# 2016 Conference Transcription

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| Date | Thursday 31 March, 2016 |
| Session Title | Earth |
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| Moderator | Kate Chappelle |
| Speakers | Kirsty Lewis |
| Notes | n/a |

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| Intro | Hello and welcome to FutureEverything 2016 Festival Podcast Series. Over two days, in Manchester's iconic Town Hall, we task designers, artists, scientists, and many more, to rethink our resources from life, earth and intelligence, to community and uncertainty, our speakers ask what we might need less, and more of, in our near future.<br><br>How do we ensure the future of the world's food security and sustainability? Climate Security Science Manager, Kirsty Lewis, leads research into climate change and security at the Met Office, delivering advice on the impact of climate change to government, particularly in relation to defence and security. |
| Kirsty Lewis | Good afternoon everyone. I'm going to talk about climate change and security. We've heard a really exciting talk there of how we tackle some of the challenges of addressing the causes of climate change, so cutting our carbon emissions. The area that I look at as a climate scientist, is how we deal with the climate change that we are going to have to live with.<br><br>We saw ground breaking negotiations in Paris in December agreeing climate targets, around the two degrees or even one point five degree mark. Now those are very ambitious to achieve and require us to deliver a low carbon economy, but there's still quite a lot of climate change in one point five or two degrees. Really, we also need to understand what are we actually facing? Can we still have a secure future? When I talk about a secure future, I don't just mean a future of conflict and wars, I mean secure in terms of human security. So will we be able to maintain our time, our livelihoods, our wellbeing, our health, our food, our water?<br><br>As a climate scientist, my tools really are the physics, the understanding of the dynamics of the atmosphere, and also our climate models, so we produce terabytes and terabytes of data about future climates. We tend to analyse that data and interpret it from a scientific perspective, so we often talk about averages. In fact, our definition of climate change is the long term trend. So one |

thirty year period of weather, compared to another thirty year period of weather in the future and the statistics of that change, we call that climate change. But it isn't what people are going to experience. They won't experience long term average trends, they will experience the weather. We heard from Carlo a lot about climate variability, and about the kind of services we can provide in terms of predicting seasonal or short term climate extremes, but we also need to be able to understand something about how that climate weather will affect us in the long term. So that is a combination of the long term climate change trend, and that variability, and the change in that variability as well.

A good example is the global average temperature last year. 2015 was a record temperature year. It was also an El Niño year, and El Niño, generally speaking, is warmer. We'd expect an El Niño to be a little bit warmer than the global average temperature. The Pacific Ocean temperatures are warmer. That is what El Niño is. The reason it was a record year, was because on top of that, we've seen this long term trend in global average temperatures. So the temperature was warmer than average because it was an El Niño, but the average was warmer because of climate change. What people really want to know is what they actually experience the combination of the two.

As much as I love studying climate and climate change, climate variability, actually what people really want to know is what will it mean for humanity? So will we have access to enough water? Will we be able to feed the nine billion people we expect on the planet in 2050? The climate's changing, but so is everything else. We have a lot of criticism maybe, or we get challenged quite often about the uncertainty in our climate projections. We have to understand that everything else is changing; the population is changing, the economy, change of political systems, our infrastructure's all changing. If we're thinking about the world in the 2050's, the one where we're living with the climate change that we've already committed to, we have to incorporate all of those things. So it's not something that climate scientists on their own can answer. That's what my team is designed to do. The research we do is about how we work with social scientists, with engineers, with economists, with agriculturalists, to put this whole picture together, and not talk about climate change on its own, but talk about the outcomes for humanity.

I'm going to give some examples of the kind of stories, if you like. The picture we can bring together when we think about this complex system interaction. How we can use our climate change models to say something about long term future. Actually, the place that we start now is no longer really with our climate projections. We want to start with the world today. We want to start with how we live.

This is from a project I did called 'The Human Dynamics of Climate Change', and if you go to the Met Office website, you can put in the search engine 'human dynamics of climate change', and get all this information. The first thing that we did was try to source information about what the world actually looks like that will be interacting with climate.

