DÁIL ÉIREANN

AN COMHCHOISTE UM GHNÍOMHÚ AR SON NA HAERÁIDE

JOINT COMMITTEE ON CLIMATE ACTION

Dé Máirt, 2 Deireadh Fómhair 2018

Tuesday, 2 October 2018

The Joint Committee met at 6.10 p.m.

MEMBERS PRESENT:

Deputy Marcella Corcoran Kennedy,	Senator Ian Marshall,
Deputy Timmy Dooley,	Senator Michelle Mulherin.
Deputy Martin Heydon,	
Deputy Tom Neville,	
Deputy Thomas Pringle,	
Deputy Eamon Ryan,	
Deputy Sean Sherlock,	
Deputy Brian Stanley,	

In attendance: Deputy Martin Kenny.

DEPUTY HILDEGARDE NAUGHTON IN THE CHAIR.

Business of Joint Committee

Chairman: Apologies have been received from Senator Devine. I confirm that a meeting with Bord na Móna and EirGrid will take place at 3 p.m. on Tuesday, 13 November.

I welcome members and viewers who may be watching our proceedings on Oireachtas TV to the fifth public meeting of the Oireachtas Joint Committee on Climate Action. Before we begin the meeting, I ask members to turn off their mobile phones or switch them to flight mode as they interfere with the broadcasting service.

Deputy Eamon Ryan: I wish to raise a matter now rather than at the end of the meeting. As the Chairman will know, at the recent meeting of the Committee on Communications, Climate Action and Environment, we asked the Minister, Deputy Naughten, about the consultation document on the national energy and climate action plan. Last week, his Secretary General said that the completion of the document was imminent and that it was about to go on to his desk, but today the Minister said that he did not receive anything. With the committee's timelines being so tight, access to information is crucial. Part of the committee's job is to open up this process. We, as a committee, should not be backward in asking Departments for documents and, if they are not presenting them, we should ask why. For example, and perhaps the Clerk to the Committee will confirm, we said that in advance of the Secretary General at the Department of Transport, Tourism and Sport coming here on Thursday, we would get some of the Department's proposals for the new plan. What we need to avoid is what we had last week, which was a Secretary General listing everything contained in previous documents that anyone can read for themselves. Listing things is of no use to the committee. What we need is to know what is new. I do not know whether we have received the presentation from the Department of Transport, Tourism and Sport in advance, which is what we asked for.

Chairman: We will ask for that. The Deputy has made a very good point.

Deputy Eamon Ryan: At a certain point we will have to play hardball with the public service if it is not-----

Chairman: Stepping up.

Deputy Eamon Ryan: -----including us and opening up this process. It must have those documents because it cannot be aiming to have a plan by Christmas yet have nothing here on 3 October.

Chairman: I agree with the Deputy. With the committee's agreement, we will write to the Secretary General for the information, the draft and the plan that the Minister has said today he has not seen yet. We will contact the Department and ask for that.

Deputy Eamon Ryan: We must also ask for a copy of the report on the update of the Project Ireland 2040 from the high-level senior officials group that the Secretary General said he would see if he could provide. He said that they would try to present that material to us as well.

We have an opportunity to open up this process in a healthy way. Recent Supreme Court or High Court decisions around access to information on Government climate papers will force the State, against precedent, to open up some of those documents. If the Departments tell us that they cannot supply information, we have legal precedent on our side now to say that they will provide open access to what is going on.

Chairman: I agree with Deputy Eamon Ryan. There is interference from a phone. As Oireachtas TV broadcasts this session, it is important that all phones are switched to flight mode. We will write to the Secretaries General and do that. Is that agreed? Agreed.

Deputy Eamon Ryan: The Department of Transport, Tourism and Sport should supply us with the material in advance of our meeting on Thursday.

Chairman: Yes. We definitely need the material by tomorrow.

Deputy Eamon Ryan: If the Department does not have anything then that is a story in its own right. If it has no plan or proposals, our first question is why.

Chairman: With agreement, we will write to both Departments about the matter.

Third Report of the Citizens' Assembly (Resumed): Professor Peter Stott

Chairman: On behalf of the committee, I extend a very warm welcome to Professor Peter Stott from the Met Office Hadley Centre. He is also professor of detection and attribution at the University of Exeter and is one of the world's leading experts in the detection and attribution of climate change. Professor Stott has made an important contribution to the subject matter of our discussions as he addressed the Citizens' Assembly in 2017 on the impact of climate change, international evidence and experience.

Before we commence our formal proceedings, I will begin with some formalities. I wish to advise the witnesses of the following. By virtue of section 17(2)(*l*) of the Defamation Act 2009, witnesses are protected by absolute privilege in respect of their evidence to the committee. However, if they are directed by it to cease giving evidence on a particular matter and continue to so do, they are entitled thereafter only to qualified privilege in respect of their evidence. Witnesses are directed that only evidence connected with the subject matter of these proceedings is to be given, and they are asked to respect the parliamentary practice to the effect that, where possible, they should not criticise or make charges against any person, persons or entity by name or in such a way as to make him, her or it identifiable.

Members are reminded of the long-standing ruling of the Chair to the effect that they should not comment on, criticise or make charges against a person outside the Houses or an official, either by name or in such a way as to make him or her identifiable.

I call Professor Peter Stott to make his opening statement.

Professor Peter Stott: I thank the committee for the invitation to attend. It is a great honour to be asked to present here. It was also an honour to be asked to present at the Citizens' Assembly, which I did last year, and I talked about climate change and its impact. My remarks today will follow on from the remarks that I made at the meeting of the Citizens' Assembly and the great discussions that I had there with those citizens about climate change and the challenges of climate change.

I will quickly say a few words about myself. I have worked on the Intergovernmental Panel on Climate Change. I was a co-ordinating lead author in the fifth assessment report and for the working group 1 part of that report, which is about the physical basis of climate change. My research interest is in looking at the causes of climate change. I also work at the Met Office

Hadley Centre where we look both at the observations and the predictions of future change.

