

Environmental Audit Committee

Oral evidence: [Heatwaves: adapting to climate change](#), HC 826

Tuesday 24 April 2018

Ordered by the House of Commons to be published on 24 April 2018.

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Members present: Mary Creagh (Chair); Colin Clark; Geraint Davies; Mr Philip Dunne; Zac Goldsmith; Mr Robert Goodwill; Caroline Lucas; Anna McMorrin; Dr Matthew Offord; Alex Sobel.

Questions 1 - 78

Witnesses

I: Kathryn Brown, Head of Adaptation, Committee on Climate Change; Professor Michael Davies, Member of Adaptation Sub-Committee, Committee on Climate Change; and Dr Peter Stott, Science Fellow in Attribution, The Met Office Hadley Centre for Climate Science and Services.

Written evidence from witnesses:

- [Committee on Climate Change](#)
- [Met Office](#)

Examination of witnesses

Witnesses: Kathryn Brown, Professor Michael Davies and Dr Peter Stott.

Q1 Chair: Can I begin the first session of our heatwaves inquiry and welcome our three brilliant guests? No pressure. We have Professor Mike Davies, member of the Adaptation Sub-Committee of the Committee on Climate Change, and you are a Professor of Building Physics and Environment at the UCL Institute for Environmental Design; Kathryn Brown, Head of Adaptation, from the Committee on Climate Change, and leading the Secretariat's work on that; and Dr Peter Stott, Science Fellow in Attribution—this is where we are looking forward to what you have to say—from the Met Office Hadley Centre for Climate Science and Services. We are delighted to see that you were involved in the third assessment report of the IPCC, which is obviously the global climate change gold standard, so thank you very much for taking the time to be with us today.

If I could kick off by asking you, Dr Stott, what is a heatwave, technically speaking, and how do you define it?

Dr Stott: It turns out that there is not a universally-agreed definition of a heatwave. What we do at the Met Office is we have a Heat Health Watch Service, where we do have a set of definitions. Those are the ones that we use to trigger alerts to the public and those definitions vary by region of the UK to be appropriate to the sort of climate that people are used to. For example, in London that would be 30 degrees Celsius¹ maximum temperature and 18 overnight minimum temperature for two consecutive days and a night in between.

However, if we think globally, you referred to the Intergovernmental Panel on Climate Change and in the fifth assessment report, which I was involved in, we did a very comprehensive assessment of changes in climate, including extreme temperatures. As a scientific community, we came up with a number of measures to measure extreme temperatures. Among that, we concluded indeed that there has been an increase in the number of extreme temperatures, their frequency and their intensity, and we can attribute that to greenhouse gas emissions.

But there is not a universally-agreed definition of heatwaves that will apply in all circumstances to all people, because I think that is related to the nature of the impact of the heatwaves, where there is this lack of a definition.

Q2 Chair: Are you developing a meteorological definition for heatwaves?

Dr Stott: Yes. In fact, in the Met Office we are engaged in a programme of work based around consultation, a wide amount of consultation, to produce a UK definition of heatwaves. That will help us communicate

¹ The Met Office later clarified that the figure is 32, not 30, degrees Celsius.



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better to the general public when we have periods of warm weather and hot weather.

Q3 **Chair:** When will that be ready?

Dr Stott: We are hoping that it will be ready in time for this summer.

Q4 **Chair:** Was it a heatwave last week?

Dr Stott: We are calling that a hot spell. We had, as you well know, some very warm—anomalously warm—temperatures. We did not quite break the record of warm temperatures. It was 29.1 degrees, I think, on 19 April at St James's Park. That was just below the all-time record for April temperatures, which was recorded at 29.4. These are extremely unusual temperatures for April, but when we think of heatwaves, then we are thinking of the hot season and we are thinking of temperatures, as I was referring to earlier, up in the 30s. So an extremely hot spell for April, but for the high summer, not what we use to trigger a heat watch system.

Q5 **Chair:** Do you think that the lack of a concrete definition of a heatwave is an obstacle to public understanding and media understanding of and a lack of concern about heatwaves? Because basically a hot spell comes and everyone is like, "Oh good, shorts on, ice creams out, factor 50. Let's hit the beach". There is no narrative about, "Look after your older people; look after your babies". None of that percolates into the consciousness, does it?

Dr Stott: Just two points to make on that. What I would say is that, as I have discussed, our Heat Health Watch Service does have clear triggers and those are designed to make sure that when we put out the alerts that there is a clear definition there. There is a clear system in place that the Met Office is involved in, clearly as a key player, to make sure that those alerts go out. There is a whole set of levels and a system behind that. That is the first point.

Having said that, the Met Office is keen to improve, for the reasons you have elucidated, our communication, which is why we have set in train this process, to have a clearer way of defining heatwaves and indeed hot spells throughout the year and a clear way of communicating that, which is why we are doing this and planning to release that in time for this summer.

Q6 **Chair:** What is the difference between a hot spell and a heatwave then?

Dr Stott: A heatwave is, in terms of the Heat Health Watch Service, only during the hot season, from 1 June to 15 September, and therefore it is only when you reach these triggers that I have talked about. The reason we are calling the April weather a hot spell is because it did not reach those triggers and it was not in the hot summer season, but for the time of year, it was very anomalously warm for April.

Q7 **Chair:** How far in advance can you predict a heatwave? Is it like five to



10 days?

Dr Stott: Yes, basically. Weather forecasting has been improving all the time and the skill of the Met Office forecasts is continually improving, thanks to the investment that we have been able to make in our computers and our weather forecasting models. It tends to be of the order of five or six days. We can get longer lead times than that, depending on the particular situation. There can be occasions when, because of the unique nature of the evolving meteorology, it can be particularly tricky to forecast, but we have very good skill at those sorts of lead times.

Q8 **Chair:** Do we have a definitive list of previous UK heatwaves?

Dr Stott: Again, we get back to the question of the definition, but what we do at the Met Office, we have a list available on our website of notable warm periods. We have analyses there and descriptions, so this includes a period in June 2017, which was the most recent one, September 2016, and a whole variety of events are described there in some detail, going back to the very notable and impactful summer heatwave of 2003, which is in there as well.

Q9 **Chair:** Can I turn to you, Ms Brown? Do you think that heatwaves are taken as seriously as other climate risks, such as flooding? Can I ask you all to sit forward as well, because otherwise the mics will not pick you up? Thank you.

Kathryn Brown: We have looked at this as part of the analysis that the committee have done for the climate change risk assessment and for our progress reports to Parliament on the National Adaptation Programme. The simple answer is no, we do not think they are taken as seriously. Some of the statistics we have collected from research that DEFRA has done, which was based on a study of public awareness of different types of weather events and whether they had changed over the course of the last 10, 15 years and whether they would change in the future, only 10% of people thought temperatures had increased over the last 20 years, whereas we know that they have, and only 29% thought that the climate was going to get warmer in the future. More people from that study thought it was going to get colder rather than hotter.

That study was done during the winter, so it could be that the local conditions at the time were influencing the responses that were collected. It would be interesting to do another study like that in the summer, but we think that is fairly compelling evidence that this is a fairly hidden risk.

Q10 **Chair:** Going back to that European heatwave, the 2003 heatwave, we had over 2,000 heat-related deaths, mortality increased by 33% in the over-75s and by 13.5% in the under-75s during that 10-day heatwave. Deaths at home increased by a third; deaths in nursing homes up by 42%, so very serious impacts. Obviously it was a tragedy for those people, but compared to France, it was the warmest for up to 500 years. In France there were 15,000 deaths and 65% of those deaths were



women. Why were women particularly impacted in that event?

Kathryn Brown: I do not know the answer to that, but there have been quite a few studies that have looked at that mortality impact, because it was so severe, particularly in and around Paris, if I remember rightly. What I have read before, which again we have used in the risk assessment, is about the vulnerability of people living in attic apartments, of which there are a lot of those in Paris, I think, and particularly you tend to get higher populations of elderly people living in that sort of accommodation. I have seen papers certainly that have looked at that impact, but why there was a male/female split, I am not too sure. I do not know if you have any information on that, Mike.

Professor Davies: I think it was also vulnerable people in terms of living without support. It may be there is a link there with that.

Q11 **Chair:** It was very gendered. That is why I am asking. Do you think women are more vulnerable in heatwaves in this country? Have we done a gender analysis of the 2,000 people that died in this country?