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| | What you can see here is a map of the world today, and if I talk you through it, what you can see in purple is where we all live. The darker the purple colour, the higher the population density. In orange is water stress. These are the communities, or areas, where there is already insufficient water for human needs. This includes agriculture, industry, as well as drinking water.<br><br>On top of that, I added information about trade, which you can see a bit more if you go to the website. Essentially, I looked at the four major crops; wheat, rice, soya bean and maize, looked at where those are being grown, and where they're going to. We're in a globally interconnected world, so you may not see high impacts of climate change where you live, but the UK, for example, is importing forty percent of its food, the food that we consume, and that is growing all the time. Where are we getting that food from? You can see here, for example, that the USA is a major exporter of all four of those crops, so what happens to climate in those crop producing areas there, will affect our food security here.<br><br>I added information about fish catch, so you can see, the larger the fish, the bigger the fish take is from those oceans. So who are the communities, who are the populations that are going to be most affected by acidification, and ocean warming? There's information here about glaciers, for some areas, particularly for agriculture, the reliable use of the annual melting glacier water is important, and obviously as we heard earlier about glaciers retreating under climate change.<br><br>I marked where there are tropical cyclones. We don't have that much information about tropical cyclones changing the climate change, but we do know that the sea level is rising. So if you're on a coastal community where the sea level is rising, whatever happens to tropical cyclones, whether they increase in frequency, or perhaps maybe we think will increase in intensity, the impact is going to be greater because of the sea level rise.<br><br>I also marked down fragile states. I thought this was important, because this says something about a country's ability to adapt to extreme weather, and to adapt to climate change, and the long term trends as well. You can see hot spots really, where there's large numbers of fragile states, where really the governance is lower, and so the ability for the countries to respond is lower.<br><br>I marked down ports and airports; this is large infrastructure that can't be moved even though the climate is changing. Where all the ships are going, that's the pale green in the background, and also maritime choke points. These are quite important, because these are areas where the ships can't reroute, regardless of where storm activity or weather systems are. From this, we built up a picture. We put this together with our climate change projections. I'm going to give you two examples. One is East Asia, where we can compare and contrast with sub-Saharan in Africa.<br><br>Here's a population density for East Asia. It's huge, and it's got some of the highest population densities in the world, in this part of the globe. It's also very highly water stressed at the moment. This is just today, bear in mind. We |

haven't even started to look at climate yet. In addition to the water stress, it's also a major fishing region. This is the largest area of fish catch actually, so an important source of protein for the populations here, and a large importer of wheat and maize. I mentioned that North America, in particular, are a major exporter of both those crops, so it means that even though you might see benign or otherwise climate change in China, in particular, that doesn't mean that they won't be affected by climate change elsewhere. In fact, forty to fifty percent of globally traded soya bean is going into China, to feed pigs. So I should say Soya bean is largely an animal feed. That means that the population of China, growing in wealth, expecting to be able to eat more pork, eat more meat products, will depend on soya bean growing elsewhere in the world; largely, the America's.

They have a huge amount of infrastructure. They're trading and growing very rapidly, and that infrastructure is exposed to typhoons. Typhoon is the name we give to tropical cyclones which are [inaudible 09:07] in the pacific. One thing that is happening here, when you look at the trends, is actually the population is not really growing here. It's staying steady or is slightly decreasing in this part of the world, but overall, this is what we [inaudible 09:18] in South East Asia. So what is actually happening to the climate in this part of the world then? How will it interact with these dynamics?

In the middle here, you have the present day, as I said, to remind you of those things, and around it I'm going to show you some of the projections from our climate impact models. The icons here are the average trend, in each of these variables, in the two regions that cover East Asia, the larger the icon the bigger the change. If it's green, it means there is a positive impact and will have a positive effect on the community. If it's red it means there will be an adverse effect. So here you can see this is already a water stressed area, and what I'm showing here, is what we call run offs, so the water available from use from rainfall, after you've accounted for the fact that some of it will evaporate, and more will evaporate of course in a warmer world. So actually, it's quite a positive picture in that sense. There will be more water available for use, although they are already water stressed, so whether that's enough is another question.

However, we also looked at how much water plants will need in the future, and as the world gets warmer, plants require more water. So the demand for water is going up, even though the population is staying the same, already water stressed, but there is more water, so there's a kind of balance here.

I looked at the change in the crops that are grown in this part of the world as well. I actually looked at the soya bean, rice and wheat all show, at least on average, average yield trends going up. So again, quite a positive picture there. Unfortunately, maize and wheat in some areas going down but again this is just the average. So this is where it starts to come in with the systems. So even though on average the yield trends are going up, what about the variability? So we started looking at incidents of drought and incidents of flood which may affect crop production. Here we saw very large increases in the return periods and the duration and intensity of drought across the whole area.