The first slide of my presentation asks the following question. What is the link between extreme weather events and either human induced climate change or natural climate variability? That was a question that the Citizens' Assembly, in particular, asked me to consider. It is one where, in scientific research, we have made quite a lot of advances. This is important because citizens around the world are asking questions when they are affected by heatwaves, droughts and other extreme weather events of that sort. It is understandable and right that they are asking whether such events are a sign of climate change. People are asking scientists whether it is right to make a link between such events and climate change. Like everyone else, scientists are aware that there are natural variations in our climate. There have always been heatwaves. There have been floods and droughts in the past. It can be seen that the predictions which have been made over many years - going right back to the early reports of the Intergovernmental Panel on Climate Change from 1990, which made it clear it was expected that extreme weather events, such as heatwaves, floods and droughts, would happen with increasing frequency - have been coming true and playing out over the intervening years. The predictions that were made by the scientific community more than 20 years ago are becoming a reality before our eyes. Our observations are bearing out what the climate models have been saying.

I have provided some examples of this in the presentation I have furnished to the joint committee. The first slide following the headline slide refers to the question of a link between extreme events and human-induced climate change. It mentions the flooding in Ireland in the winter of 2015-16 and some of the storms that have been seen in Ireland. It includes a photograph of the railway line to Cornwall, in the west of England, which was washed away in January 2014. This happened close to my home in Devon. This slide also includes a map of the temperatures we saw in the summer of 2018, which was a particularly hot summer in Ireland and in the UK. The temperature anomalies depicted in the map show the difference between this summer's temperatures and average summer temperatures. The red parts of the map show the areas where temperatures were warmer than the average. It can be seen that this summer, temperatures in large parts of the northern hemisphere were much higher than average. There was a heatwave in Japan. There were extreme temperatures in northern Scandinavia, North America and Europe. The unusual thing about the summer of 2018 was that there were heatwaves in many parts of the northern hemisphere. In the UK, comparisons were made with and the heatwave of 1976, when there was an extended period of heatwave and drought. The UK Met Office made the point that this summer, weather conditions across the northern hemisphere as a whole were different from 1976. It was not the case in 1976 that there were warm temperatures throughout the northern hemisphere.

The third slide, at the bottom of the first page of my presentation, contains a graph based on a remarkable set of scientific observations and measurements that have been taken from the summit of the Hawaiian volcano Mauna Loa since the 1950s. The graph shows that carbon dioxide concentrations at that location are more than 400 parts per million, which is the highest level they have reached for at least 800,000 years, and have increased steadily by more than 2 parts per million by volume every year. There is a seasonal cycle in carbon dioxide concentrations due to processes in the land. In the spring, the biosphere takes up carbon dioxide. It is almost like it breathes it in during the spring and breathes it out during the autumn and winter. The reason for the annual cycle across the globe as a whole is that there is more land in the northern hemisphere than there is in the southern hemisphere. This means that the seasonal cycle for the north wins out relative to the south. It is a scientific fact that carbon dioxide concentrations are increasing. It has been well established for a long time that a natural greenhouse effect in the

atmosphere keeps temperatures on the surface of the earth approximately 33° Celsius warmer than they would be if we did not have an atmosphere. Solar radiation from the sun acts to warm up the atmosphere more than it would if we did not have this natural greenhouse effect. Carbon dioxide is a greenhouse gas and through human activities, we are adding to this greenhouse gas and thereby enhancing the natural greenhouse effect and warming up the planet.

The next slide, which depicts average global temperatures, is based on a set of data compiled by the UK Met Office's Hadley Centre in collaboration with the climatic research unit at the University of East Anglia. It shows the average temperatures at the surface of our planet going back to 1850. We can construct reliable, instrument-based measures of global average temperature over this period by looking at readings taken from land-based thermometers and weather stations, as well as measurements of the temperature of the surface of the sea taken from ships. It can be seen from this slide that temperatures have been warming up. Temperatures are now approximately 1° Celsius warmer than the pre-industrial average, which is considered to be the average between 1850 and 1900. It is worth remembering that number when they think about climate change in the context of remarks I will make in a minute. It can be noticed from this slide that temperatures vary from year to year. The grey band in the graph represents our scientific uncertainty about making this measurement. While there is some scientific uncertainty, the 1° Celsius increase to which I have referred is way outside that uncertainty. As the intergovernmental panel put it, warming is unequivocal. It is of the nature of a scientific fact.

The next graph I have prepared is taken from the intergovernmental panel's fifth assessment report, which was published in 2013. It is another way of illustrating the average surface temperatures across the globe. There are fewer points marked on this graph because it depicts the average for every decade. The end of the graph shows that temperatures are approximately 1° Celsius warmer than they were at the start of the previous century. The variations that are seen when the figures are averaged across an entire decade are smaller than the year-to-year variations seen in the previous graph. We have averaged out some of the variations.

The blue band on the next graph relates to climate models that have been run in the past period in an attempt to see whether we can simulate what has been happening in observations if we include only natural causes of climate change when we run our climate models. We know that the solar output varies on an 11-year cycle. That has been included in these climate model simulations. Explosive volcanic eruptions occasionally eject dust way up into the higher atmosphere, which can temporarily cool temperatures. We also know that there are natural climate variations. Members may have heard about the El Niño southern oscillation, which occasionally means temperatures are warmer. All of those things have been included in the climate models represented in the graph to which I refer. It is clear from the graph that such factors do not explain the observed warming, which is well outside of anything that could possibly be accounted for by taking account of natural factors only.

The red band on the next graph shows what happens when the increase in greenhouse gas concentrations I have mentioned - it is now at 400 parts per million by volume in the atmosphere - is included in the climate models shown in the previous graph. Other human-induced factors, including factors associated with air pollution, aerosols and the effects of pollutants in the atmosphere, are also included for the purposes of this graph. It can be seen in this graph that the observed warming is well accounted for by these climate models when these factors are included in them. I referred earlier to projections that were made in the early 1990s on the basis of an earlier generation of climate models, which were not as sophisticated as those being used by the scientific community now. What has happened since is consistent with what the

scientific community was saying even back in the 1990s.

