... Their climate models agree. Ideally, we would want to have observations of the future. Reality is we can't. And so the climate models are the best we can do, and there has been quite a bit of progress, and some of the actions, or at least the path that we have been undertaking, the point to these exacerbation of extreme conditions. Much more so if we keep moving along the same trajectory that we currently are. And so, just to frame some of the [inaudible 00:18:09] we have been getting, if you look at one and a half, two degree climate projections, the Paris Agreement that Greg just mentioned, you look at projected changes in extreme precipitation anywhere in the world, the problem is that by being able to control greenhouse gas emissions, and you're looking at extreme precip, this idea that the dry gets dry or wet gets wet are actually can be mitigated, where the dry gets wetter and the wet gets dryer, so that you are more aware [inaudible 00:18:43] gained globally.

Gabriele Villar: There have been indications, and it's consistent with what we'd expect from physics, physical processes, and the way that the response would look like.

From a climate acceptance of the public, well that's... A little bit more of a... Its a very polarized issue.

Joan Kjaer: Well, I don't know if everyone had a chance to see this today, but today when the French president, President Macron, spoke before Congress, he said, "I predict that the United States will once again join the Paris Accord." And, we'll see. So, I want to thank you both very much for taking the time to be with us this afternoon. Greg Carmichael and Gabriele Villarini, thank you. And, for all of you. Please.

Joan Kjaer: We'll take a break for a moment here and then have our second set of guests join us. I'm Joan Kjaer, this is WorldCanvass for International Programs, and we'll be back in a minute.

Joan Kjaer: Hello, and welcome to WorldCanvass from International Programs at the University of Iowa. I'm Joan Kjaer, and we're coming to you from Merge in downtown Iowa City. Our topic tonight is "Climate Science and the Environment: What's Next?"

Joan Kjaer: We turn our attention to water quality, nutrient management, and something called the "Iowa Watershed Approach" in this segment with our two guests, Craig Just, just next to me here, an assistant professor in the University of Iowa College of Engineering, and Larry Weber, a professor in the University of Iowa College of Engineering. Thanks you guys, for joining us.

Craig Just: Thank you.

Larry Weber: Thank you.

Joan Kjaer: So, I think it goes without saying, I hope it goes without saying, that Iowans value clean water, our rich soil, healthy rivers, flood control, and so on and so on, but with a variety of agricultural, rural, and urban interests--and cost, always, always an issue--it takes long term planning, a certain amount of compromise, and perhaps most importantly, a real understanding of how science can inform decision making to the benefit of our communities and citizens.

Joan Kjaer: Craig, if I can start with you, I'd like to ask you to tell us about your work related to the health and sustainability of Iowa's waterways and where you feel we are in that long process?

Craig Just: I feel it's gonna be a long process for sure. And your opening part, that, you know, not all Iowans appreciate the value of the water, and the functions of our rivers, and various ecosystem services they're in. I'm reminded of the 2008 flood that was brought up in the earlier segment, and as a potential solution to that, I think someone suggested that we just essentially pave the river so the water can move through more quickly and move out.

Craig Just: Not all ... Very few Iowans think that way, thankfully, but what it highlighted for me was the invisible ecosystem service that is inherent, embedded, in many of these waterways, rivers, streams, lakes, and other entities like that. And when they're kind of invisible like that, it's hard to bring that service to life, and how it does impact you as an Iowan, or just a citizen of the planet.

Craig Just: And so, with that in mind some of my research has been to try to make some of those ecosystem services tangible and real. And I also ... I'm thinking that it might take a long time through policy and education to restore some of our rivers and streams. I wanted to try to find a way to maybe improve their own ability to self protect, and that led me to some of my work on mussels and other things.

Joan Kjaer: Yeah, so this has been a little bit in the news in recent months. Freshwater mussels help you to clean Iowa's rivers?

Craig Just: Sure. And by the way, I highly recommend this. I got to do a gig at Hancher, and it's ... And they have beer at theirs. I would certainly, by the way, just a note to International Programs in general, it was called Science on Tap. And ... The beers are seven bucks apiece. So, that was an issue.

Craig Just: But I was able to talk about, and let's be clear, native freshwater mussels, not the zebra mussels that you hear about so often. They have a totally different life cycle, and their impact on the ecosystem's very different than the native freshwater mussels.

Craig Just: But, you know, seeing kind of the trajectory of our dialogues with respect to nutrient impacts on our surface waters here in Iowa, I wanted to do something as a researcher that could maybe make a positive impact on that, and having been introduced to freshwater mussels and what they do, as part of their ecosystem service, and just their natural lifecycle, I thought about some ways we could better quantify their value to us, and also try to find a way to bring them to life for folks.

Craig Just: They're bottom feeders. They're burrowers; they live in the bottom of these rivers, and like a healthy pocketbook mussel, for example, very large mussel, must be about the size of my hand extended. They're very ... Some of these organisms are very old, could be 50 years old. And just one of those mussels of that size can filter 10 gallons of water per day.

Craig Just: And so, they're filter feeders, and they remove particles from the water. Those particles would be algae and phytoplankton that are the result of over fertilization of our surface water. So, I thought, well, if I could somehow find a way to advocate for habitat restoration for mussels, maybe I can make a little bit of a dent in this overall problem. I'd just as soon we keep the nitrogen on the land, but until we do that a little bit better, I thought this might be one way to make an impact.