Kathryn Brown: I have not seen any analysis of the 2003 heatwave, but we do have papers that look at that gender split that we can send you to have a look at.

Chair: Could you?

Kathryn Brown: Yes.

Chair: Professor Davies, anything to add?

Professor Davies: Just one point. The inquiry is about heatwaves, but I think we all know the impacts of heat are not just limited to periods of heatwaves and that while heatwaves can lead to rapid increases in mortality, owing to the relative infrequency of heatwaves, it is normal periods of warm weather in summer that contribute to a greater burden of heat-related mortality. The greatest burden of heat mortality is outside of heatwave periods.

Q12 **Chair:** It is just from warm weather?

Professor Davies: Yes, so the threshold that we observe for when people start dying of heat-related issues is below the threshold for heatwaves.

Q13 **Chair:** When do people start dying, at what temperature?

Professor Davies: It varies between cities and countries. In London, in terms of maximum temperature, it is around 24.7 degrees and for mean daily temperature it would be, I think, just under 20 degrees for London. The temperatures are lower for the cities in the UK. For a maximum temperature of 24.7—it is 24 something—it is below the threshold, as we have heard, for the heatwave.

Q14 **Chair:** Could you send us the city maps, the city temperature maps?



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Professor Davies: Yes. There are studies, which I think colleagues at the London School of Hygiene & Tropical Medicine led on. That has been done for the UK; it has also been done for a set of international cities too, which I think is a useful comparison between cities, so you still see the increased risk of mortality and for heat and cold in most international cities. But these threshold temperatures are different and in terms of how people and cities have adapted, that temperature would be higher in Athens, for example, than it would be London.

Q15 **Chair:** Ms Brown, we obviously had a lower mortality rate during the 2006 Heat Health Watch Service. We had 680 excess deaths, which was much lower than August 2003. Do you think that the Heat Health Watch Service that Dr Stott talked to us about, is that the cause of that or do you think there is public awareness or is that just good luck?

Kathryn Brown: We do not really know at the moment is the answer to that. PHE are doing a review of the Heatwave Plan at the moment, which is meant to publish later this year, which is looking at that question, because in 2013 the mortality was even lower than in 2006; I think it was in the low hundreds. Obviously all of those were different events. The 2003 heatwave was a different kind of event to 2006 and 2013, but colleagues at London School of Hygiene and PHE will try to estimate what they think the mortality burden would be and then they look to see whether the statistics match that or not. Certainly for 2013 there was a much lower mortality rate than they had estimated and the review of the Heatwave Plan is looking at whether that plan had any impact on that or whether it was another reason.

Professor Davies: It could also be related to the periods of time above these thresholds as well.

Q16 **Colin Clark:** Is there any evidence of a pattern of heatwaves in the UK and how has this changed over time?

Dr Stott: There is evidence on that, yes. That is consistent with the global picture. I worked on the Intergovernmental Panel on Climate Change and we have seen very clearly the evidence that has led us to conclude that human influence on the climate system is clear. But within the UK we have seen the general warming of temperatures, and with that, we have seen a warming of extreme temperatures. If we look at the period from 1961 to present, we have seen larger increases in the highest temperatures in the south-east of England than in northern UK. We have seen an increase in the highest maximum temperature, so that is basically the hottest day of the year, of about 1.5 degrees in south-east England. It is less in northern Scotland, 0.3 degrees. That is a change that we have seen just from 1961 to present.

Q17 **Colin Clark:** If I can ask a supplementary, obviously being from a Scottish constituency, we have seen our springs get warmer and our summers get probably slightly cooler. Is there any explanation of why the south-east of England and the north of the country is not seeing such a



marked change, apart from it is obviously cooler in the north-east of Scotland? Wouldn't you expect to see the same increase?

Dr Stott: I think it is that the south-east of England has, generally speaking, a more continental type of climate and the north-west of the country is more moderated by the ocean. That maps then on to how climate change impacts the country. There is an impact of climate change throughout the country, but it is moderated in the north-west by the ocean.

Q18 **Colin Clark:** That makes sense. How does the potential of warming above 2 degrees impact projections of heatwaves and is there a warming tipping point at which heatwaves become a much more significant risk to the UK?

Dr Stott: It is the case that the impacts of warming become increasingly more significant as we go above 2 degrees and that of course is behind the Paris Climate Agreement to keep temperatures well below 2 degrees relative to pre-industrial levels. We have worked with a project called HELIX, which has been a project under EU funding to look at the impacts of warming, at different levels of warming. What it has done is it has compared, for example, the 2 degrees warming level relative to pre-industrial with 4 degrees. Again, if we look at the hottest day of the year, if you go to 4 degrees global warming, the hottest day of the year in the UK increases by between 5.2 and 5.8 degrees. You can see it is higher than the global warming level.

That is a well-recognised phenomenon of global warming, that warming over land is faster than the global average, so we need to remember that when we think about these numbers. Can I identify a clear tipping point between 2 and 4 degrees where there is a qualitative change? No, but I think what you seeing is a ramping up of increasing risk as a result of that. If you think what 5 degrees or more means on top of the hottest day already, then you can get a sense of the impact of that.

Colin Clark: Would anybody else like to comment on those points?

Kathryn Brown: Just in terms of heatwave intensity with average warming, one of the studies that the Met Office did—which we use when we are looking at the climate change risk assessment—was estimating heatwave intensity of an increase between 1.5 and 7.5 degrees for a 2 degree rise in global temperature, so there is quite a big uncertainty range around that as well. From what I understand, a lot of it is to do with the assumptions around soil drying, which we may come back to, because we know you are interested in talking about drought as well and how that impacts with heatwaves.

The uncertainty goes up the more extreme in terms of the temperature events that you are looking at. When you are starting to look at heatwave intensity, it is quite difficult to project that forward.



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Dr Stott: That is a very good point, that when we think about the risks of climate change, many of those scientific uncertainties project on to the worst risk, that is correct.

Q19 **Colin Clark:** Coming from my culture, I remember 1976 and the soil splitting open for metres down into the clay and crops burning. I cannot remember since 1976 the same sort of trauma for agricultural production. Which is more of a threat, more frequent but relatively short heatwaves, or less frequent and longer heatwaves, like 1976?

Kathryn Brown: What we have said in previous reports is that it is the variation that is really the health impact, because you do get physiological adaptation, so people will adapt to their average temperature in a country, which is why you see different populations in different countries have adapted to very different temperature ranges. What we are concerned about, I guess, in the future is that the temperature variability is going to go up, because you would expect with patterns of warming that there is going to be more extreme weather and a more variable climate. Because people might not be adapted—this is the same with cold extremes as it is with heat extremes—you will get bigger impacts because of that variability. That does not quite answer your question in terms of which is the more dangerous. I have not seen any analysis that looks at that question specifically.

Dr Stott: I suspect the answer depends also on the sort of impacts you are thinking of as to that.

Q20 **Colin Clark:** Yes, it is the extreme. I suppose it is the longevity of drought and a heatwave as opposed to the high heats that we get from time to time, which aren't necessarily sustained.

Kathryn Brown: The other work we have used in the risk assessment is we are looking at how people adapt through a heatwave. The biggest impact on mortality tends to occur at the beginning of a heatwave and then you do find people starting to adapt. Public Health England will be able to give you some good evidence on that.

Professor Davies: Just on timescales, we have people adapting, but adapting the built environment itself takes a long time. It needs time and planning to put that into process if we are to adapt our cities and buildings to a changing climate. It is something that needs long-term planning, because it is not a quick fix necessarily.

Q21 **Colin Clark:** A question specifically to the Met Office: your research found that the likelihood of the 2003 European heatwave was at least doubled by human influence. How do you isolate and account for the impact of human activities when predicting the likelihood of a heatwave?

Dr Stott: This was work that I led and published in 2004. What we do is we use our climate models to basically compare conditions that we have and we had in 2003 with the conditions that we would have had had we not changed the climate. We can do that because we can reduce the



greenhouse concentrations to pre-industrial levels and then we can run our climate models and compare. Within those models, even without having increased greenhouse gas concentrations, even without human activities, there would still have been variations in the weather, there would have still have been heatwaves, there would still have been occasions with exceptionally unusual temperatures, like in 2003. But what we showed—and it was the first study to make that link between unusual weather and climate change—with very high confidence, which has been borne out by subsequent research, is that there was a significant increase in the likelihood of such a heatwave as we saw in 2003. We were very confident that it was at least more than doubled.