The next slide shows a couple of photographs from the plenary meeting I attended with governments to agree the fifth assessment report. The governments agreed with our scientific statement that human influence on the climate system is clear. I apologise as the next slide works a little better as an animation but I can describe what I seek to explain. It illustrates what happens with a warming world for extremes, such as heatwaves. We can think of pre-industrial climate, when climate was relatively stable, as it was for many thousands of years before the industrial era. We can plot temperatures in a particular place and see that some years were warmer and some were colder. Many years are average and only occasionally do we see particularly hot or cold years. We can then think about what happens if the climate is warmed. Even if climate is warmed by only 1° Celsius in the global average, which is where we are now, the probability increases significantly of having extreme temperatures in Ireland or Europe over a summer season. That is a property of the basic mathematics of the issue. What were very rare events have now become much more frequent.

I was involved with a pioneering study that looked at the European heatwave of 2003. It was fair to say this was something of a wake-up call for citizens of Europe as the European average temperatures were the highest they have been in the entire instrumental record of temperatures for Europe. This led to many tens of thousands of people dying in the heatwave, particularly vulnerable elderly people in urban centres. It was a wake-up call as maybe people did not realise how vulnerable elderly people could be in such a heatwave. We did a study, published in *Nature* in 2004, and found that as a result of this effect of warming on the risk of heatwaves, human influence had very likely at least doubled the risk of European summer temperatures being as hot as in 2003. We have come back to the work since and published a paper in 2015. We found the conclusion was robust. We have improved climate models and the study was still correct. We also found the risk of such heatwaves has continued to increase with further warming. Events that would occur twice per century in the early 2000s are now expected to occur twice per decade.

What about heavy rainfall and flooding? Storm Desmond had a major impact in December 2015. I have a graph that I showed to the Citizens' Assembly. It is a map produced in a collaboration between Met Éireann and the Met Office demonstrating rainfall anomalies, or how unusual were the rainfall totals in that month relative to a climatological average, which is often taken to be 1961 to 1990. The rainfall averages were extremely high in particular parts, including Ireland, north-west England and western Scotland and Wales. These were very extreme rainfall totals.

How can this be related to climate change? It is important to underline there was much variability in climate, and looking at rainfall in particular there is much variation. In our experience we know some months are particularly wet or dry, and there is much variation. There is an important scientific fact to be mentioned, which is that in a warmer atmosphere, there is more moisture. This is a rather basic physical property of how the atmosphere behaves as sea surface temperatures and the oceans warm, leading to more evaporation and the water holding capacity of the atmosphere increasing. That means there is approximately 6% to 7% more moisture in the air for every 1° Celsius of warming. I indicated earlier that it is approximately 1° Celsius warmer in the global average than in pre-industrial times, and that means there is approximately 6% or 7% more moisture in the air. That is what one would expect from physical principles, and it is what has been observed from satellite data. We have the observations to bear that out and it is what is happening.

What does this mean for extreme weather events and the risk of floods and droughts? In a scientific sense we must be a little careful as we must recognise there is much weather variation. The weather in this part of the world is very much associated with what is happening in the Atlantic Ocean and the storm tracks that bring storms across the Atlantic and hit us in our part of the world. We need to do some careful analysis and I thank Dr. Conor Murphy from Maynooth University for the result included in the documentation. He and his colleagues did an analysis of Storm Desmond in which they found evidence for this human fingerprint on this event. It is interesting as Storm Desmond was associated with what is known as an atmospheric river, a natural phenomenon that brings moisture from subtropical latitudes and transports it to the mid-latitudes, such as here in Ireland. We have seen such events in Cumbria, and parts of the world like New Zealand have also experienced the effects of atmospheric rivers. The point is that the analysis of Storm Desmond indicates that with warmer ocean temperatures and their effect whereby the atmosphere contains more moisture, there is a very much increased risk that when atmospheric rivers occur they will bring higher moisture than we had in pre-industrial times. Therefore, the impact of these atmospheric rivers is greater.

I will move to what this means for the future. The next slide has two graphs taken again from the fifth assessment report of the Intergovernmental Panel on Climate Change. In 2013, we agreed a conclusion with governments in the plenary. The statement indicates that continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system, while limiting climate change will require substantial and sustained reductions of greenhouse gas emissions. The graphs illustrate the point. The first shows global average temperatures, indicating how they are projected to increase with continued emissions and what might be referred to as a business as usual scenario. They show temperatures increasing by the order of 4° Celsius or more relative to pre-industrial levels. A change of 4° Celsius or 5° Celsius is significant. To put it in context, in the last ice age, when the climate was radically different from now and we had large ice caps covering many of today's inhabited areas, global average temperatures were only 5° Celsius colder than now. It a major shift in the climate. If emissions are reduced, warming will be very much less. The graph on the slide indicates the dramatic changes to Arctic sea ice that would result under continued emission rises. Under a business as usual scenario, there is the potential that there would be no Arctic sea ice at all in the summer.

I will move to what this means for Ireland. I thank my colleague from the Irish scientific community, Dr. Conor Murphy from Maynooth, for this. We see a picture of drier summers, wetter winters and increasing temperatures in the summer. What is being done here is to relate the probability of the types of season that we had in the past. If one thinks back to the particularly dry summer here of 1995, one in every eight years could be as dry as that summer by the end of this century with continued emissions. Likewise, one in eight years could be as wet as the winter of 1994. The temperature of the 1995 summer could be once every seven years because warming would make that summer a relatively cool summer in the new climate. Therefore, only one in seven years could be as cool as that summer. It shows that with continued emissions what would once have been thought of as rather hot summers could become rather cool.

On the impact of climate change, this last set of graphs is taken from some work we did at the Met Office, and it looks at the impacts that could be avoided with mitigation. The basic point is that with continued emissions the risks of exposure to heatwaves and the risks to food security, flooding, water stress and water availability across the globe are significant and substantial. These graphs show that with continued emissions, and with continued business as usu-

al, large factions of the population will be affected by substantial and significant impacts that would be difficult, if at all possible, to cope with. If the Paris Agreement of 2015, which states that governments should strive to keep warming to below 2° Celsius relative to pre-industrial levels and make efforts to keep warming to below 1.5° Celsius relative to pre-industrial levels, is successful, at least some of those impacts could be avoided. As I stated at the beginning, we are now already at 1° Celsius relative to pre-industrial levels. The Paris Agreement to limit warming to well below 2° Celsius needs to be thought of in that context.