Craig Just: And so, I like to tell people in that context, that I studied how freshwater mussels eat, pee, poop, and puke, with respect to nitrogen. I know all of those things. Right? I know how much they eat. I know when they eat. I know when they sleep, and I know when they excrete. I know all those things, and then we can quantify those things and try to put that on the map. Then we advocate for habitat restoration in the midst of other things we might spend those dollars on.

Joan Kjaer: Do these ... Do these mussels you've been talking about, do they live in all Iowa's rivers or just in the river ...

Craig Just: Yeah, they're all around. And there was a recent statewide survey, which ironically led to five stream stretches that went off of the Iowa impaired list,

because they found several mussels during those surveys that they didn't know to be there. And so, for folks that think that we just keep impairing and impairing our waters, sometimes they get off the impaired list too.

Craig Just: The mussels I ... And by the way, mussels are amazing. You really should check it out. They're all shapes and sizes, big and small. As an engineer, I went for the big ones that pump a lot of water, that filter a lot of water, because I wanted to have an, again, an impact on the water column itself and the particles in there. And then, there are billions of them in the Mississippi River, for example. Billions of them, just in the upper Mississippi River. But there used to be tens of billions of them.

Craig Just: One of the things that we did to them, years ago ... It's ironic, a nice feature of plastic is that the plastic buttons replaced pearl buttons that used to be made out of mussel shells, and there were operations a hundred years ago in Muscatine and other places. In fact, you can go to the Pearl Button Museum in Muscatine, if you want to check these things out for yourself.

Craig Just: But huge barges and grappling hooks just scraping up tons of mussels and bringing them in just to kill them so you could punch holes out of them and make buttons. And then, you know, we depleted that resource, and then plastic came along, and you know, yay for plastic, in that context.

Craig Just: But nonetheless, and so we've depleted that resource. It's never really recovered. And then a modern threat to them is sedimentation. As, again, the nitrogen runs off the land, that four to five tons of soil runs off per acre off the land as well and essentially buries these mussels in place. And that's one of the major threats to their livelihood today, not to mention the fact that they need a fish host to reproduce.

Craig Just: And so, pregnant mussels have a kind of fleshy tissue that looks like a small minnow or a small fish. They attract a host fish like a perch or small mouth bass, and when that fish gets close enough, they inject their ... They spit their eggs out, and they get caught on the gills of the fish. And that's how they can move.

Craig Just: They don't swim, or you know, they don't walk very fast. They do have a muscular foot. But the only way they can spread out is through this fish host sort of an application. As that resource has also been depleted in many of our rivers and streams, their ability to procreate has been threatened as well. So, they're like the canary in the coal mines for our rivers, as far as I'm concerned. And how they go, the overall health of our rivers and streams go. And so, we're studying just for that reason alone.

Joan Kjaer: Yeah. Wow. Terrific. Well, Larry, let's move over to you. We've been talking about runoff, and agricultural implications to what happens with our waterways, and our groundwater resources, and all that. Tell us about something called the Iowa Watershed Approach.

Larry Weber: Yeah, it's a long story. I'll try to stay on task here a bit. The Iowa Watershed Approach Project is one that was funded through a joint-funded program with Housing and Urban Development and the Rockefeller Foundation, who came together a few years ago and put 500 million dollars each, or a billion dollars, into a fund to create the National Disaster Resilience Competition. It was in response largely to super storm Sandy, and the eastern seaboard states looking for another 180 million dollars of recovery funds.

Larry Weber: When they went to Congress and asked for those funds, many of the representatives from other parts of the U.S. said, "Well, what about us? We had a presidential disaster in our area as well." So, they put this program together, created a billion dollar fund, 63 jurisdictions around the U.S. applied for those funds in a pre-proposal activity. The state of Iowa was one of them.

Larry Weber: 40 were invited for full proposal development, one of those being this state. We were asked to lead the proposal development on behalf of the state of Iowa. So, we put this proposal together, and our focus there is to spend about 40 million dollars in urban infrastructure, about 40 million dollars in rural watershed protection and programs.

Larry Weber: And that watershed approach, that we call the Iowa Watershed Approach, we start with establishing a local government structure that's a watershed management authority, and established Iowa code for a few years. We have over 20 in the state now. We put sensors out in the watershed to monitor stream run-off, soil moisture, soil temperature, stream flow, water quality. Then, we work with that local government structure to create a watershed plan. So, now they have a plan that hopefully can guide them for the next 20 years. And then we spend 40 million dollars or so on these conservation practices.

Larry Weber: And so, here's where things get really exciting, because putting wetlands, arm ponds, reconnected flood plains out on the landscape, to hold that water back where it falls during heavy rainfall, reduces stream flow downstream. And working with local landowners in this Iowa Watershed Approach Project, we can provide 75 percent cost share to getting those practices built. Then we use the monitoring and some very high end modeling that we do to quantify the benefit of those practices.

Larry Weber: We do the work very locally. We target within those large watersheds, the smaller watersheds, where in each one we want to spend about a one and a half to two million dollars to really concentrate practices. We have sensors; we concentrate those practices. We can then measure the quantifiable benefit.

Larry Weber: We think that with a local governing structure, the watershed plan that gives them a vision for the next 20 years or so, the experience of building these practices and working with local landowners, the quantification of the benefit is that we can really develop some sort of long term vision for flood damage reduction, water quality improvement across the state.

Larry Weber: We're working in the eight watersheds from the far northeast in the upper Iowa watershed around Decorah, the upper [inaudible 00:11:10], the Middle Cedar as it comes into Cedar Rapids, Clear Creek just outside of Coralville, the English River around Kalona, the North Raccoon as it flows to Des Moines, and in far southwest Iowa, the East and West [00:11:23] Rivers. So, we've covered the state. We've canvassed the state, if you will, in this program, and we're working in all those geomorphic landforms. We're working with agricultural practices that vary quite a lot across that region. And so, I think we really have developed a long term vision for Iowa.