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| | This is an interesting picture, because I've already just said, there will be more water available from rainfall. But the nature of that rain is what we're picking up here. There will be more water from rain, but actually it will fall in heavier, more intense periods, with longer periods without rain in between. You see that here, when I looked at the flooding. So the house is the icon that represents the information about land based flooding. This is the rain falling in more intense periods. Whether they're actually able to make use of that additional water for use depends on making infrastructure changes. Then probably, the most significant thing for this part of the world is that person icon here. This is where we calculated the number of people who will be affected by coastal flooding as a result of sea level rise if they take no additional measures to defend the coast line. This measure is in tens of millions of people along this coast line. Of course the temperature is going up, so here we looked at the heatwave.<br><br>So the story for South East Asia is about high population density, a struggle for water, but potentially options for making more water available. Possibly not a big issue with food security, although we haven't accounted for the fact that they're trading food, but certainly dealing with more variabilities. So more droughts, more floods, and large, large numbers of the population along the coast being affected by sea level rise, combined also with the potential with the health impacts of heatwaves and so on.<br><br>So because we're interested in starting with the present day conditions we can compare that to sub-Saharan Africa. This is a really different part of the world. It's got different climate change, but it's got different conditions of sensitivity as well. Here you can see the population density. There's highly dense urban areas, but actually far fewer people live here. But those people are extremely water stressed, and very high levels of food insecurity as well. They don't really catch much fish, and they don't really trade actually. So they're not in the top ten importers or exporters of any of the major crops. Largely, they're growing their own food and they're eating their own food. Although, I have to say that the proportion of imports is going up over time. They don't really have much infrastructure. No ports and airports. This is on a global scale which is relative to the rest of the world. They are exposed to tropical cyclones, again, along the East coast. The one big difference here is that there's a large number of fragile states, so this is about adaptive capacity. The levels of climate change maybe higher or lower than other parts of the world, but are they in a good enough position to prepare? Do they have the levels of governance we need? The other big thing about sub-Saharan Africa is the huge population projections. In some countries, you're looking at three to four hundred percent increase in population by the 2050s, so a very different population in the long term.<br><br>Then we can put this together with the climate projections that we looked at. Again, we looked at the water available for use from rainfall after temperature, after evaporation, and here you can see the icons are red. So these are large decreases in an already water stressed part of the world. On top of that, of course the same as we saw everywhere really, the crops need more water because it's a warmer world. So if you want to irrigate those crops, you're going to have to take more water out of the system to do so. If you do water those crops though, even then the higher temperatures mean that average yields are |

going down as a result of climate change. Again, we see that even the rain, that we do see these longer periods of droughts in between going up particularly significantly, I think, in South Africa, where they grow quite a lot of food. Again, we've got a picture of flooding. So long periods without rain and then periods of intense rainfall affecting increase in a return period of frequency of flooding everywhere. Then you can see on the West Coast and the South East Coast, people being affected by sea level rise and coastal flooding in urban communities there.

Then finally of course, the same as we see everywhere, temperatures going up, so number of hot days and heatwaves are going up. Actually, you can see that in terms of what the challenges that we face here are, these are quite different. So this is the developing part of the world where they're not really trading very much. So in some sense, they have to live with the climate change that is affecting their own country. They're not able to mitigate the risk in any way by trading as much, but on the other hand, they're not therefore exposed to climate change elsewhere.

I would encourage you to have a look at the website. We look at all the different regions, and really I've shown you what I can see from these plots, but you can look at it yourself and start to see this combination. The interaction between the sensitivities of the human systems and what our climate projections tell us about what's happening in those parts of the world.

I also want to give you an example looking specifically at food security. We've got two projects going on at the moment looking at food security. This is the one where we've worked with the World Food Programme, and again, if you go to the Met Office website and type 'food insecurity' into the search engine, we have an interactive website where you can actually look at this work that we've done. We did exactly the same in that we started with the present day. Where do people live now and where do they suffer food insecurity? Here we looked at how vulnerable those food systems are to weather shocks, so we looked at floods, droughts and storms. What you can see here is not anything about climate, although climate information is driving this, what you can see here is this compound results which basically the Met Office and the World Food Programme produced together, which says where people are vulnerable to food insecurity in the present day. You can clearly see, again, sub-Saharan Africa coming out for that. This means that they're vulnerable because they're exposed to floods, droughts and storms.