To sum up, I restate the point that climate is warming, and that with increasing warming comes an increasing risk of some of the impacts I have talked about, namely, heatwaves, heavy rainfall, flooding and other impacts of climate change. Taking action to limit climate change will significantly reduce the severity of impacts on people and society.

Chairman: I thank the professor. I will invite members to speak in the order they have indicated. I call Deputy Dooley.

Deputy Timmy Dooley: I appreciate that because I must attend another meeting. I thank the professor for his straightforward and relatively simple explanation of the science of climate change. As parliamentarians, we are regularly confronted by people, sometimes within these four walls, who tend to be deniers of climate change. The old standard is that they look back to the Ice Age and they indicate how different things were then, and they look to hot events that took place in the past. The professor's explanation of the change in average temperatures is one of the best and clearest explanations we have seen for some time. If we are to be successful as parliamentarians in attempting to show leadership about climate change, we must bring people with us, and we must move to some extent away from academia and into the vernacular, trying to talk about the practical implications of climate change. In one sense we must draw a line under the science.

Climate change is there and it is happening. The professor's rather simple explanation of the average temperature rising suggests the only reason for it is the level of industrialisation that has taken place in society and the impact of CO2 emissions, among other harmful gases. That is a fact. We need to quickly bring into focus the impact of all this, as the professor has done. His final slide boils down the work that we have to do as parliamentarians, which in the first instance is to inform and create the dialogue and discussion. I recall previous work that a committee in this House did on the failure of the Lisbon treaty. A rather wise journalist appeared before us and explained in clear terms that the Lisbon treaty was lost because people did not understand it and they were not talking about it or the implications of it because it was not boiled down to relatively straightforward conversations that could be had in the pub, the shop or where people congregate. The point was made that if we are not talking about it in here, it is unlikely people will talk about it outside. This is why I was anxious to see somebody like the professor appear before the committee who moves on to some extent from academia and science to the causes and effects. The effect is clear. In the past ten years we have seen such extreme weather events, such as storms and flooding, which created enormous difficulties for people.

Much of the time we wish and hope we will have a hot summer, but when we get a hot summer it is much more extreme and prolonged than we are used to. We are now deeply concerned with the impact on our capacity to provide water for citizens or the impact on farmers to be able to grow fodder to get them through the winter period. While it is good to have a nice July and August, the extremes bring into really sharp focus the serious effects. It is incumbent on us to hammer home the message that these events will happen more regularly and the weather patterns will change, according to the predictions. Someone must talk about the science but it is

incumbent on us to talk about the effect which we see happening.

Again, I welcome and thank the professor for his relatively simple presentation. For far too long climate change has been locked up in scientific investigation, mapping, logging and so on, which is all wonderful work, but it has not found its way into the general dialogue. It is starting now, as a result of people realising that something must be happening, this is not normal and the changes in weather patterns have a negative impact. We must move to the next stage, in this committee and in this Parliament, and take difficult decisions which will require leadership from the Government and the Opposition to implement them in such a way as to address or mitigate, to some extent, the really negative impact of a continuation of climate change.

Chairman: I call Deputy Sherlock. I will invite the professor to respond to both Deputies afterwards, if that is okay.

Deputy Sean Sherlock: I, too, welcome Professor Stott to the committee. This has been a useful tutorial for us in an academic sense and a fruitful exercise. One of the professor's slides mentions the global average surface temperature change from 1850 to 2000. Are we talking about an increase in temperature of up to 5° Celsius? What will be the permutations for life of the planet if the average temperature increases by that amount by 2100? Will we be in an existential crisis at that stage if we keep going the way we are going?

What kind of radical measures do governments need to take now in respect of policies that will halt the effects of human-induced climate change? The key message that I have taken from Professor Stott's intervention is that human-induced climate change is a major contributory factor to the increases in temperature. If I understand the professor correctly, he is stating that if we continue to go in the way we are going in terms of the production of carbon, we will overshoot what is envisaged in the Paris Agreement as a result of human-induced climate change and that the lack of policy interventions by governments across the globe means that the change being implemented is not radical enough to halt the effects of temperature increases as measured on the Celsius scale. Will the professor expand on that a little?

Chairman: Does Deputy Stanley wish to put his questions before he leaves? With the permission of Professor Stott, I will allow Deputy Stanley to ask his questions.

Deputy Brian Stanley: I thank Professor Stott for coming before the committee. His contribution - in plain straightforward language - was very useful. Let us assume we have moved beyond denial. The evidence across the globe stacks up - it is undeniable that there is climate change. The vast majority of people accept that. The danger of rising sea levels to infrastructure is an issue that bothered Ireland because it is an island nation. At the present rate of increase in global warming, will Professor Stott tell us what this means for the city of Liverpool or for London, which has a population of 8 million or 9 million people? Some of the households in those cities are situated just a couple of metres above water level? What is the timeline? What is the extent of the risk?

It may be unfair to ask Professor Stott about the Irish situation because he is probably more familiar with the situation in England. However, does what he envisages mean that there could eventually be seawater flowing up Kildare Street? I was at an event earlier in the year at which was displayed a map on which one quarter of Ireland was shown as being underwater. Everybody talks about what Government needs to do - and I am sure Government needs to take action - but individuals, local authorities, businesses, households and farmers have to do something. In terms of society overall, what are the three biggest things we need to do in the next two to

three years?

Chairman: I thank Deputy Stanley. Professor Stott might answer the questions in whatever order he wishes.

Professor Peter Stott: I thank the members for the questions. It is a great list of questions. I will go through them in order.

Yes, we need to move on and the scientific community is ready to respond to the new challenge we have in the scientific community. The fifth assessment report, AR5, in which I was involved was a very important staging post. Human influence on the climate system is clear. It was a very clear statement. What the scientific community is ready to do - and I provided an example from Maynooth University - is provide our science in order to understand exactly what the risks are, understand them on a more granular level and help citizens to respond. Climate change is now part of everyday conservation in light of some of the recent events in the UK and Ireland, such as the floods, the heatwave and the drought. The scientific community is ready to engage in that discussion and to help citizens and governments respond in the most appropriate way to this challenge. It is a really important challenge for the scientific community because it requires us to provide further refinement into our levels of prediction. For example, we need to have an even greater understanding of exactly how particular localities would be affected by climate change.