Joan Kjaer: That sounds wonderful. Are there any tough touch points? Are there any real areas of disagreement, either between an individual ... maybe a farmer who wants to do something in a certain way and the county plan, a regional plan, might suggest a different way of looking at it? Is this often rather, you know, difficult?

Larry Weber: Well, you know, I wouldn't say that it's been that difficult, in the sense that even though we have 40 million dollars of conservation that we're going to build, you know, it's a significant issue, a real challenge out there. So, we need much more funding to really be able to address this statewide.

Larry Weber: So, when we go into a watershed, and even these smaller watersheds, where we're going to spend two million dollars, you know, it is an opportunity-rich environment. There are so many opportunities for us to build these practices. We run out of funding before we run out of interests. And so, we really do have, usually, a long line, if you will, of farmers that want to come forward, learn more about the project, find out how they can get cost share to build a practice on their land, and then when we go back a few years later, we see these wetlands. We see the natural resources benefits. We see the enjoyment that the landowners have with those practices. And you know it just is something that builds off of positive experience. We really think there's a lot of value.

Larry Weber: You know, certainly issues of farmers ... You know, typically in an agricultural production, you know, they want to get water off their land as quickly as they can. But we're talking about holding it back in areas where they've seen repeated flooding. And the more we go forward in time, and the more these areas had seen repeated flood damage, the more interest there is from those producers to say, "You know what? I think I should take that land out of production. It's not really serving my agricultural enterprise very well. Maybe I can do that."

Joan Kjaer: And how is that you've determined which areas you wanted to concentrate on first, these first 20? How was it that those areas were defined?

Larry Weber: Well, you know, the areas were defined, and there's a long kind of eligibility process that HUD takes us through. I think the more interesting part for our conversation tonight is how do we determine where the practices go onto the landscape?

Larry Weber: And it's amazing the amount of data and resources we have available today. We're working in partnership with the Iowa Department of Natural Resources and Iowa State University, and they're doing a project right now across the entire state where they use aerial photogrammetry, and light air-based elevation maps of the entire state, and they're identifying every pond, every wetland, every grassed waterway, every location of all the conservation practices that exist in our landscape today.

Larry Weber: In our project we can run a model that was created by the U.S. Department of Agriculture called the Agricultural Conservation Planning Framework Tool. And so, we run this model, and it shows within that watershed, every place where a farm pond, a wetland, is viable, every place where a grass waterway could be installed, an agricultural drainage buffer, and all of the kind of practices that reduce flow and also improve water quality.

Larry Weber: What we can then do, is we can take the map that shows where all of the practices are, and the map that shows where all of the practices are possible, and then we can target landowners that don't currently have adoption of those practices. What's been kind of a validation for us is that when you look at the grassed waterways that exist, and you compare that with the grassed waterways that are possible, the saturation is close to 80 percent. So, farmers have done a really good job over the last 20 to 30 years.

Larry Weber: Go back into the 70s, and you think about the amount of soil loss we had then, much, much, much more soil than it is today. Grassed waterways have done a great job. Farmers saw that. The soil and water conservation districts, which was really the Soil Commission, began by working with landowners to hold that soil back on their land. They've done that, done a great job with it. It was all voluntary. It's how voluntary actions can really happen.

Larry Weber: But we look at wetlands and farm ponds, and saturated buffers and bioreactors, it's much different. Saturation levels out there at about one percent, perhaps two percent. So, there's an opportunity. How do we go out and get those wetlands built? How do we get those bioreactors built? How do we get the saturation, or the number of those practices, to increase and increase much more rapidly?

Joan Kjaer: And can you tell us anything about the groundwater situation, or the aquifer situation in Iowa? In a program we did some time ago, the indication was that we were ... That water doesn't come back very fast. Right? So, if we pollute the underlying waters, or if they don't get replenished, Iowa suffers.

Larry Weber: Certainly. And there are others that can speak to this much better than I can, but I would say that we have a real shortage of information about groundwater in Iowa. It's an unseen resource.

Joan Kjaer: Yeah.

Larry Weber: Sometimes unthought of. But as we tap into that water that oftentimes is hundreds of thousands or millions of years old, and we take it as a resource, and we want to use it for various municipal uses, and drinking water, of course, is a real high value use. There's certainly a need to understand that resource and understand how quickly we're depleting it.

Larry Weber: If we start using that for irrigation of agricultural lands, then you know, we start raising maybe some greater questions.

Joan Kjaer: Yeah.

Larry Weber: Or we start using it for some industrial uses, you know, at some point some of those resources will run out, and if we're not careful, we don't do the appropriate studies, we don't do the appropriate monitoring of them, we could be left in a situation where we're just simply unprepared for the eventual decline of that resource.

Joan Kjaer: Yeah. Well, as we were preparing for this program, Craig made a very important point, which was we should be talking about all of these things related to the environment, the earth, waters, and all the rest of it. But let's also talk about the impact on individual people, vulnerable populations...all of us who want to enjoy the earth as much as we can. I want to turn it to you, and tell me what you think about when you're working on these issues, Craig?

Craig Just: Well, tied to the Iowa Watershed Approach, in that project I lead our flood resilience team. And as Larry mentioned, it was part of the National Disaster Resilience Competition funded partly by HUD. And so, as part of that, HUD left us by and large to define what "resilience" means and how we were gonna operationalize the creation of more resilience in these watersheds as one of the objectives.