We have published work since then. We updated that study a couple of years ago and we showed both that the projections that we had made then had been borne by reality in terms of what had happened since, but also that the chances of such extreme temperatures throughout Europe—not just in the UK, but looking throughout Europe—had increased by a factor of 10 in the intervening period since 2003 to now.

Q22 Chair: Do you have a more granular breakdown of that? Because that sounds like almost exponential risk, if it is increasing by a factor of 10 over 15 years. Do you think it is going to increase by another factor of 10 over the next 15 years or don't you know?

Dr Stott: Back in the 2004 paper, we projected forward to the middle part of this century. Just to be very clear here, we were looking at temperatures over a large part of continental Europe over the entire summer, but what we showed there is that by the middle of this century, we would expect such large-scale temperature anomalies, as we call it, such large-scale temperature escalations, to become a regular occurrence. Within that, then it is about how that maps on to the UK or individual places. That is another step, if you like, but that is the way that a continuing warming of temperatures and continuing greenhouse gas emissions maps on to extreme temperatures. It is a multiplying risk factor, effectively.

Chair: Sobering thought. Zac.

Q23 Zac Goldsmith: Thank you very much. We were told by the Tyndall Centre that even under a low-emission scenario, the number of days at 27 degrees per year will increase from eight to 25, and under a high-emission scenario, that will lead to around 50. Do you share that view and is that research that you endorse?

Dr Stott: I am sure I would endorse it. I am just mentally going through the numbers. As a scientist, I want to just check back exactly on those numbers.

Zac Goldsmith: Eight to 25 under low emission, eight to 50 under a high-emission scenario. A gigantic increase either way is what they are predicting.



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Dr Stott: Yes, we are seeing large numbers. Yes, I would agree with that.

- Q24 **Zac Goldsmith:** Someone has already mentioned the HELIX project; I forget who it was who mentioned it. The HELIX project believe that the UK daily minimum temperature is expected to warm more than the global average. I know you touched on this in your answer to Colin, but can you elaborate on that? Why would we be disproportionately affected?

Dr Stott: I did touch on that, that is right, and that is a good question. The global average of course is an average over the entire globe, over both the land and the oceans. One of the main fingerprints, as I have researched for many years, of climate change is the fact that land is warming faster than oceans. The basic reason for that is the cooling nature of the water in the oceans, the fact that you have this evaporative cooling capacity of the oceans and that changes the energy balance in a different way over the oceans than it does over the land. Therefore we do see land warming faster than oceans. The UK shares in that, and particularly when we have heatwaves or when we have hot spells, as we saw just recently, we are basically then sharing in very much a continental type of weather pattern, basically we are sharing in the land signature, if you like. That is why we are seeing faster increases in the UK over land than we are as a global average.

- Q25 **Zac Goldsmith:** The UK daily minimum temperature, the projected rises, how do you translate that into projections in relation to the heatwaves? What is the link there? How does that work?

Dr Stott: If you think of the UK daily minimum temperatures, that is one of these indices, as we call them, that we use to look at how extremes are changing, for example, the warmest—or indeed, the coldest—daily minimum throughout the year. That is an index of change and you can see how that tracks. That is one measure, but another measure, as we touched on already, is the duration. If you are looking at the duration of a heatwave, you would then want to track how often the daily minimum, the night-time minimum temperature stays above a certain level, for example, and that will give you one measure of heatwave. That has an impact of course on health, because it is often the fact that temperatures do not drop below a level for several nights in a row, which as we saw in 2003 had a very adverse effect on people.

- Q26 **Zac Goldsmith:** We will be focusing—we have already been focusing today and we will continue to focus—on the significant risks associated with these projects that we are discussing, but there must also be opportunities there in relation to tourism and various other aspects of human activity here. The first question is are you looking enough at those opportunities? Can you map out and describe what you see as those opportunities?

Professor Davies: Whether you would call it an opportunity, but before Kathryn goes on in further detail, there would be—not as a result of



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heatwaves per se, but general warming—a predicted reduction in cold-related deaths. That was not quite your question, but I think it is something we should be—

Q27 Zac Goldsmith: The Chair was talking about deaths as a result of a heatwave, but presumably there are many more deaths as a result of people dying of cold.

Professor Davies: I think the best estimates at the moment are around 40,000 per year, as opposed to 2,000 for heat, so there is an order of magnitude. I think the best estimates at the moment are that by 2050, the 2,000 heat-related deaths might increase to around 7,000, but there would be a reduction in the cold-related deaths, but it would be relatively small, perhaps by 1,000, about 2%. That is in part at least to do with the population increases and also the ageing population. You would see some reduction in cold-related deaths.

Q28 Zac Goldsmith: Do you have figures in relation to that?

Professor Davies: Yes. I can point you to studies, relatively recent work, which has made those comparisons between the trade-offs between heat and cold-related mortality.

Q29 Zac Goldsmith: I would be very interested if we could see them at some point. Not now, obviously, but afterwards.

The broader opportunities in terms of our economic activity, what would you see as the bits to look out for?

Kathryn Brown: I had already mentioned the CCC prepares the UK climate change risk assessment, or it prepared the last one, which was published in 2016 and we are just in the beginning stages of preparing the next one for the Government. We look at opportunities in that as well as threats. What we did with the second CCRA, which was the one that was published in 2016, it was really a literature review, so we were looking at all the evidence for opportunities.

There is very little published evidence for the UK on opportunities, but there are quite a few studies from other countries that look at things like increased outdoor activity, increased active transport and different types of commercial opportunities and tourism is one of those. There is an index that tourism boards tend to use a lot, which is about thermal comfort. The UK looks comparatively favourable compared to other Mediterranean countries obviously into the future if you use that index. They are not very well-quantified, these impacts. Compared to the number of studies on threats, there are not as many studies on opportunities.

Q30 Zac Goldsmith: Who should be doing that work though in terms of looking at the opportunities with the increased exposure to the outdoors and possibly mental health implications for that? Is that work that your committee will be doing or is that something that another organisation is



taking the lead on?

Kathryn Brown: We do not generally fund that kind of research because we do not have the resources to do so, but one thing we do in between each cycle of the CCRA, the risk assessment, is to have discussions with the research councils, with the Government Office of Science, with BEIS and with DEFRA about where the research gaps are that need to be filled in between each CCRA and the opportunities from heat was definitely one of those. Every five years we collate all of the evidence that has been done in between, so that opportunity is definitely in there, yes.

Q31 **Caroline Lucas:** This is the first time that the Adaptation Sub-Committee has produced an evidence report to support the Government's climate change risk assessment. I wanted to ask what improvements you are setting out to make on the 2012 evidence that was produced by a DEFRA working group.

Kathryn Brown: The methods between the first and second CCRAs were different. The first risk assessment was very much starting with the UK climate projects, which are produced by the Met Office, and scaling those into different types of impacts over time for different emissions scenarios. The first CCRA looked very much like an analytical exercise that was scaling impacts. That is very helpful in trying to compare different risks and opportunities against each other because you are using the same assumptions, but what we found was it was difficult to bring in other types of evidence that are just as valid, which may be based on other types of projections or other studies.

The second risk assessment we deliberately took much more of a literature review approach, partly because we had fewer resources to do it as well and it is a cheaper exercise. The first thing is we were able to bring in a lot more evidence than maybe we could for the first CCRA. We went a bit further in looking at aspects of the indoor built environment; Mike was one of the contributing authors for that chapter. We looked more at urban heat islands and the latest evidence on how that may change and whether it has changed already and whether that might change in the future. We did more on opportunities. There was a little bit of that in the first CCRA, but not as much.

We looked more at overheating on public transport, which was not really looked at in detail in the first CCRA, although that one did look at increased cooling demand, which is another interesting aspect of air-conditioning demand in the future. I would say those were the main things, but there were also a lot of gaps in the second CCRA. I have a long list of those.

Q32 **Caroline Lucas:** Was it relevant to bring in the assumptions of the potential of a 4 degree rise? Is that something that was different between the two assessments? Because I noticed that in some of the evidence that we have that the sub-committee noted that there remains at least a small chance of a 4 degree rise by the end of the century.