Let me stress again the clear point that the basic physics mean there is an increasing frequency of many of these types of extreme weather events. We have seen these events play out and they are giving us a lot of confidence that the climate model projects are reliable and that we can use them to provide an extra level of detail.

We had a question on the implications of business-as-usual scenario, with the member pointing to the graph that shows a rise in temperature of 4o Celsius or 5o Celsius relative to pre-industrial levels. Earlier, I related that to the climate of the most recent ice age. There is no doubt that emissions continuing to grow and a business-as-usual mindset remaining in place for the rest of the century will lead to levels of warming weather and significant risks. I refer, for example, to rising sea levels resulting from the melting of the west Antarctic ice sheet and the melting of ice in Greenland. There are significant challenges associated with food security. In circumstances where there is 4o Celsius or 5o Celsius of warming, there is a significantly enhanced risk of the sort of drought that would mean, potentially, that the world would really struggle its population. One can see already that there is not total food security in certain parts of the world. With levels of climate change such as those to which I refer, feeding the world's population will become extremely challenging. There are significant risks associated with rising sea levels and concomitant flooding. As the item on the infographic relating to the water stress hows, there will be a challenge in the context of ensuring that people will have access to water. Given that there are concomitant risks, climate change is also a threat multiplier as well. There are already particular levels of threat in existence even without climate change. However, the latter is then adding to those stresses in terms of, for example, migration.

To be honest, scientifically, it is difficult to paint a picture of the type of world I am describing. This is where we need to look very much in a risk-based context. We can paint pictures of what could happen. I could talk at length about the west Antarctic ice sheet and the fact that there is this massive body of ice that is what we term "dynamically unstable" because seawater is warming and melting the ice from beneath. The latter process poses the risk of the entire mass of ice being dislodged. If the scientific community or I were asked to give a precise prob-

ability of that to which I refer happening, we would both potentially struggle to do so. What I can tell members, however, is that there is a risk of it happening and that the impact would be considerable.

We need to think about food security and other issues in the same sort of way, particularly as they have such major impacts. As a scientist, I can say that there is plenty of evidence to support the supposition that we really do not want to discover what a world such as that which I am describing would look like in reality.

Deputy Sean Sherlock: I asked about radical policies.

Professor Peter Stott: Yes. We can draw on the scientific evidence to imagine a "2° world". We have scientifically examined the measures that need to be taken to make it at least likely - a 66% chance - that we will not exceed an increase of 2 degrees Celsius on pre-industrial levels. We can see the global measures we need to take. For example, we need to reduce emissions by 50% by 2050 and to zero net emissions by approximately 2080 or towards the latter end of this century. Essentially, this means the world must put itself on a trajectory towards zero emissions and, in the grand scheme of things, in quite a short length of time, although beyond the length of time many of us expect to see, but it is the length of time our children and grandchildren could well see.

We must remember that it is the developed nations of the world that have been responsible for many of the emissions. I argue that the next question is for politicians, rather than me as a scientist; it is a question of equity in how the burden is to be shared among nations. The scientific point is that very considerable reductions need to happen to get to the 2° world mentioned in the Paris agreement. That brings us to the question of sea levels, etc. As an aside, I was born in Liverpool and have a connection with the city. The sea level is currently rising by over 3 mm a year. It should be borne in mind that because of the way climate works, "sea level" is termed as an "integrator", which means that it sums up the net effect of everything being done as a consequence of human emissions over long periods. It is not something that can be switched on and off. There is a very long-term commitment - over many centuries - to continued sea level rises as a result of the emissions we are seeing today. Sea level rises also significantly increase the risk of storm surges that have been alluded to. There is a gradually increasing sea level which is clearly attributable to human-induced emissions which result in a warming of the oceans which leads to expansion and also the melting of snow and ice on land.

The scientific community now has a very good and robust explanation and all of the terms in the equation add up. There is very strong scientific confidence in their attribution to rising sea levels. The risk to places like Liverpool and London, as mentioned, is increasing. It is a little like the way I spoke about rising temperatures and heatwaves. I refer to the curve of the background level in sea levels gradually increasing. The Thames Barrier protects London from the consequences of a storm surge, but the risk of overtopping is being increased very significantly because of a baseline rise in the sea level. Thanks to the Thames Barrier, London is currently protected, but if we consider the high levels of global warming with continued high emissions, the question of the Thames Barrier needs to be reconsidered.

Having precise numbers depends on where we look and the configuration of a particular city, the sea bed and all the rest. This is where the scientific community is ready to provide the detailed assessments. There would be differences between Liverpool, London, Dublin or wherever else we might look. I will not give precise numbers, but the scientific community is ready to advise on the matter.

Deputy Thomas Pringle: I thank Professor Stott for his very interesting presentation. I have a number of questions which I will ask quickly.

What are attribution signs and how has the concept evolved in recent years? Does the growing confidence in attribution signs change the way climate change policies should be evaluated for costs and benefits? For example, if we know that increases in temperature will make weather events more likely and intense, how should we measure the potential cost of actions to reduce emissions against the likelihood of these risks?

Met Éireann does not communicate climate science or risk in its forecasting. Does best practice involve reporting climate risk through the meteorological service or what is the best way of doing it? The Intergovernmental Panel on Climate Change is drafting a summary for policymakers of its latest report on how to limit global warming to 1.5 degrees Celsius. The BBC has reported that the differences between 1.5 degrees Celsius and 2 degrees Celsius are quite stark. For example, 10 million fewer people would lose their homes and become refugees; 2 million sq. km of permafrost would be saved over centuries and there would be a 50% global reduction in the level of water scarcity. Does such an analysis and information make us demand more ambitious climate change mitigation policies or are we looking for enough already?

Climate Action Network Europe has published an infographic which estimates that in 2017 extreme weather events in Europe caused €14 billion worth of damage. It estimates that with an increase of 3 degrees Celsius this figure could increase to €190 billion. What would be the total cost of damage for Ireland in either scenario?