Craig Just: And also, since it's HUD funded there's special consideration, special requirements, for benefit to low to moderate income populations. And so, those populations are not very well defined in many ways, and so we've taken that to another level using census data and social vulnerability indicators, particularly for people ... This is research from here on campus, particularly social vulnerability indicators that represent flood risk or flood vulnerability. It could be percent poverty, percent black, percent Hispanic, percent female, head of household, those sorts indicators, and then mapping those at the census tract level, those indicators, creating a social vulnerability index that then [00:19:07] flood risk.

Craig Just: So, where you have highly vulnerable populations at a very high flood risk, that's a special place you need to be focusing resources. And most recently, I presented this to an organization called LAPAID, which is Linn Area Partners Active in Disasters. And that was formed after the 2008 flood. And the brand new ... His name's Steve. I forget his last name, but the brand new emergency

manager for Linn County just fell in love with these maps because not only does he know where the vulnerable folks are, but he knows the top three indicators on why they're vulnerable.

Craig Just: Some people just don't have cars, and you can't flee. You can't leave. And with respect to emergency management, when you want to plan for evacuations or plan for ways to respond to floods, you need to know those sorts of issues. And so, to provide a little bit of geographic granularity to their planning efforts, and their mitigation plans, and their disaster plans was ... So, he immediately booked us. So, we're going back. We're gonna train him on how to do that.

Craig Just: And I told that group, though, because if you've seen [00:20:14] Flood Information System, we map anything. We have amazing folks that do that sort of work. For us, is what we're mapping valuable? And again, my goal in this project is to literally put people on the map. I wanted ... And the other reason why I wanted to do that is as we do this mitigation planning efforts many times we optimize for the reduction of damage to buildings and their [00:20:39], just raw dollars.

Craig Just: By definition, socially vulnerable people are not valuable on the dollar scale, and so many times I'd see folks say, "Well, we don't have the data to account for benefit to low to moderate income populations, so we just won't consider that." Those people are literally on the map now. You cannot avoid the conversation as you choose your mitigation plans, and where you put some of those [00:21:06] practices, and how those benefits then get added up. Those folks are literally on the map now, and that was very important for me.

Joan Kjaer: Well, that's terrific. Yeah. Yeah. And, Larry, in the work you do, kind of thinking maybe beyond Iowa here, thinking about water resources generally, and what is faced by people around the world, are there bright spots? Do you think that there are places where really innovative ideas have been embraced?

Larry Weber: Yeah, you know, there really are, and again, a lot of the times we look to the Dutch in terms of flood protection. You know, they have a very different system than we have here in the United States.

Larry Weber: But as we really try to focus on our water quality challenge, we've also learned a lot from the Danish. And the Danish have similar nutrient-related issues, very agriculturally driven economy. They had a lot of fjords that had [00:21:58] issues, and it was affecting migratory salmon, which was a real life blood of their economy and their culture. And they've come a long way towards their water quality goals.

Larry Weber: One of the ways that I like to put it into context for Iowa, just to bring it back to Iowa for a minute, I mentioned that we work in these local, small watersheds. My estimate is that we would have to spend about three million dollars in these

watersheds for the work that we need to do on flood damage reduction. In Iowa there's 1,660 of those. Okay, so three million times 1,660 is 4.8 billion.

Joan Kjaer: Yeah.

Larry Weber: Just kind of a rough number. We'll round it up to five billion dollars. Likewise, I think we need to spend about three million dollars in each of these watersheds to achieve our water quality goals. Again, three million times 1,600, we'll round that up to five billion. So, that's a 10 billion dollar challenge ...

Joan Kjaer: Yeah.

Larry Weber: That we have in front of our state. If we tried to put that into context of a planning perspective, Iowa's watering land legacy, which would generate roughly 160 to 180 million dollars, we'll round it up for tonight to 200 million. If we take 200 million into 10 billion, that's 50 years.

Joan Kjaer: Yeah.

Larry Weber: So, imagine Iowa in 50 years, if we had roughly 200 million dollars a year to tackle these challenges. It could be a different state, like it was a different state 50 years ago before we really started addressing soil loss in Iowa. We've changed how soil comes off our land. We've done tremendous improvements there. If we could do the same thing on water quality and flood damage reduction the state could be a different state in 50 years.

Joan Kjaer: Well, you're both active teachers in the college of engineering. You work with students with bright ideas all the time and add your own. And Craig, I know that you have taken students to other countries so that they can help build wells and see the impact on a community of a new water resource. What gives you the most hope, as you see your students come through year after year after year?

Craig Just: There's some parents of some of those students in here.

Joan Kjaer: Oh yeah?

Craig Just: Yeah, I was just chatting with some of them earlier, and Facebook is real. You know they take your data. But to see these students that we're friends with, out doing their projects, some are harvesting water from fog, in areas that don't have sufficient water just to drink.

Craig Just: The other thing about that is that it does provide perspective to us all. These places where we go are always culturally rich, family centric sort of places. Time is kind of in a different dimension than it is here, and I appreciate that in many ways. And yet, some of the basic development issues that potentially [00:24:45] health outcomes and whatnot, those are those struggles there.

Craig Just: And so, the willingness to partner and the kind of friendships that get made through these interactions I think are part of the collaboration that was mentioned that was needed in the first section, the first segment here. And I think that more the collaboration, beyond the technical or any particular well that gets provided or what not, that's the thing that lasts, I think, through the lifetime of our own students as they go out and learn in these situations. And I think that's absolutely invaluable.