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Kathryn Brown: Yes, that is right. Both risk assessments looked between a low-emission scenario, which is hovering around 2 degrees, up to what we call high emissions, which is approaching 4 degrees. CCRA 2, the heat-related mortality estimates were between about a 0.5 degree and 3.75 degree rise. That is what the studies that we had available were based on. CCRA 1 was very similar, so the range that we looked at was very similar.

Q33 **Caroline Lucas:** Has there been more evidence in the time between the two assessments of the potential for a 4 degree rise?

Kathryn Brown: No, I would not say there has been.

Q34 **Caroline Lucas:** That is interesting. Have the Government completed the action points in the 2013 adaptation programme related to heatwaves? Has progress been made and how is it being measured?

Kathryn Brown: Most of the actions related to heat from the 2013 NAP were completed. Some of them were ongoing actions. For example, there was one about continuously looking at the Heatwave Plan, updating it over time and including more information in it. Obviously we cannot say that is complete, because it is still ongoing. All of the actions that had deadlines were completed, so the way we assess progress of those actions in the ASC is to ask three questions for each area. For heat-related impacts, we would look at whether we think there are plans in place that deal with the impact of climate change, whether the actions that were signed up to as part of the NAP were completed, so is action taking place?

Then the third question, which is probably the most important, is any of that having an impact on vulnerability to climate risks? We very deliberately look at the vulnerability to the risk rather than the impact from the risk itself, because obviously you get a lot of variability for other reasons through time. We use a series of indicators of exposure, vulnerability and action to assess whether we think vulnerability is changing or not as a result of the NAP.

Q35 **Caroline Lucas:** Some of the evidence that we received in a written form was quite critical, basically saying that the first NAP was a list of activities that were either already planned, already being delivered; it was basically just a list rather than addressing the things that might be more easy to measure in your third category. Is that a fair criticism, do you think?

Kathryn Brown: To some extent, yes. When DEFRA were preparing the first NAP, they were fairly limited in what they could do by way of new policy announcements, so a lot of it was a collection of what was already happening. I am sure they will talk to you about that when you have them in for evidence.

What I would say is the things that we think are the most important on dealing with the effects of heat were not included in the first NAP. The ASC has recommended every year since we have been looking at this



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issue that we think a standard or a regulation on overheating in new homes is required. We can get into the detail of that a bit more, if you like. We have also fairly strongly stated that with existing homes and other types of buildings, hospitals, schools, prisons, workplaces, that more needs to be done to assess and then take action to reduce the risk. There is quite a lot of evidence that we have that there is a risk and that it appears that it is not being managed in a lot of cases at the moment.

Q36 Caroline Lucas: Did you say that that was not reflected in the first plan, even though that was evidence that you submitted?

Kathryn Brown: That was our assessment of the first NAP, so that was after it was published.

Caroline Lucas: Do you want to add to that?

Professor Davies: There was a general point as well, a recommendation to try to ensure that objectives are outcome-focused and measurable and time bound and have clear ownership. I think that is a strong general recommendation—not just for those two areas—that the committee has made.

Q37 Caroline Lucas: You have touched on this already, but how could the Government make the action points to address heatwaves in the forthcoming programme more effective? Is there anything more you would say on that?

Kathryn Brown: It is in relation to the recommendations we have already given, our assessment of the first NAP, so to look much more carefully at a standard or a regulation on overheating in new homes, to do more work—which is either research or survey-type exercises—to assess what is happening in hospitals, care homes, schools et cetera and then to take action to manage that risk better where it is not being managed.

We have looked in the past as well about trends in urban green space, so that is another one of the indicators that we are concerned about, because there has been a drop in the overall percentage of urban areas that are covered by green space since 2001, although that has levelled off in the last five-year period. We did not make a recommendation on that in our most recent report in 2017, but it is one that we keep looking at as well.

Professor Davies: On that point of green space, the Mayor's Office, in their new draft London Environment Strategy, has a target to increase the green space in London from 47% to 50%, so there is some commitment at a city level anyway.

Q38 Chair: Can I ask a couple of very quick follow-ups on that? The Zero Carbon Housing standard, did that include an overheating measure, the standard that was dropped in 2015?



Professor Davies: Quite an extensive body of research was undertaken by the Zero Carbon Hub that looked into overheating. I think their recommendations tallied with what Kathryn has just summarised, that is a requirement for some regulation or standard in relation to the new homes in particular. It is something that I think there is a general consensus around.

Q39 **Chair:** That is not the question. The question is was that included in the Zero Carbon Housing standard, which was then scrapped in autumn 2015?

Professor Davies: I think there is some guidance on temperatures within that. I would have to double-check.

Kathryn Brown: I think there was guidance, but to the best of my knowledge, I don't recall that it was included, but we can check back on that as well for you.

Q40 **Chair:** That would be interesting. Why is there is no overheating guidance for hospitals and care homes and schools that are being built?

Professor Davies: There is some guidance for schools. Part L of the building regulations refers to building bulletin 101, I think it is, which provides some guidance on ventilation in schools. I think that the original was published in 2006 and there is a new version about to be released; it is with Ministers, I believe. That does give some guidance on temperatures in schools, but it is referred to by the building regulations and my understanding is it is not in itself binding, but it is guidance. There has been a lot of work done to develop an understanding of temperatures and appropriate criteria, but the issue is part L of the building regulations at the moment relates to the control of solar gains specifically, rather than overheating in general. While there is some guidance in respect to solar gains control, there is not the general guidance or criteria for overheating in general. There is that connection between the regulations and guidance.

Chair: Thank you, that is helpful.

Professor Davies: That is the approved document L that I was referring to.

Q41 **Geraint Davies:** I wanted to ask the Met Office about the Heatwave Plan for England in terms of reducing heat-related mortality, first in relation to heat warnings—and indeed the relationship between heat and pollution increasing mortality risk—and why you are not following what the Environment Agency does with flood risk warnings. When there is a heatwave there is not a knowledge that people should not go out, there aren't closures of roads if there is excess pollution correlating with sunlight, photochemical pollution et cetera. There can be environments where there is very little wind and obviously there is an issue of heat inversion, where the particulates are held down, so you end up with this very high-risk scenario. It seems to me that no proper warnings are



issued.

Dr Stott: What I would say is that the Heat Health Watch Service is done in close association with Public Health England, so we are providing our meteorological guidance and that includes potentially information about the meteorological situation and the air quality, but we do this through the channel of Public Health England. It is based around having some very clear criteria for when to trigger those Heat Health Watch warnings. I take your point that there are potentially links between air quality and heatwaves. At the Met Office, we continue to seek to both improve our forecasting of these episodes and also communicate about the meteorological situation, but we do this very much in close collaboration with Public Health England at the end of the day.

- Q42 **Geraint Davies:** Maybe the other panellists have knowledge of the science in terms of the relationship between heat and pollution, because we know that ozone, for instance, is a photo-driven reaction and there are other chemicals that are problematic. We also know that if it is not windy, as I say, heat inversion particulates are held down. Presumably there must be quite a lot of knowledge around the risks relating to heat and health and what to do about them. Perhaps Professor Davies knows the answer.

Professor Davies: The CCRA 2 did refer to a couple of studies in particular that cover changes in emissions in the future, that while higher mean temperatures could indeed lead to increased ozone concentrations, for example, that the changes in emissions in the future might be more important than changes in the climate. There was some evidence presented in the CCRA 2 report.

- Q43 **Geraint Davies:** We have had a situation in Paris, in Athens, where in hot circumstances, given the level of traffic, they have closed down roads because of the danger to the population. It seems to me from what is being said that the science on pollution and the science on heat seems to be siloed and separated. When you do your warnings, are you bearing in mind the pollution risks as well as the heat risks?

Professor Davies: Speaking separately from my role on the committee, I am aware that there are groups that are looking at it. I believe Public Health England are looking at it and the group dimension there. There is some work on it. I think the evidence with regard to particles is more uncertain. Certainly that is how it was reported in the latest CCRA.

Kathryn Brown: I would also add one of the actions that was in the National Adaptation Programme in 2013 was for Public Health England to expand what was in the Heatwave Plan to include air pollution episodes and issues about transport. That was done. However, it would be a good question to check with PHE, when they come in, as to how effective they think that has been and whether there is a gap still there.