Chairman: Professor Stott might answer the many questions asked before we move on.

Professor Peter Stott: Yes and I will try to be brief. I thank the Deputy for his questions.

I have been involved in the attribution science area for a long time. The nub is trying to understand the world in which we live today and the counterfactual world in which we could be living if we had not collectively changed the climate. In comparing the two scenarios we can work out how things have changed in ways which are attributable to human induced emissions. We have shown that we can do this reliably because we have the climate models and understanding to simulate quite accurately on a large scale the current climate and how it has changed over time. For example, the work I did on the European heatwave is robust and the calculations I made demonstrated that the risk of such a heatwave had more than doubled. Subsequent work indicates that the work I did was quite robust.

That brings me to the question of a cost-benefit analysis. The science is starting to try to assess the probability of such events and using attribution science to do so. That is to what the question alludes. It is probably fair to say it is still difficult to be very precise about the cost-benefit trade-off. One needs to understand quite clearly what the costs are, including the avoided costs, and the role adaptation has played. We are adapting. If we look back to the 2003 heatwave, lessons were learned and, thankfully, some of the impacts of it have not been felt since, because the societal systems are better adapted to supporting vulnerable people through heatwaves.

It is not a straightforward exercise. The science can, nevertheless, inform this, especially when it is thought of in a risk context, and can highlight some of the risks and provide storylines of what might happen, what is happening and what we might have avoided. In that storyline context, that can be quite helpful.

On the question on the meteorological service, I refer to the Met Office in the UK. We are now working in the Hadley Centre for Climate Prediction and Research, which was set up many years ago by our Prime Minister at the time, Mrs. Thatcher. We have had a long remit to look at climate projections. Later this year we will be releasing a new set of climate projections for the UK. That will provide a lot of information in this risk-based context and will provide probabilistic information, because we cannot provide a single figure as to what the temperature or heatwaves will be in 50 years' time. What we can provide is a probability, and provide that contextual information for people to understand that and to engage in planning. However one does this exercise, it is important to do this in the probabilistic sense, which folds in one's scientific understanding. There are plenty of quite sophisticated uses where that information can be taken and applied it in their particular context. As to 1.5° report, what I learned just as I came in, is that the committee will hear evidence from the co-chair of working group one, and the co-chair of working group three, who are currently at the plenary meeting in Korea, agreeing that report. This is happening this week. It would be most appropriate to defer that answer to them, if the committee agrees. For sure, as one goes to higher levels of warming, there will be more overall net consequences of climate change, which is true relative to 1.5° Celsius. The co-chairs will be able to provide the committee with much more information on that, which will be in light of a report that will have been approved and published.

As to costs, there are very significant costs associated with extreme weather such as heatwaves, floods, droughts and windstorms. They increase with climate change, but I do not have a precise number for Ireland. It is a good question to ask, however, as to what sort of estimates might be available here.

Chairman: I thank the professor and call Senator Ian Marshall.

Senator Ian Marshall: I thank Professor Stott for a very interesting presentation. My question is slightly different from some of the questions that have gone before. If we accept that the phenomenon of climate change is a global one and deal with it in that context, there is no doubt that human activity is hastening change and what is happening in the environment. When we consider that the global population is 7.5 billion and is predicted to rise to 9.3 billion by 2050, that is going to have an effect. When we consider this on a *per capita* basis, because we accept there are more people on the planet which will have a bigger impact, how much is that changing as we go forward, when we consider people are becoming more aware of these issues?

I refer to the studies carried out on the impact of climate change on developed countries compared to underdeveloped countries, that is, First World countries compared to Third World countries, or the impact of climate change between different continents. I am interested to learn, in the wake of the Kyoto and Paris Agreements, about countries that could benefit from climate change, and do not have a huge appetite to join us on this issue and try to deal with climate change. We all accept that we have responsibility to deal with this and to address the problems and to lead by example, especially the UK and Ireland. Could this good work be offset by an appetite in other parts of the world to industrialise and grow? If that is the case, how do we address this conundrum of collective responsibility?

Chairman: I will let the professor come in on those points.

Professor Peter Stott: Let me address that with a remark from a scientist working with other scientists, but in a different national context. I have done a lot of work in the past few years with Chinese scientists, not just around the attribution science but around the whole area of climate science, as part of a collaborative project I am involved in. It has been very interest-

ing for me to learn a little about the context in China, and to meet some academics talking about the challenges, and to meet colleagues from the Chinese meteorological administration. What I learned there is that China is facing some very significant challenges around, for example, food security - feeding its population - and issues to do with flooding and drought. Chinese scientists have been writing very important papers about how climate change is changing the risk of these extreme weather events. It is clear to me, as a scientist, that the Government in China takes these threats of climate change to its population very seriously. I take that to mean that when China engages in this international political discussion, it is taking that evidence and those impacts on board. This is in the context of looking across the globe, and seeing some countries feeling the benefits from climate change. That may be the case but if one looks across the world, it is probably true to say that the great majority of countries have very significant challenges, including the example I have given of China. While China clearly has its own policies, which I will not go into, one of the issues it is addressing is the issue of its population. This is a serious issue, and it is true of many places.

On the impacts, one of the things the scientific evidence is showing is that many of the areas in the tropics are significantly affected by climate change. These are countries that are very poor and vulnerable. There are very big challenges there. That is something we need to stress because if we think of drought, in particular, the signal of climate change is rather large, relative to the variations in those place in the tropics. The hazard is large there, as is the vulnerability, and therefore, the impact is also.

Impacts, including deleterious ones, are being felt in many parts of the world. One obvious positive benefit is the potential in some northern high latitudes for crops. Studies have looked at that and looking at the global picture, they have concluded that, in the context of continued emissions, it is very clear the net effect is a negative impact.

Deputy Eamon Ryan: I thank Professor Stott for a fascinating presentation. Sometimes we hear in policy discussions on this issue the argument - maybe this is not the professor's science area because he is connected with the IPCC reports - that we might not have to concentrate on methane gas emissions. Due to their short lifecycle, they are not as significant as the CO2 lifecycle, which is much longer. Does the professor have a sense of that? Would it be an appropriate response to discount methane somewhat or are other factors, such as the melting of tundra ice resulting in the release of methane, moving us beyond natural tipping points and bringing methane back into the frame? Perhaps that is outside Professor Stott's area of expertise but if he had a view on it, I would appreciate it.