We then put this information into our climate models and we wanted to answer the question, would climate change make the situation better or worse? Can we tackle the causes of climate change and would that make it better? Can we adapt to the changes that we're already committed to and will that help food insecurity? Actually, which is more important? Is it more important that we cut carbon emissions and stop climate change worse than we're already committed to, or is it more important that we adapt? Then, can we adapt enough? So it's quite hard to see all this here, but essentially this is the present day here at the bottom. Then as you go out, you see the 2050s and the 2080s. The 2050s, all of these maps along here, so on the left hand side you can see a low emission

world. So this is essentially a one point five. The two degree world that the negotiations in Paris are aiming for. On the right hand side, you see a high emission world. This is the world where we do nothing. Then if all the fantastic action goes ahead, we just carry on emitting greenhouse gases as we have done today, and we look at what happens to food security.

We also then included, if you look at each side, there's obviously two pathways. One pathway is where we put a lot of money into investment into adapting. So adapting in this case means improving agriculture. So, for example, moving from rain fed to irrigated agriculture, improving the technology, filling in the yield gap essentially. So optimising agricultural systems so that there not so sensitive to changes in climate. It also means improving the economic output of those countries, so for developing countries bringing up their GDP, so that they have the money to buy their way out, or to buy in food, for example, when they have a climate shock.

So on the far left-hand side, we have the world where we've done both of those things. So we've adapted to climate change and we've cut greenhouse gas emissions. What you see is that world in the 2050s looks about the same as today. But why does it look the same? Why doesn't it look better if we're adapting? The reason is because we've committed already to a certain amount of climate, so in the next few decades we will see more floods, more droughts, and more storms in some of these areas. But adaptation can keep pace with that, so we see it not getting any worse. When we look at the 2080s though, we start to see climate change levels off, because we've tackled the causes of it. It's got to two degrees, it's sort of stayed there. We don't see anything worse, and we carry on putting money into adaptation and we see a better world in the future. This was the best thing about this graph, is that we actually do see a future which is better than the present. Food insecurity has gone down.

We can contrast that with all the way over to the side. We look out to the 2050s, the picture is worse than today because we've done nothing, we've just let climate change carry on. By the 2080s, it's very much worse. This is the worst case scenario on the far right. In the middle, there's a sort of combination. In the low emission world, we don't adapt to climate change, we just let it happen, and we see that even if we've tackled the causes of climate change, things get worse because we've committed, but then this steady's off. If you look at this middle, just to the left globe, that's a bit worse than the present day, but not worse than the 2050s. If you have the high emission, so the middle to the right, but you decide to adapt. So some people will say that we shouldn't be trying to tackle the causes of climate change, let's just adapt as it happens. Here you see that actually by the 2050s, things are a little bit worse than today, but adaptation has offset most of the climate change. By the time you get to the 2080s, it's worse, because adaptation cannot keep up with climate change. So that's essentially the message. If we adapt and we mitigate climate change, then we can make a better world in terms of food security for the world's poorest in the future. If we just adapt on its own, we can't keep pace with the climate change. If we just mitigate on its own, we'll still see some decrease in food insecurity, we'll still have to live with some level of climate change. So the important thing is that we do both.

The reason that this work is important in terms of the information about climate change is that actually, even though all this is driven by climate models, you can't see any information about the actual climate change. Nobody cares what the return period of the ninety nine percent of flooding is, or the average change in the number of days of drought everywhere. What they want to know is what will happen to food insecurity? The idea was to present this information to the negotiators in Paris, so that they could see what the difference is between mitigating and not mitigating, why we should be setting one point five and two degrees, and should we be putting money into adaptation?

Climate change and even food security isn't just about the world's most food insecure, which we focus on there with the World Food Programme. So I just want to finish by talking about the research that we're looking at now. We've talked about these complex systems and it's a globalised world, and we're starting to look at, is there something more we could be getting out of our climate information if we think about that globalised picture of food production?