- Q44 **Geraint Davies:** What, in simple terms, is the emergency or responsive plan to a certain heatwave in terms of emergency services or the Health



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Department? I am not trying to be rude to the health service job, but isn't there a risk that a lot of doctors may be on holiday when it is hot? The heart has to beat faster when your blood pressure is lower because your blood vessels dilate and so you have heart attacks. Are heart specialists less likely to be on holiday when it is hot or not?

Kathryn Brown: The Heatwave Plan is split into two bits, if you like. There is a year-round long-term planning part and then there is the reactive emergency response part. They are called different levels. Level 0 is year-round planning. It goes up to level 4, which is a full-on national emergency. For each level there is guidance that is issued to the NHS, emergency responders and others such as care homes, schools and so on about what actions should be taken. The Heatwave Plan is guidance. It is not a requirement or a policy. It is really up to those NHS trusts to decide what action they are going to take. The review of the Heatwave Plan that is happening at the moment in part is trying to ascertain what impact it is having, or whether it is having an impact on both long-term planning and this reactive response.

Professor Davies: I believe that is reporting this year.

Kathryn Brown: We think it is reporting over the summer.

Professor Davies: I think there will be evidence addressing some of that.

Q45 **Geraint Davies:** This might be controversial, but is there a case that in certain predicted and predictable heat scenarios people should be advised not to participate in the London Marathon or similar? I appreciate these people are ready, but it is obviously increasing the risk. Is there a case to have it in the winter?

Kathryn Brown: That is a very difficult question for us to answer. We do not have the epidemiological expertise to answer that.

Q46 **Geraint Davies:** Can I ask something less controversial? I want to ask about how effective the Environment Agency's Climate Ready Support Service for helping vulnerable people adapt to heatwaves is and what we are doing about that. We know, as I say, it affects the heart and respiratory problems. It is more likely that older people are going to be affected. We know 10% of children in low-emission zones have reduced lung capacity already. They are therefore children at risk because of pollution when it is hot. What is being done about heatwave risk for vulnerable people, old and young, particularly in polluted areas?

Kathryn Brown: A large part of what is the Heatwave Plan is about the healthcare sector and social care sectors making sure they are looking at their vulnerable groups. For example, when a heatwave alert is triggered, surgeries have a list of vulnerable people and their job is to contact those people to make sure they have what they need and that someone is there to look after them. You will see during a heatwave, and during cold weather as well, that advice is issued by Public Health England about



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making sure vulnerable people are being checked on by relatives and also by the health service.

Q47 **Geraint Davies:** The Chair mentioned women. If we imagine an elderly isolated woman in the centre of London and there is suddenly a heatwave, will she have any warning or advice? I am presuming she will not.

Kathryn Brown: What the Heatwave Plan suggests should happen is that the local surgery of that person contact them to make them aware a heatwave is happening and to check they have what they need.

Q48 **Geraint Davies:** If I was a GP I would have to contact all the local people in the categories you have identified by telephone?

Kathryn Brown: I do not know what the mechanism is.

Geraint Davies: It seems a completely impractical suggestion.

Kathryn Brown: There have been previous reviews of the Heatwave Plan. There was a review in 2006 and another review in 2011. One of the things they found was that that does not happen as often as it should. I have some numbers in here I can look up for you. About a third of surgeries were reporting they either do not have those lists or that consultation was not being followed up. It will be interesting to see in this review of the Heatwave Plan whether that has improved.

Q49 **Geraint Davies:** I wonder whether there could be co-ordination with the Environment Agency. It has a database of people and does automated calls to say, "There is a flood coming, get in your boat" or whatever they say.

Kathryn Brown: The other thing PHE is looking at is merging the Heatwave Plan with the Cold Weather Plan and having an Extreme Weather Plan that also looks at flood risk and other extreme events. As part of that work I imagine they are doing some work to map out vulnerable people.

Professor Davies: Separate from my role in the committee we have been doing work within the NIHR-funded Health Protection Research Unit with Public Health England. We did some work within London on initial scoping with boroughs to try to assess the quality of homes with potential vulnerability to heat, then mapping on to that where particularly vulnerable people lived to see where those coincided. That might be a useful flag to local authorities.

Q50 **Geraint Davies:** My general question is what work has been done to learn from the adaptation plans of the Environment Agency on flood risk management in relation to heat risk management and the correlation with pollution? I was wondering whether there were any plans to take that forward.

Kathryn Brown: I do not know myself if that link has been made.



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Chair: One of the things that was astonishing from this inquiry is we had no evidence from either councils or the LGA. They said, “We have had our climate ready funding cut so we do not do this work anymore”. These are the first line of defence in a heatwave and they have nothing to say on it. That is concerning.

Q51 **Mr Philip Dunne:** We have also had relatively little evidence from the NHS or Public Health England. What you are telling us about the review that Public Health England is undertaking is quite helpful.

I am going to follow up what Geraint was saying and your response in relation to the comparison between extreme cold and extreme heat. Can you give us a sense of preparedness levels for the two alternatives? We have just come through winter. NHS does a great deal of work to prepare for winter. Can you compare that with how they prepare for summer?

Kathryn Brown: We have not done any studies that do that direct comparison. There is obviously a year-long plan that goes on and a system in place to ramp up for the winter every year. That is very well established and takes a lot of work, effort and months of planning.

The information we do have is about the impact of previous heatwave plans. For example, at the hospital level the review of the 2011 plan found that hospital managers were generally aware of the plan, but frontline staff, nurses, were not so aware of it. There has been quite a lot of work done through Cambridge University looking at actual temperatures and actual activities in hospitals and what they do during heatwave events. We can send you some of the papers on that.

Professor Davies: There has been similar work on care homes led by Oxford Brookes University.

Kathryn Brown: I think Professor Rajat Gupta submitted some evidence to you. He has done a study, funded by the Joseph Rowntree Foundation, looking at instances of overheating in care homes. He looked at a case study selection of four care homes. That was very interesting. Although the projections that had been done for those buildings did not show any overheating risk, even up to 2050, all of those care homes were overheating while he was monitoring temperatures. There is obviously an issue there with a tiny sample size.

Professor Davies: That reflects the desire to see more evidence.

Kathryn Brown: Yes, we would like to understand what is happening there. You cannot draw too many conclusions from a sample size of four. However, there is obviously an issue that needs looking into more. Some of the work that has been done on hospitals suggests that temperatures sometimes exceed 30 degrees when the outside temperature is about 22 degrees. That is much more of a risk with 1960s newer builds. The older Victorian buildings tend to be much more resilient to heat.



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Professor Davies: I think that evidence is in some of the submissions you have received from other organisations.

- Q52 **Mr Philip Dunne:** In relation to building requirements there are again stringent requirements on coping with climatic conditions in hospitals. Have you seen any evidence of hospitals coming under pressure to meet those should they fail tests in relation to heat?

Kathryn Brown: We would say there is a lack of evidence. That is exactly what we do not know. There is more work now being done through the Estates Returns Information Collection—ERIC, an ongoing monitoring survey—where the Department of Health and PHE now ask for reporting of instances of overheating in hospitals. That will be really useful as a dataset. That has only just started, it began last year, and we have not seen the numbers for that yet. We will be trying to collect those for our progress report next year.

- Q53 **Mr Philip Dunne:** Is there any requirement for care homes to also be assessed in the same way, to ask the same questions?

Kathryn Brown: Yes. In our last report we had a recommendation on assessing and managing the risk in care homes. We did go to talk to the Care Quality Commission about what that might look like. Their feeling was at the moment they are not sure what they should be inspecting for. If you are looking at a building outside of a hot day obviously you are not going to see overheating, but there are particular aspects of how the building is set up and how it is managed that might point to a risk. Some of the work we are doing at the moment with Public Health England, the Department of Health and DEFRA is to think about whether the Departments and PHE can prepare some guidance for the CQC so when they are inspecting care homes they could look at that issue in more detail.

Professor Davies: Spot temperatures may not be useful if it is outside of a particularly hot period.

- Q54 **Mr Philip Dunne:** One example would be whether or not they have air-conditioning units available in bedrooms.

Kathryn Brown: Yes. Particularly with care homes, a lot of it—this is what the Oxford Brookes study looked at as well—is how heating is controlled. We know from other studies there is a general perception that elderly people need to be kept warm and often the heating is left on in the summer. If you talk to people working in care homes there is often a fairly complicated decision tree about how to influence heating controls. That was something the Oxford Brookes study was looking at as well. There is a behavioural aspect of how internal temperatures are managed and a perception about what is considered a safe temperature inside care homes.