My understanding is that in recent years, carbon-equivalent global emissions have started to stabilise somewhat - for three or four years they were relatively stable - but that the concentrations in the atmosphere of CO2 equivalent gases have increased significantly from approximately 2.5 parts per million to almost 3 parts per million. Does that tell Professor Stott anything? Is there anything significant we should read into this or is it just a result of natural variability?

I have seen the work of Jennifer Francis from Rutgers University on explaining the phenomenon by which the jet stream is altering and becoming slightly stuck in a more undulating pattern. She argues this is a result of some of the changes occurring in the ice caps. In those circumstances, if Ireland were to end up on a down point of a jet stream groove, as it were, we could end up with a colder climate.

Professor Stott will present some of his assessments on the more local implications of cli-

mate change to the UK Government in the next six months or so. Can he give us a sneak preview of any of that? He mentioned wetter winters and drier summers. We have had similar research from Maynooth University, which has done some very good work on this issue, but the granularity is difficult. Does Professor Stott have a general sense of what the implications might be from looking at this incredibly complex system with all the moving parts? Ireland is not a great distance from the UK. Will Professor Stott share the latest available information on the specific conditions we might expect here in 20, 30, 40 or 50 years?

Professor Peter Stott: They are really good questions. I will take them one by one. If I have interpreted the question on methane correctly, there are two sides, one on emissions and one on the impacts of climate change. There is no getting away from the fact that we need to reduce emissions if we are to move away from what I call a business as usual scenario. There is no easy fix. We cannot play methane off against CO2 or nitrous oxide or something else. There has to be a concerted effort to achieve 50% global reductions by 2050. That means we have to tackle all the human induced greenhouse gases and take a co-ordinated approach. We cannot only look at methane, for example. There is no easy fix unfortunately.

Deputy Eamon Ryan: Methane should not get a pass.

Professor Peter Stott: Methane should not get a pass. Nothing should get a pass. That is the spirit of-----

Deputy Eamon Ryan: Some people argue it should.

Professor Peter Stott: We have to get emissions down over a period of time. That is the big picture and there is no getting away from it. One can get into very detailed arguments about timing and exactly what we do in which year and what a particular country does in which year but that was not the spirit of my remark. My remark concerned the big picture. That is the context in which one has to view it.

The Deputy referred to the tundra. One of the risks of continued climate change arises from the fact there is methane in the tundra. The methane clathrates right at the bottom of the ocean must also be considered. If one is talking about the more extreme warming rates, there are risks we cannot quantify very precisely. There could be very large releases of methane which could have a significant warming effect.

On the Deputy's question on emissions versus concentrations, the big picture still stands. Emissions and concentrations continue to increase. There are some variations from year to year potentially to do with economic activity and there are probably difficulties with precisely measuring emissions. The big picture is it is certainly the case that emissions and concentrations continue to increase. The only way to stabilise the concentrations is to reduce the emissions.

The Deputy asked about the jet stream and the work of Jennifer Francis. There is some fascinating work being done on trying to unpick the issue of the jet stream, which carries our weather systems and varies. For example, the position of the jet stream was relevant to the sort of weather conditions we had this summer. Exactly how the jet stream is varying and exactly how it might be impacted are subjects of intense scientific debate. So far there is not very strong scientific consensus that there is a very direct link between, for example, the Arctic sea ice decline, which is very clear and absolutely the case, and how that is affecting the jet stream. There have been lots of studies about that and about precisely how the jet stream is changing. What we do know is that the high latitudes are warming up more than the lower latitudes. The Arctic

is warming up much more rapidly than the lower latitudes and that is changing the temperature gradient of the surface. We also know about what is happening at the upper atmosphere. Potentially it could be pushing the jet stream further north and potentially weakening it.

Taking account of some of those details does not change the overall message that, broadly speaking, summers are getting warmer and are expected to get warmer and that there will be wetter winters. The day after tomorrow type scenario of a dramatic change towards colder temperatures in Ireland or the UK is not likely. The day after tomorrow scenario is associated with overturning circulation and the currents in the Atlantic Ocean and the idea that the whole system shuts down and potentially cools down temperatures at these latitudes. One might think of it as a risk but I would say it is a low probability that can only be thought of in the context of more extreme levels of climate change. What we need to concentrate on in terms of planning and adaptation are the narratives around warmer summers and wetter winters and then to add the details on to that. In terms of the UK climate predictions, we will do that later this year.

Deputy Marcella Corcoran Kennedy: I thank Professor Stott. He gave a very interesting presentation and I appreciate his attendance to assist our committee. I was thinking about the graph concerning the 1° Celsius temperature increase. If we do not get our act together globally, at what point will the temperature increase by 4° Celsius? How many decades or centuries are we looking at? What would the planet look like if we experienced such an increase?

Professor Peter Stott: One of the graphs I showed to the committee addresses the question about the 4° Celsius increase. It shows a scenario, which in the jargon is called RCP8.5, which is the business as usual scenario of continued emissions. One of the graphs with a red band shows the different climate models and is a portrayal of the scientific uncertainty.

In answer to the Deputy's question about 4° Celsius, and remembering that there is a slight technicality here because this is being referenced relative to the 1981 to 2010 average, so one must read it off quite carefully in terms of where that is, but looking at the median of that towards the latter part of this century, maybe about the 2080s or so, it can be seen from that that there is some uncertainty about when that 4° Celsius will be crossed. There could be a range of times. If climate is warming up faster, it could be earlier, perhaps as soon as the 2060s, or it could be considerably later than that, depending on whether we are lucky or unlucky in terms of the exact climate sensitivity.