So again, what I'm showing here, isn't climate change information. This is information about our food production system today. What I've plotted here, for each of these four main crops, which account for the majority of calories eaten around the world, is what's the minimal area that I can plot which will give me fifty percent of the global production of each of those crops? When I first plotted this, and this data is not my background, I was astounded. I couldn't believe what we could see here, is how concentrated are those food productions. This is today. So you look at maize, for example. You can see that one area in the Mid-West of the USA and the North East China plane, those two places together count for around fifty or sixty percent of global food production. If you had two weather events in those two places in the same year, you've lost half of your calories for maize. Nobody has ever asked me what the likelihood is of getting two weather events in those two places are, because I don't think people have quite understood how exposed, or how vulnerable, or sensitive our systems are to these events.

Similarly, if you look at soya bean, it's important for animal feed, as I said, and that's ninety nine percent of all soya bean that's traded is grown in the America's and you can see fifty percent in just those two areas in North and South America. Wheat is a bit more distributed, but actually, wheat is an interesting one because you can actually see what the effects of this concentration are in wheat. If you look at 2010, there was a large drought in Russia, and they lost between seventeen to twenty percent of their wheat production. The response then from the Russian government was to put in an export ban, to not export any more wheat, and they account for about ten percent of globally traded wheat. So ten percent of wheat was lost off the global market. The wheat price went through the roof. If you went back and looked at the first map I showed you, importing and exporting countries, you will see all across North Africa, countries highly dependent upon wheat import. So their wheat prices went through the roof, they had to buy it off the market, and the market didn't have sufficient amount of wheat.

So this starts [inaudible 23:19] that actually there are stories, there are patterns here, there are things happening that are sensitive to weather events. It's not all about the weather, because it wasn't just the drought in Russia, it was the response of the Russian government, but it's those combination of things interacting together that can either amplify or dampen the response of climate change, or the impact of climate change.

Then finally, if you look at rice, which accounts for fifty percent of calories consumed in the world, you can see how highly concentrated it is. As a meteorologist, you look at that and immediately I'm thinking about South Asia monsoon. I'm thinking about the annual rains that go back and forward and affect that whole area of the globe. It's all connected in similar weather systems. It's easy to understand that they can all be affected in a single year.

So I haven't talked about climate change, I'm just talking about how exposed our current systems are to weather events actually. I think this is the important point, because when I look at this, I'm working with others. So in this case, food trade experts. I'm now asking new questions of the climate science. So I'm asking questions like, what is the probability of multiple bread basket failures, of adverse weather events happening in more than one of these regions at a time. Not just anywhere in the globe, but those specific regions, and we started to look at the meteorological connections about that. Not just singularly, but across different crops together. I'm also starting to work with economists and political scientists to understand: what if one of these countries got knocked out, how the other countries will respond. Under climate change, should we be thinking about renegotiating some of our trade deals, some of our relationships with countries we trade with to ensure that we build in more resilience. It's not just about the average trend in yield. Some of these are going up under climate change, at least in the short term. It's about the variability in the weather as well.

To finish, I just want to talk about this new approach that we're trying to take to understand the climate science. We want to interpret climate projections, not from the probability of distribution, or to find an extreme event is the most unusual in the climatology, but to finding it as the biggest impact on the system. So looking at the system first and then using that to understand risk, and to plan, and build resilience. We want to start with a present day risk profile, so you saw the maps, for example, of maize production. How risky is our current food production system, just to weather and climate? We can start to build resilience. Should we be diversifying where we're growing these crops? Should we be making sure they're in areas which are not meteorologically linked? Then look at our climate change models and say, can we say something about how that will change over time? We know that the average trends are changing, but how is the variability changing as well, and are we increasing risk? Should we be starting to put in places to manage that variability and risk? You can use that to talk about strategic planning, big horizon scanning ideas.

Ultimately, it comes back to what Carlo was talking about, which is the weather and climate prediction. If we know how risky our systems are now, we know where they're going in the long term, we're in a much better position to take probabilistic seasonal advice about what is the chance in our last El Niño year,

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| | or if we see a El Niño following, what's the chance of that complex food system being hit in multiple areas? What level of risk are we facing in the next year, and how does that fit into the long term trend?<br><br>Thank you very much. |
| Outro | We hope you enjoyed Kirsty's talk and thanks for listening. You can hear the rest of the talks from 2016 at futureeverything.org/2016podcasts. |

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