- Q55 **Mr Philip Dunne:** These things can happen at peculiar times of the year. I was on a train last week where the heating was on and it was 24



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degrees outside. That is uncomfortable. We do not normally expect it to be—as you were saying, Dr Stott—temperatures of that level.

Do you think there are any building regulation recommendations that should be made in looking at licensing of care homes?

Professor Davies: The recommendations we have made to the building regulations relate to new homes and also to gathering more evidence to understand what would be useful within the building regulations. Those are the recommendations the committee has made. For new homes it is a fairly clear recommendation that regulation standards should be brought in, for other buildings it is to gather more evidence and to better understand what would be an appropriate process to apply.

Q56 **Mr Philip Dunne:** Going back to the point you were making about the estates questionnaire, does that include requiring hospitals to record the frequency of high temperature instances?

Kathryn Brown: That is my understanding, yes. Again, PHE will be able to give you a more detailed answer. What I think they have asked for, from looking at previous iterations of the survey, is to record instances of when the temperature exceeds a certain value.

Q57 **Alex Sobel:** Turning to buildings now, I was in Westminster Hall for three hours yesterday. I was thinking then how uncomfortable it would be in the summer, considering it was already pretty hot yesterday. That building was built in the 11th century. In terms of public buildings, do you think there should be different thresholds for different public buildings? Is the 28 degree criteria that has been used in some studies appropriate? How do you define overheating in buildings?

Professor Davies: There has been a move away from fixed temperatures to using an adaptive criteria for comfort. That work has been adopted, for example, by the Chartered Institution of Building Services Engineers in the UK. I think in the evidence they have given to you they work through that.

If I can for a second reflect on homes, for example, while there is useful evidence in relation to external temperatures and their impact on health, there is much less evidence on the impact of internal temperatures on health because of the size of studies that would be required to do that and that they are expensive. For one external temperature in a city you have a whole spectrum of internal temperatures. Therefore trying to tease out what the critical threshold temperatures are for internal temperatures is very challenging, but there has been some work done on that. The setting of both comfort and heat thresholds for built environments is challenging and there is still evidence missing in that respect.

Kathryn Brown: The Department of Health has guidelines on standards for hospital internal temperatures. They do differentiate between what they call sensitive areas—maternity wards, for example, will be classed



as a sensitive area—where the maximum is 25 degrees and other areas where it is 28 degrees. From what we have seen when we have assessed this in the past for our reports is that seems sensible from a health point of view.

The other point I would make is that there is a difference between talking about comfort and talking about health. The adaptive comfort model that tends to be used for building design is based around the idea that as it gets warmer outside you will be more adapted to those warmer temperatures so it can be warmer inside, which makes perfect sense from a comfort point of view. I do not think that works from a health point of view. When we have looked at this for our past reports, what we have understood from our colleagues in PHE, the London School of Hygiene & Tropical Medicine and elsewhere is that these thresholds over which mortality starts to increase are fairly fixed. Therefore the adaptive comfort model is not necessarily the model you would use if you are thinking about safeguarding health, because that really is about an absolute temperature and not about a dynamic threshold that changes with outside temperature.

Professor Davies: Indeed, I think in a city-wide survey for bedrooms they did still use a fixed temperature of 26 degrees, in part reflecting the lack of potential to adapt in the bedroom.

Q58 **Alex Sobel:** Obviously this is a complex area that does lack regulation. Do you think we need regulation? If so, what sort of regulation do we need? Do we need it in the area of health or more broadly in terms of working conditions as well?

Kathryn Brown: What we stated in our report is that we do need a mandatory standard or regulation for new homes. We do not have a view on whether that is part of the building regulations or not. What we have said for existing buildings and healthcare, schools and prisons is that there is not a lack of evidence, but there is certainly less evidence than there is for homes on what the scale of the problem is. The studies we have mentioned are very small-scale studies. They are great to have, but we would like to see more of that to try to replicate some of those findings. It is very difficult to judge at the moment whether regulation is needed or not for those areas. There is a lot of guidance already there, but we do not understand the extent to which that guidance is having an impact and whether there is a problem or not.

Professor Davies: Specifically on new homes, there is an ongoing study that is due to report shortly led by AECOM, funded by CLG. We hope that will be reporting shortly and should provide some evidence that will inform potential changes to the regulations.

Kathryn Brown: Every time we have recommended a standard or a regulation, CLG has said to us they feel they need to understand the costs and benefits of different actions before they can make a decision on what is needed. The study that AECOM is doing for them now, which is



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meant to report in the summer, is looking at the evidence for those costs and benefits.

We would argue—and have argued in our past reports—if you wait for perfect information on costs and particularly the benefits from a health perspective, because they are very difficult to quantify, you could be waiting an awfully long time. We think there is enough evidence to support a standard or a regulation. Zero Carbon Hub, before it closed down, came to the same conclusion as well. It said, “Overheating cannot yet be considered to be a managed risk. There is enough information and evidence about the causes to warrant taking careful yet concerted action”.

Q59 Alex Sobel: In terms of older people, every retirement home I have ever been in is always 5 degrees warmer than anywhere else in the city. How important is it that we make housing and buildings older people use heatwave resilient and what measures do you think we can implement for that?

Professor Davies: There has been some recent work that has looked at the behaviour of different groups of people, led by Exeter, if I recall correctly. It has looked at homes in which the elderly are living and their use of heating. If I recall correctly they are turning the heating off much later in the season and also—for reasons of mobility perhaps—not opening windows in a way that perhaps assumptions have been made that they might be. Because of that, for example, heating being on for longer and the lack of ventilation, behavioural-driven risks are something that, in my view, should receive more attention, rather than the assumptions that are being made in terms of assessing and trying to evaluate groups at risk.

Q60 Mr Robert Goodwill: It is interesting that Professor Davies just mentioned opening windows, because in this building, where I have an office upstairs, you cannot open a window if it is too hot. For example, in 2013 the large skyscraper at 20 Fenchurch Street was reflecting light, melting plastic on cars and setting things on fire so it had to be changed.

In terms of building regulation, what specific changes may need to be made because of more heatwaves? Are they in place specifically referencing overheating for new buildings or to adapt existing buildings? Is enough being done in regulation or do we need to do more?

Professor Davies: The recommendation is that either a standard or a regulation should be in place to address overheating in new homes. As Kathryn has said, there is a strong recommendation that further evidence should be gathered for other types of building.

Q61 Mr Robert Goodwill: How easy would it be to incorporate published guidance on addressing overheating in buildings, such as the work completed by the Zero Carbon Hub and the Chartered Institution of Building Services Engineers, into policy and regulations and would this sufficiently address the risks?



Kathryn Brown: What we have said in the past in our report is that we have looked at building regulations in terms of what is already there. Part F and part L look at ventilation and solar gains. CLG has been fairly emphatic with us that those regulations are not designed to protect health. They are for other reasons to do with indoor air quality and, in the case of solar gains, to do with energy use in summer for cooling and trying to minimise energy use. They are not health building regulations. We recommended that something was needed—we do not have a view whether that is in the building regulations or not—that looks at the health aspects of overheating.

The work the Zero Carbon Hub did in 2015 looked at what that might be. Do you need a dynamic modelling approach to tackling this issue or could you have something quite simple that is maybe criteria-based? There are a lot of characteristics of buildings—Mike will be able to say a lot more on this—that we know make them more prone to overheating. If you have single-aspect flats, communal heating systems in buildings and pipes are not well-insulated, you know that is going to increase the risk of overheating, even if you do not know exactly what the internal temperatures are. There is probably something that could be done that is simpler to look at those high-risk buildings, putting in place measures to alleviate those problem design spots. We talked a bit about this back in our 2014 progress report, so I can send you the analysis we did for that.

Professor Davies: In my view, the Zero Carbon Hub did a very substantial and useful body of work. It was built on by CIBSE TM59 for its guidance on how to evaluate overheating in homes. That is a useful process that has been tested and piloted.

Q62 **Mr Robert Goodwill:** A number of years ago I was in Ontario meeting with their electricity generators. They explained that just that year the summer demand for electricity had passed winter demand because of more air-conditioning. Are we basically going to be in a situation where we have to put more air-conditioning into buildings and therefore have to generate more electricity, potentially producing more CO₂? Are we in a vicious circle or are there other simple things we can do in the way we build buildings to take account of the fact we might have a hotter climate?