Joan Kjaer: Do you have anything to add, Larry?

Larry Weber: You know, one fun project that we have going on, a colleague of Craig and mine, has a project right now. And it's a really great way to engage people. And you can take these very inexpensive strips, dip it in the water, hold it up to a reference card, and you can get a rough estimate of what the nitrate concentration is.

Larry Weber: So, we have this contaminate in our water that we can't see, and so people don't really know how big of an issue it is. Now we have the ability to take that strip and put it on a credit card sized reference card, take a photo of it with your iPhone or Android device, and it does the [00:25:58] for you automatically. So, it tells you have the [inaudible 00:26:02] the concentration is, but more interestingly, it will upload it to a website and will show the GPS location on a geo-spatially referenced map that shows what that water quality concentration is.

Larry Weber: So, imagine going to the country fair, or perhaps the state fair, and handing out these little strips that cost a few pennies a strip, and a little credit card reference. And everybody seems like they have a smart phone today. We could do event-type sampling. We could do sampling that would become ubiquitous across our state and not have to rely just on these high-end 30,000 dollar per location water quality sensors. That could be a game changer.

Craig Just: Well, I'm writing a proposal now with our colleagues in Nicaragua to do just that in 750 communities so they can monitor their own water wells and do ... So, it's a leapfrog technology. You know, there's very few landlines in these places, but there's cell phones everywhere. I mean, I can get 4g internet speed in the middle of nowhere, Ghana, Nicaragua, done it multiple times, but yet they don't have some of these basic resources that we're accustomed to having. And so, we can leapfrog right over some of these issues as we develop things here that they can apply to other places, and that's a great example.

Joan Kjaer: Fantastic. Gosh. Great to have you both here. Craig Just and Larry Weber, thank you very much for being with us this afternoon. And we're gonna break here and go into our third segment in just a moment. This is WorldCanvass. I'm Joan Kjaer, and we'll be back in just a second.

Joan Kjaer: Hello. I'm Joan Kjaer from WorldCanvass and International Programs and I'm happy to have you here with us for this program tonight on climate science and the environment and in this part of the program we will really be concentrating on the last part of our program title, which is 'what's next?' Scientists, community leaders, environmental watchdogs, and others are studying the effects of climate change on the environment and are advancing new solutions by the day, but will it be enough to avoid catastrophic damage to the most vulnerable parts of our planet or a steady degradation of the air, the land and the sea?

Joan Kjaer: Our guests in this segment on global responses to environmental challenges will help us get to some of those questions. Maybe we can't provide all the answers, but we can at least ask the right questions. Our guests tonight are Jerry Anthony, associate professor in the UI School of Urban and Regional Planning. Thank you, Jerry, for being here.

Joan Kjaer: Next to him is Tyler Priest, an associate professor in the UI Department of History and the UI Department of Geographical and Sustainability Sciences. Thanks, Ty.

Tyler Priest: Thanks, Joan.

Joan Kjaer: Mm-hmm (affirmative). And at the far end we have Jerry Schnoor, professor in the University of Iowa College of Engineering and co-director of the Center for Global and Regional Environmental Research. Thank you for being here, Jerry.

Jerald Schnoor: Thanks, Joan.

Joan Kjaer: Mm-hmm (affirmative). Alright, so I'm going to start with you first ,Jerry Anthony. As we said, you're a professor in urban and regional planning, and when we look at population centers and shorelines, you have to ask, "What's being done to lower the risks?" To vulnerable populations, to homeowners, communities, economic interests, transportation, you name it. Can you give us a picture of what-- choose any part of the world you want to talk about-- and tell us what people are thinking about.

Jerry Anthony: Well, you know cities and urban areas are ground zero for a couple of different reasons, One, cities, they occupy about 2.5-3 percent of the land mass of the earth, but they account for about 2/3 of the energy consumption and about 2/3 of all greenhouse gas emissions. So in some ways they are responsible for a lot of climate change. But on the other hand, cities are what drive the economy of states and nations, so you can't get rid of cities. But, also, if you can address these issues in cities, you can address and have a big, a positive impact on climate change.

Jerry Anthony: And the good news is that a lot of mitigative efforts on climate change are happening in the cities. In countries abroad, and even in the U.S. federal

governments might kick the can down the road to the states, the states might not act, but cities have to act. Their political leaders have to act. They're responsible, and generally they have been very, very responsive. Over the years there have been many, many cities that have engaged in positive things to mitigate climate change.

Jerry Anthony: The United Nations does a sustainable cities initiative and many, many cities have signed on. Many good things are happening. They have fantastic knowledge bases. They share information with each other. There's an organization founded in 2005 called the C40 Compact of Cities, network of cities. It has 92 member cities that account for 650 million population, about 25% of the global GDP, and they've been doing amazing things and sharing information, their information. For example, Copenhagen came and set up a lab for mitigating climate change from all of the urban heat-added effect in New York. So there's that transfer of innovation happening,

Jerry Anthony: So I'm very, very optimistic that good things are gonna come. But till those good things come, there are a couple things we have to keep in mind. One is this: right now, 52-53 percent lives in urban areas, and within about 25-30 years it's going to be about 70-75 percent. We have a fantastic opportunity to build the emerging urban areas in a way that would mitigate the negative impacts of climate change. So there is a fantastic opportunity here that we must seize.

Jerry Anthony: Now, most of that opportunity is in developing countries. We must ensure the developing countries adopt urban development patterns that are much better than the development patterns that we have used in the West in the many years. And as we do these things, we must be cognizant of three things. We must be cognizant definitely of the environment, but we must ensure that as we put in these mitigated measures, they are not inequitable. And as we put in these mitigated measures, they do not compromise economic development. And it can be done, and has been done in many cities.