Professor Davies: In London there is this cooling hierarchy where mechanical cooling is the last resort. There is a whole range of other options you should be addressing first in terms of sensible design, location, orientation, use of thermal mass and trying to passively ventilate the building. As a last resort, if no combination of the above is fully satisfactory, only then to resort to mechanical cooling, air-conditioning.

I agree with you, this is an important issue, but there is also the additional issue of these anthropogenic heat emissions that air-conditioning would contribute to in cities, contributing to the urban heat island as well. There has been work done to make some estimates of how



significant the current rates of anthropogenic heat emissions are. Clearly if that was to increase there would be this cycle where you are cooling the buildings, but increasing the intensity of the urban heat island.

Q63 Mr Robert Goodwill: Do we need a carrot in terms of things like Green Deal offers and that type of potential offer, or do we need a stick in terms of regulation to make that happen? Presumably people building buildings tend to go for the cheapest option. It may not be the cheapest option to build a building that is thermally able to cope with high temperatures in summer.

Kathryn Brown: We have done analysis of what is cost beneficial in terms of passive cooling measures. Back in 2011 the ASC funded a study looking at measures such as shutters, tinted window film, painting roofs white and a whole slew of behavioural measures for passive cooling that showed that in new builds in particular they are very cost beneficial compared to installing air-conditioning. The social cost of air-conditioning was the comparison that was made.

We do look at projections of future air-conditioning uptake as well as part of the work we do on the mitigation side of the Committee on Climate Change. We use the old DECC—now BEIS—2050 calculator projections. They are at different levels, but some of those are going up to near full penetration of air-conditioning in new builds. That is not the projection we necessarily use, but is one of the projections. Uptake is about 3% in homes at the moment for air-conditioning. BEIS does a survey of that, which is one of our indicators as well and that is very helpful.

Q64 Anna McMorris: Turning to the urban heat island, how significant is it that urban heat island effects are not included in current climate models, particularly when used to predict future temperature trends in UK cities? We have seen in the London Marathon, for example, last weekend runners experiencing temperatures of 30 degrees and more.

Chair: Through the city of London.

Dr Stott: It is possible to estimate the urban heat island effect and it is possible to make reasonably good estimates of what that means over and above our climate projections. For example, a study we have done has shown we would expect the urban heat island effect—the average that tends to manifest itself most over night-time temperatures—will potentially increase by a little over 0.5 degrees. That is the change in the effect. The effect in terms of air temperatures might be up to about 4 degrees where you have the conditions that allow the urban heat island effect to express itself most fully. Therefore it is not that we cannot estimate it. Having said that, as researchers we do want to improve the advice to the public.

We are doing work, for example, in partnership with the University of Reading to develop our models. What we need to do then is to develop the resolution, the spatial scale, in which we can represent our models. We have made a lot of progress in that. We are now at the level where



we can represent, for example, individual convective storms in summertime. When we think about going right the way through to the urban scale, ultimately we would want to be able to start modelling interactions with buildings with a microclimate. There are a lot of challenges to get down to the really fine detail. What I would say in summary is that we can make a broad estimate that can be quite useful, but there is more work to do to refine those estimates.

Q65 Anna McMorris: Asking all of you, how can local plans be adapted to take into account the risk posed by the urban heat island effect?

Kathryn Brown: An interesting thing about local plans is the lack of coverage of overheating at all at the moment. In our last progress report we reported on a couple studies—the TCPA did one and we funded another—looking at coverage of adaptation issues in local plans. Flood risk tends to get talked about, but overheating, in almost all cases, does not have a lot of coverage. Mary mentioned some of the evidence. We have heard a lot from local planning authorities that their budgets have been squeezed. Planning department budgets have gone down in real terms by 45% since 2010 and adaptation has been deprioritised. We did a study looking at what has been happening in those planning departments. A very firm message was coming back that they felt there was no scope to do much on adaptation, which is not to say dealing with overheating risk now, but obviously we are interested in the future effects as well.

The NPPF—the National Planning Policy Framework—consultation that is out at the moment does include raising the profile of overheating. It has gone from an appendix, where there was guidance, into the main discussion about what should be in local plans on climate change adaptation. That is positive. We have not responded to that consultation yet, but we will be putting in a consultation response from the committee.

Professor Davies: Some useful leadership is being shown by the Mayor's Office in London with the London Environment Strategy. That has a useful section on green infrastructure and proposed strategies to address these types of issues within that strategy. In my view that is a useful document to refer to.

Q66 Anna McMorris: Touching on that, we have had written evidence that green spaces help to reduce the urban heat island effect. The Tyndall Centre pointed out that those green areas would have to be drastic to have a significant effect. How effective would you say green space is in reducing the urban heat island effect?

Kathryn Brown: There are a few studies we have included in the latest climate change risk assessment that looked at this. One of them, which was in Glasgow, looked at increasing green cover by 20%, which is obviously quite a big amount. The estimates for that suggested it could eliminate 30% to 50% of the expected extra urban heat island effect. It



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is not a temperature metric, but is the increase in the urban heat island by 2050. It was looking at reductions in surface temperature of around 2 degrees. There have been quite a few studies from Manchester and some from London that do similar work, which you might want to comment on.

Professor Davies: There is some empirical evidence of parks locally reducing temperatures. I have to check on this, but I believe there was some work done by Reading and the Met Office a few years ago in a project I was involved in, which did point to the value of green space being distributed across London, for example. It tended to inhibit the full development of the urban heat island. I could send you on that reference if I can find it. It has localised value. I would have to double-check, but there may be some value in having this distributed across a city such as London to prevent the full development of the potential maximum of the urban heat island.

Q67 Dr Matthew Offord: I want to get your opinion and thoughts upon the effect of heat waste, particularly on the transport infrastructure, in London. I am sure you will be aware of what it is like being on the Tube when the temperature increases. What knowledge do you have about disruption of transport services, both in terms of the infrastructure and also in terms of the safety and security of passengers?

Kathryn Brown: We have very little. Transport for London has quite a lot. The Cooling the Tube Programme and the associated work that underpins that has been going on for at least five years. Although we do not have the data, they have done fairly sophisticated modelling of impacts on passenger comfort in different situations. Obviously they are rolling out new S-stock on some of the lines, which is fully air-conditioned. We know there is a lot of work going on for London.

What we found in the risk assessment was that we were not sure anywhere else in the country was doing that level of work. On the public transport side of things, it was a definite evidence gap for us in the risk assessment that outside of London we did not know anything about the scale of risk or the action underway.

Professor Davies: That does not mean it is not there, of course, but it was not uncovered in that process.

Q68 Dr Matthew Offord: I also wanted to explore further about the economic cost of heat waste, particularly on productivity, not just on the Underground, but also among the population as a whole. How do we quantify the effect heat has upon productivity?

Professor Davies: There has been a lot of work done in terms of how temperatures in an office impact on people's productivity, which influenced the development of the CIBSE guidelines in its guide A. There has been much less work in quantifying the economic impact of that on a wider scale. There is evidence to suggest a reasonably established link between overheating and productivity. In terms of converting that into



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hard economic impacts—there has been some work, which maybe Kathryn has—it is an area in which evidence is somewhat lacking. It would be an area that could benefit from further work.

Kathryn Brown: Alistair Hunt at the University of Bath has done a lot of work on the economic impact of the 2003 heatwave. DEFRA funded a study back in 2006 on that as well. The sort of numbers that study came up with were health costs of £41 million. The manufacturing cost was put at £500 million in a different study that we also looked at in the risk assessment.

I would not be able to tell you the detailed methodology for how those numbers are come up with. However, both of those studies looked at the opportunities as well as the costs and have come up with sector-specific estimates. I have not seen any studies that have come up with an overall estimate of the costs and benefits of specific heatwaves.

Professor Davies: There is some ongoing work internationally, which we could pass on to you, using the wet-bulb globe temperature as a metric to understand the impact on people's potential for manual work and at what point it becomes impossible to continue. I know there has been some work at the London School of Hygiene & Tropical Medicine and I can certainly pass on that evidence to you.

Q69 **Dr Matthew Offord:** Over the years the ASC has suggested to businesses they relax the dress code, which is quite understandable. I am aware police will often wear shirt sleeves and do not need to wear a tie in hot weather. A year or so ago the TUC also said there should be a maximum working temperature, just the same as we have a minimum working temperature. What is your view on the viability of that? How possible is it to achieve that; is it realistic?