Joan Kjaer: So if we were to take an example of one of these cities of the future that could be built, what would be the wisest way to build one of these new cities?

Jerry Anthony: Well, there is a city of the future that does exist today. And that city is Hong Kong. Hong Kong is a very small city, population of 6 or 7 million. Way, way back in the 1970s, it decided that it would not allow development on more than 30 percent of the total land mass of the different islands that constitute the city. So they drew this line in the sand, and identified where growth will happen, identified places where growth will not happen. And by and large, they've stuck to it. And to enable a lot of people to live, they decided they're gonna build high density. When you build high density, you have an amazing thing happens. You have the residential density to provide the ridership density for public transit. So they've built a transportation system that is completely transit dependent, and not auto dependent. So they've reduced their greenhouse gas emissions very, very significantly.

Jerry Anthony: Now, when you restrict development, you have a land scarcity effect, which drives up housing prices. And how do they respond to that? By building a lot of public housing. So about 60-65 percent of the population in Hong Kong lives in subsidized housing. So the average university professor there lives in subsidized housing. And there's no stigma attached to this. Here in this country, we have a stigma attached. We have very poor people living in subsidized housing, and we have very rich people living in subsidized housing. For example, in my housing policy classes I often show a picture of the White House, because that is one of the most expensive subsidized housing units we have in the country. And so-

Joan Kjaer: So, do you see interest within national plans, outside of Hong Kong? Do you see a lot of interest in pursuing this kind of planned development?

Jerry Anthony: National plans, definitely, but I think the bigger impact is seeing it at the city level.

Joan Kjaer: Yeah.

Jerry Anthony: And we're seeing amazing things here in the city of Iowa City as well. We have seen significant improvements. For example, reducing the amount of miles traveled. Increasing the number of bicycle trips, increasing the number of walking trips. The city has a plan to reduce the greenhouse gas emissions by reducing the flaring of landfill gas.

Joan Kjaer: Of yeah.

Jerry Anthony: So, amazing things are happening in small, small cities in spite of all the rhetoric of about is there global warming or no global warming?

Joan Kjaer: Mm-hmm (affirmative)-

Jerry Anthony: Amazing things are happening in cities. So I'm very, very hopeful. That doesn't mean that we can rest on our laurels, because there are also these dark political clouds on the horizon in certain places, in certain states. And I think we are seeing trends where certain state governments are trying to reign in the powers of local governments, and they might try to do that for actions that help with reducing global warming.-

Joan Kjaer: Yeah.

Jerry Anthony: -global warming and climate change.

Joan Kjaer: Mm-hmm (affirmative). And before we move down to Ty, let me ask you a question about the rising sea levels-

Jerry Anthony: Yeah.

Joan Kjaer: -and coastal cities and are there some examples of some good actions that are being taken there?

Jerry Anthony: I can share a couple of examples from news stories from the last seven days. So about a week ago, Public Television, PBS, ran a story on the flooding that is happening around Norfolk, Virginia. That area in southeast Virginia houses about one million people and is the site of the largest naval base in the world. And because of rising sea levels, its being difficult for people to get to the naval base. What happens in the event of a defense response? People can't get to that naval base. So there is that, it's compromising a lack of adequate response to climate change and global warming is compromising our ability to protect our country.

Joan Kjaer: Wow.

Jerry Anthony: So we got to do that.

Joan Kjaer: Yeah.

Jerry Anthony: The other examples that I can say, there is an article that is just coming out in the Journal of Environmental Economics, and this is cited today in either the New York Times or The Wall Street Journal ,came out three or four days ago. This is about flooding in Miami, in the greater Miami area, and how because of persistent flooding many high end neighborhoods are losing their value.

Joan Kjaer: Oh my.

Jerry Anthony: Okay, so its starting to impact.

Joan Kjaer: Yeah, yeah.

Jerry Anthony: Its starting to impact.

Joan Kjaer: Yeah, right. Wow, thank you. Got us off to a good start there. I'm gonna bring it down to Ty now, and talk about the need to reduce greenhouse gas emissions and the prospect we have for living a fossil free future. Is there a way we can imagine our future with fewer fossil fuels?

Tyler Priest: As a historian I somehow always find myself having to comment on the future. In fact, I can barely make sense of the past-

Joan Kjaer: Yeah.

Tyler Priest: -let alone comment on the future. So, its becoming harder to live with fossil fuels, but the prospect of a fossil fuel future is almost unlivable too. That dilemma, we can't live them and we can't live without them, right? You know,

there are huge challenges that have come out of this program to reduce greenhouse gas emissions, reduce our dependence on coal, oil and gas.

Joan Kjaer: Yeah.

Tyler Priest: Fossil fuels. We can certainly, so what we need to do is attack the biggest problem, I think. To avoid despair and despondency when we look at these challenges. What can we do now? What is the biggest thing we can do as a society, through policy, through technology? And that is radically reduce our consumption of coal. We still need coal to produce steel and cement, but we can eliminate it from the power and electricity sector. Easier for us in the United States and developed countries than in places like India and China, as you've heard.

Tyler Priest: I think their energy systems will evolve in similar ways that ours have. It's hard to imagine eliminating the use of crude oil and natural gas. We just use it for too much. I can't imagine a future without oil and gas; I can imagine a future where we curtail our use of oil and gas in a way that will lead us on that path so that we try to stay under two degrees warming, or possibly three degrees warming by the end of the century.