Kathryn Brown: We do not have a view on that particular question, unfortunately. The difficulty we have heard from our stakeholder groups about maximum temperatures is that they are difficult to enforce and to enable. Mike, you can say more about when you are planning a building design. If you have a set temperature, I imagine it is complicated to work out how you would address that.

Professor Davies: You have recourse to complex dynamic building thermal simulation models. However, of course a lot of assumptions go into those and uncertainty and you need parameters. Then there is how the building operates under real conditions rather than the approved weather files you drive them with. My view is they should be involved to inform the design of buildings. That way you can achieve a better design of building. However, you can never guarantee it will not overheat. For example, people may behave in ways you do not anticipate they will. Rather than having the certain number of people you have planned for in a room, you may have double that number because the use of the room changes. There is useful technology you can deploy in the design stage, but you can never rule it out completely.



- Q70 **Chair:** Dr Stott, you mentioned the HELIX project earlier on in the session, which is an EU climate project. What is the status of the funding for that project, given the proposal to leave the European Union? How long is that project funded for? Will we still have access to that project and will we still participate in it if we leave the EU?

Dr Stott: The HELIX project itself has come to an end and has very successfully achieved its aims. The broader question is around our involvement in new projects more generally. With the Met Office and academic colleagues we very much value our collaboration in European projects. The general situation is that we continue to participate in European projects. We continue to regard them as important and we value the Government's continued support in that as a key part of how we develop our scientific capability for this country as well. I lead a European project related to the attribution question, to what extent we can link individual weather events to climate change, for example. By drawing in expertise from the Netherlands and France in particular—because there is key expertise there—we can deliver a greater impact here in the UK. We very much value the continuation of that work.

- Q71 **Chair:** How likely are droughts in the future? Is the likelihood of drought increased by heatwaves?

Dr Stott: I am going to separate that question into two types of drought, the short-term hydrological drought in summer and the longer-term meteorological drought. The answer is a bit different for the two types. For the short-term hydrological drought in summer, it is rather clear that there is evidence for increasing risk related to warmer temperatures and the greater risk of soils drying out. This sort of drought has implications for crops in particular.

The longer-term meteorological drought is caused by persistent rainfall deficit over a long period of time. That is where it does not rain for a significant period of time or where the rainfall amount is significantly lower over a significant period of time. There is much more variability there in the climate. The general picture remains to be wetter winters and drier summers, but there is a large amount of variability within that. What I could say is that when the meteorological conditions are favourable to a long-term meteorological drought then the impacts potentially are worse in a warmer world. We have to recognise there is a large amount of variation with that. What I am saying is that the climate change signal is much clearer on short-term drought than it is on the longer-term meteorological drought.

- Q72 **Chair:** Thank you, that is helpful. We had some evidence from water companies that they want stricter water efficiency targets of 105 litres per head. What do the panel think about that?

Kathryn Brown: When we looked at this issue back in 2012 or 2013 we did some analysis that looked at whether it was cost beneficial to get per capita consumption down to that sort of level. The level we had was 115



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litres per head per day. That was shown to be cost beneficial. Water UK has done a fairly recent study looking at that 115 litres as well and found it was achievable, but would require significant behaviour change.

We have not recommended a specific per capita consumption level that we think should be achieved. However, we have said what we think is possible and certainly 125 litres going down to 115 litres is possible. We did not make a recommendation on this in our 2017 report because the indicators we use show that PCC is going down in line with what we would expect to happen, to get down towards that level by about 2030, and metering uptake is going up in line with what we would expect from the trend we would like to see.

There is obviously a lot of work going on through DEFRA and others at the moment, so the abstraction reform process, the resilience duty on Ofwat, there is the national policy statement consultation that is out for water infrastructure. It is a kind of wait and see for us at the moment as to what happens with all of those, but we will be picking that up obviously in our progress report next year.

Chair: Professor Davies, any comments?

Professor Davies: I do not have anything on that.

Q73 **Chair:** How important is soil? There was a brief mention of soil, so here we are, now is the time to talk about soil. Tell us what we need to know about dry, cracked, burned earth and how that impacts. We are huge fans of soil on this Committee.

Dr Stott: My interest in soil as a physical climate scientist is in terms of what we call the feedback. I made a reference to the oceans. In the oceans you have an infinite amount of water because it is a body of water, but on land the amount of water available to cool the atmosphere through evaporative processes, evaporative cooling, is limited. The fact that the soils are moist, the contained moisture can be very beneficial in moderating a heatwave. When, as we saw in 2003, you get a situation where those soils dry out, then that function completely ceases. This is rendered more likely with warmer temperatures. That is what I am talking about in terms of the feedback because it makes those heatwaves worse because that cooling effect of the soil is no longer there.

Q74 **Chair:** You said there is a feedback mechanism. We know about feedback mechanisms with polar ice caps and oceans. Are you saying there is a feedback mechanism in our own back gardens?

Dr Stott: Yes. This is related to the comment we had about variability, the increased potential variability, because when you get those situations—and that is potentially becoming more frequent when the soils have dried out—then you get the big spikes of temperature because of that feedback. As you say, it is in our own back gardens and if we concrete over our back gardens it is not available.



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Q75 **Chair:** If there was a heatwave and you went out with your garden hose—often you end up with a hose ban in a heatwave or recommendations of not using water on your garden—are you saying it is beneficial to water your garden during—

Dr Stott: You have to be a little bit careful there because—

Chair: I just want to know what we are supposed to do.

Dr Stott: We have to be careful about that because it is the moisture through the depth of the soil that really matters. If the soil is so dried out and you pour water on it, it will just run off. That is what happens when you get this baked earth. I would not say that would necessarily be a good strategy and of course it would be a use of water in a period when there is potentially a shortage of water. There is a storage within the depth of the soil that really matters, not what you put on the surface.

Chair: I was planting gooseberries this weekend and it was baked on the top, but wet underneath and I thought, “Oh, this is all good” and then thankfully it rained so I did not even have to water it in. Robert, you wanted to come in.

Q76 **Mr Robert Goodwill:** I want to ask what the correlation is between very hot and very wet weather because we do often have a situation where we have thunderstorms associated with very hot weather. In 1976, I can remember our own farm, it was very dry and it was very hot, so every hot day was seen by the farmer as a bad thing. Normally a hot cloudless day is brilliant if there is some moisture in the soil. In terms of the overall effect on crop production, are we going to see 1976 scenarios where it is going to be dry and hot? Are we going to have the traditional hot summer weather where we get thunderstorms interspersed between periods of hot weather?

Dr Stott: I would say there is definitely an increased potential for that sort of summer, yes, because when we have that continental weather pattern, warmer temperatures, greater risk of soil drying out, as you say, when that weather situation is very hot, the weather situation breaks down. In fact, we had thunderstorms where I live in Exeter only a few days ago when the weather situation broke down because the cold polar air was meeting the warm tropical air. That is when you get the thunderstorms, which may not be beneficial. You probably know more about this than me, but hail can be very damaging to crops or if the soils are so dry the water will just run off and not necessarily replenish the soils.

Q77 **Chair:** Should soil protection be a key focus then of the National Adaptation Programme?

Kathryn Brown: We have not looked at this aspect of soils from a heatwave perspective, but obviously, as you are well aware, we have made lots of recommendations on soils in the past. In the most recent report certainly we were looking at the fact that there is an aspiration for soils to be sustainably managed by 2030—this was before the 25-Year



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Environment Plan came out—but there was not anything behind that in terms of how that was going to be achieved.

Q78 **Chair:** Apart from the target of four parts per 1,000 increase—

Kathryn Brown: Yes, there is that as well.

Chair: —which the Secretary of State last week was unaware of. What we signed up to two years ago is not reflected in that. What do you think, not as part of heatwaves?

Kathryn Brown: I think we need to look at it as part of the next risk assessment because that is something that was a bit of a gap for CCRA 2. The next progress report, which will be with the new National Adaptation Programme, we will be doing next summer and we will be looking to see what has been done on soil fertility and soil conservation as part of that. As I said, most of the work we have in the past really is about the natural environment aspects of that, particularly peatlands, and not so much on the link with heatwaves.

Chair: Any final thoughts on soil? Okay, thank you very much indeed, it has been a fascinating session.