Tyler Priest: So when you talk about our energy use, its important to look at the four different sectors, the way that we use energy. Power and electricity, transportation fuels, heat and cooling, which partially comes from electricity. We heat our homes and businesses in the United States about 50 percent with natural gas in this country. And then agriculture. The two places where the biggest, the most intensive uses of fossil fuels, are the first two. Electricity and power and transportation fuels. And the biggest strides that we have made and will continue to make are in power and electricity, and the United States is the leader. Our greenhouse gas emissions in 2017 were 800 million tons less than they were in 2005.

Tyler Priest: European Union was about the same, but they have 2 hundred million more people than we do. So on a per capita basis we reduced our CO2 emissions more than any other nation. China, in that period of time, increased their CO2 emissions by three billion tons, India has increased their CO2 emissions by one billion tons. How do we do it? We've been phasing out coal. That is the main reason, and we've done it with natural gas one, and wind power a distant second.

Tyler Priest: So as mentioned in the very first segment, there's no silver bullet. I think a lot of people tend to think that wind and solar are gonna be a silver bullet that are gonna save us from our dependence on fossil fuel, that is just simply not the case. When you look at scale, when you look at physics, when you look at economics, we can certainly phase out coal, phase in wind and solar, but the intermittency factor and the low power density of those sources of energy are going to make it very difficult. Natural gas emits 50-60 percent fewer carbon dioxide than coal, oil emits about 25 percent less carbon dioxide than coal.

When you put up a wind farm, because of the intermittency, you know people like to turn on the lights when they want, right? So you need base load power, you need peaking power, you need backup power. And the most versatile, and the least carbon intensive, source for that is natural gas.

Tyler Priest: And it's a result of the fracking revolution that we have these abundant supplies of natural gas. Fracking has its own problems. And that's an entirely different discussion which -

Joan Kjaer: We had.

Tyler Priest: -we've had in the previous WorldCanvass program. We can continue to make strides. You here about the dramatic increases in wind and solar capacity installations and the declining costs of towers and blades and photovoltaic cells, but even then, wind only accounts for six percent of our electricity generation, and solar is less than one percent.

Joan Kjaer: Mm-hmm (affirmative)

Tyler Priest: So, you know, big challenges ahead. A lot of discussion about energy storage, if we can find a way to store electricity. Elon Musk and Tesla are working on this, but the problem is the lithium ion battery. It's not, that's not the future. I mean, its helping create a market for high end electric vehicles, but a lithium ion, the cost and the weight of a lithium ion battery is 1200 pounds in the Tesla Model S.

Joan Kjaer: Yeah.

Tyler Priest: So, the biggest challenge is gonna be the transportation sector, right? And just to give you some numbers, and these are depressing numbers, but when you think about it. But we need to think about it. We can't avoid the numbers. We have 270 million registered light duty vehicles in the United States running on gasoline, we have 68 million heavy duty trucks running on diesel fuel, we have 7000 commercial airplanes, there are 7000 tankers and cargo ships and container ships that make 70,000 calls at U.S. ports every year. It's a much taller order to decarbonize that sector than it is the power and electricity sector. And instead of thinking of a fossil free future, I like to think of it in terms of de-carbonization. It gives us an achievable goal.

Tyler Priest: Fossil free future is a good aspirational goal, but its not an achievable goal in any conceivable time frame for us right now.

Joan Kjaer: Yeah. So Jerry, I'm gonna go to you for an optimistic set of conclusions to all of this. Obviously, we need to think about these tough things. You wrote a great piece in the paper the other day, Jerry, about some of the issues related to climate change, climate science, the environment, and some of the strides that have been made by certain industries. For example, you mentioned the

maritime industry on its own making some strides and reducing its pollutants. So take us into this.

Jerald Schnoor: Well that was about the shipping industry, which is a very large emitter, in fact, equal to about Germany.

Joan Kjaer: Yeah.

Jerald Schnoor: And they agreed, this month, in fact, by 2050, to reduce their emissions by 50 percent. And that was a very difficult vote actually. The shipping industry is very international, but they did. So there are some good things happening at the international and the global level. Of course, most all countries agree on what needs to be done. In fact, now that Syria has joined the Paris Climate Agreement, I think we're singular in our lack thereof, I guess that's American exceptionalism. Because we're the only ones who aren't a member of that, and that does throw a wrench into certain things. But on the other hand, maybe it energizes some other countries. China, for example, to become more a leader on the world stage. And I think the European Union, too, although they're certainly affected by Brexit and the break-up of England from the EU.

Jerald Schnoor: The agreement itself was amazing. My wife, Janna, who is here, we were actually there. I was part of the media at the Paris Climate Agreement. There were a lot of Iowans there, by the way. Our mayors were from Dubuque and Des Moines, played a very prominent role and, as Jerry Anthony said, the action is at the cities, and I would add the states and business and industry. That's where the action is, that's where innovation is occurring. That's where the real hope is.

Jerald Schnoor: So maybe the international agreement isn't quite as important, but at least we are trying to keep track of our emissions, and we are falling short even there, while all countries agreed that this is a serious problem. And all countries agreed that they would embark on a plan to reduce their emissions, and raise money for the poorest and most vulnerable and affected countries. We're falling short of even those goals. So, it's really a voluntary agreement. President Obama couldn't possibly have brought an agreement back to the Senate to try to have a formal treaty endorsed, so it is a voluntary treaty, but it's one in which we are making progress, but the promises so far are not sufficient to contain our climate to less than 2 degrees Celsius warming,

Jerald Schnoor: We're already about one degree Celsius warming. We've probably loaded the system because the climate system is sluggish, we've probably loaded the system for about another 0.6 degrees Celsius, even if we could stop all emissions tomorrow. So climate change is here already, we're going to have more climate change, we need to adapt to it, which was part of the first two segments. But we need to help stop it also. And this international agreement is an effort to do that, but on the good side the cities and the states are really where the action is taking place, and we need more action.

Joan Kjaer: Mm-hmm (affirmative).

Jerald Schnoor: Even the financing, this is where our one American exceptionalism makes a difference. We pledged three billion dollars towards a hundred billion dollars of aid for the most vulnerable countries. I believe under Obama, we paid about one billion of that three billion dollar pledge, but there's nothing else forthcoming. Thank heavens for the cities. Bloomberg paid our bill to the UN FCC, the framework convention on climate change, of 4.5 million dollars this week. He also paid one of our other pledges of 15 million dollars last year, so thank heavens for philanthropy, as well. Again, the action is at the cities. I see Mayor Throgmorton in the back. He is one of four mayors in Iowa who will join the climate mayors, including I think Dubuque and Des Moines and Iowa City and Fairfield, I think, if I'm not right.

Jerald Schnoor: So that's where the hope is, that's where the action is. I may not be quite as pessimistic as my colleague, Ty. We could talk about scenarios where we might be able to affect change a little bit faster.

Joan Kjaer: Mm-hmm (affirmative).

Jerald Schnoor: But, there's good things happening. Just because the United States isn't a part and party to the climate convention at Paris, it really doesn't matter too much. I might add that, by the way, the United States is on track to follow the Obama pledge right now, of 24-26% reduction by 2025. So we're actually on that track, and we certainly energized some other countries, so I think there's some hopeful prospects.

Joan Kjaer: So let's continue that discussion-

Tyler Priest: I'm not pessimistic. The one thing that I've found very helpful in recent years is the Obama administration's approach to a coordinated strategy to try and position the United States to meet its pledges in the Paris conference through fuel efficiency standards, and EPA auto emissions, which were combined to double the requirements for fuel efficiency standards. The clean power plan, which has kind of been over taken by events, and states are really leading the charge, and you're having places like California and the states in New England following through. Iowa was certainly on track to meet its target for the clean power plan.

Tyler Priest: And I think that despite what the current administration is trying to do, a lot of the things that Obama did are gonna hold. He did a lot with trying to limit methane emissions from fracking on public lands, and through EPA rules. The Trump administration under Scott Pruitt has been trying to roll those back, but they are going to face defeat in the courts on a lot of these things. Ryan Zinke's plan to open up the entire U.S. coast to offshore drilling is not going to go anywhere. They'll never be drilling off the coast of California. So if anything, they are shooting themselves in the foot with their policies. They are politically

stupid. If we can just reverse course in four years and get back onto the policy track that the Obama administration had placed us on, I think we are gonna make great strides.

Joan Kjaer: And one of the things you mentioned in your commentary Jerry, was that here in Iowa, jobs can come out of a new way of looking at energy.

Jerald Schnoor: We are a great example of the good things that can come. There was a famous economist, Jerry Anthony I am sure can tell us about Schumpeter, who was Harvard, Austrian born. I actually don't like his economics very well, but he coined quite a very famous term, called creative destruction, and that was the notion that if you really wanna grow the economy, what you do is wipe out whole systems and replace them with something better, and that's what we've gotta do. I tell my students the fossil fuel age, its been a good run. For more than 200 years, we've heated our homes, we've clothed ourselves, we've built our houses, but it's got to come to an end. We cannot burn even the coal, oil or natural gas which we have in proven reserve. We cannot. We have to leave it in the ground. The oil resources that Ty was talking about are about two trillion dollars, you're talking about stresses? Two trillion dollars in assets, oil companies already own in proven reserve. We can't burn it, we won't burn it. I guarantee you we will not burn it.

Jerald Schnoor: I also tell my students, coal, oil and natural gas will all be essentially phased out in their lifetime. It's already happening to the coal industry, they can't borrow money, the largest coal company, Peabody, has gone out of business, its filed chapter 12 I believe it is. And it will happen to the oil companies next. And transportation fuels are actually a very easy one to replace. When you talk about oil, you're talking about a transportation fuel problem. That one is easy to replace. We'll replace it with electric vehicles, we'll have, in fact, of the 270 million vehicles that Ty mentioned, if we put batteries in each and every one of them and connected it to the grid, that would be 660 gigawatts. Right now we have about 340 gigawatts of nuclear power. We would have about 660 gigawatts of electrical storage by going to the vehicle to grid type program. Its an obvious pathway for the future, and one which will create tons of jobs, as Elon Musk has shown us the way.

Tyler Priest: I would say, yes, I would agree that we can replace the cars with battery EVs, cars, if we find a battery that no one has yet invented. It's not going to be the lithium ion battery.

Joan Kjaer: Well, I have faith that the engineers and the thinkers and this group and elsewhere will find such a device, and we'll get there. And you're a young man, you'll still be teaching history when you can look back on these days and say, "I once promised this would never happen." Anyway, thank you so much, Jerry Schnoor, Ty Priest and Jerry Anthony, for being with us this afternoon. It was great fun to have you here.

Tyler Priest: Thank you.

Jerry Anthony: Thank you so much.

Jerald Schnoor: Thank you.

Joan Kjaer: Thank you. And that's our last program for this season. Thank you for being here, and we hope to see you next fall. Good night.