In terms of the impact of that, I refer back to my earlier comments that once we reach 4° Celsius or more, then to some extent we will be in a scenario where there are these risks that we know exist and that we know have very significant impacts, for example, in terms of food security, agriculture, a sea level rise from melting ice from Greenland and the west Antarctic, and significant increases in flooding events, heatwaves and droughts. At such levels of warming, it is difficult to be very precise about the probabilities of such impacts and what that will mean. The last graph I showed members illustrated the level at 5° Celsius when we would see impacts on huge numbers of the global population. These graphs show that there are not many parts of the world that will escape this, and this raises the question of how we will adapt. It is a difficult question to answer. It is hard to know how the global population would be able to cope with such impacts. It is hard to be precise. It is much easier to paint the picture of the graph I displayed, with the heatwaves, the cropland decline, the flooding and the water stress, which summarises briefly from an exercise that we did in the Met Office. It is easier to paint a general picture of an extremely challenging situation that would be very difficult for people to cope with.

Deputy Marcella Corcoran Kennedy: We are naturally bound to think of the impact on ourselves and on the hard infrastructure to mitigate against flooding and so on, but what about the impact on plants and animals on the planet? There must be an impact on the ecology. If the water temperatures are increasing, there will be all sorts of impacts. How will fish survive, for example, or what kind of microbial activity will follow and what impact will that have on us? It is Armageddon stuff we are talking about. If the pollinators are impacted, there will be no one to pollinate our plants. I do not think that we have thought through the seriousness of this at all.

Professor Peter Stott: It is a good point that we should not forget the natural world. I have not yet mentioned ocean acidification, which is another impact of climate change. The ocean is becoming less alkaline as a result of carbon dioxide being taken up and there is a substantial threat to marine organisms to make their shells because of the ocean's changed chemistry. We are already starting to see the impact of climate change in the oceans through coral reef bleaching as temperatures rise, to which the effects of ocean acidification is added. Discussion has begun on using geoengineering to geoengineer our way out of the climate issue through, for instance, putting dust into the atmosphere which might cool the planet. That would not address ocean acidification because, if we continue to pump out carbon dioxide, the ocean will continue to draw it down and it will continue to have this impact on the ocean ecosystems. That is an important point to remember.

Deputy Marcella Corcoran Kennedy: My other question builds on Deputy Pringle's earlier point on reaching the citizen and explaining what is happening. Professor Stott said that the Met Office had a long remit to look at climate projections. What is its relationship with the BBC in terms of using its service to explain what is happening with the weather relative to the individual? Does it have a specific policy remit in that regard?

I am interested in Professor Stott's views on policies. It seems there is a policy where when a broadcaster features a climate scientist, they automatically have a climate change denier on too. That seems insane at this point. We should not give a platform to people like that at this stage when we are trying to explain to citizens what is going on, why the climate is changing and why we must make certain decisions. We have failed badly here in getting our message across. Our meteorological service in this country should be doing more to explain to the population what is happening. Does the Met Office in the UK have policies that enable it to do that? Met offices around the world are doing very innovative things in communicating what is going on.

Professor Peter Stott: The BBC has recently issued guidelines on communication around climate change. I cannot speak for the BBC but I understand that there is a clear understanding that it is not productive to have someone saying things that are scientifically not correct. I have some experience of this myself. Lord Lawson was on the BBC "Today" programme where he said things to the effect that global warming had stopped. I was on the "Today" programme the next day to correct that statement and state that that was not the case. With the new guidance that has come out very recently, the BBC has recognised that it is not productive to have such a non-debate because the established fact is that climate is changing and that there is a relationship to human emissions.

The Met Office has a wide remit to advise Government on a range of issues relating to climate change. We take opportunities whenever we can and wherever it is appropriate to communicate to the press. For instance, during the recent heatwave there was considerable interest in the media and I was interviewed for the 10 o'clock news on the BBC by David Shukman to talk about the heatwave and how it was linked to climate change. That remit is seen in the context

of a general remit to communicate our findings to the British public, and it is in that spirit. We try to do this in a way that is scientifically informative and to be available when asked. We try to bring our latest science to that. The Met Office often produces briefing notes and we provide information when there are particular weather events or there are particular issues on which this scientific information would be useful. We try to do that at those moments. The BBC is one means by which we can communicate this but there are others such as newspapers, online, and social media. There are other means by which that can be communicated as well.

Deputy Marcella Corcoran Kennedy: Professor Stott referred to the atmospheric river. Will he explain that further?

Professor Peter Stott: It is a weather phenomenon and it occurs in both hemispheres. I was involved in a study that examined extremely heavy rainfall and flooding in New Zealand. New Zealand has atmospheric rivers as well. Basically, it is what happens when there is a plume of air moving up from the subtropics, which brings air that is more normally found much further south in the northern hemisphere. It brings that air, heavily laden with moisture, in a steady plume from much warmer ocean temperatures than we are used to here, transporting it many thousands of kilometres up to our latitudes. The issue is that due to how the atmosphere works this stream of air can be quite steady for many hours, even for several days, and basically dumps rain in a particular locality. It is almost like bringing somebody else's weather to our shores. When it happens it shows our vulnerability to that type of weather event. The issue with climate change, as the study from Maynooth University has shown, is that with warmer ocean temperatures - I spoke about 6% or 7% more moisture in the atmosphere for 1° Celsius of warming - that is loading the atmosphere even more and the impact when it happens is even greater than it would have been without climate change.

Deputy Tom Neville: I apologise for being late. I have been reading about methane and agriculture in Professor Stott's presentation. This might be outside his remit but does he have any proposals to mitigate the methane emissions in agriculture? Second, he mentioned dust and cooling the planet. Will he elaborate on that? I found it interesting as I have not heard that previously.

Professor Peter Stott: With regard to methane, I see it in a wider context, but if the Deputy is looking at a specific national context, I would not necessarily wish to comment in great detail on that.

Deputy Tom Neville: The last paragraph of the report I have states that 90% of Irish methane emissions comes from agriculture. That is the reason for the question. Is the report I have different?

Chairman: That could be the one from the Citizens' Assembly.

Deputy Tom Neville: That is what we were given and that is the reason for my question.

Professor Peter Stott: I am not questioning that statement whatsoever. All I am trying to say is that it has to be seen in the context of other gases.

Deputy Tom Neville: What I am trying to ascertain from witnesses who appear before the committee is practical solutions that we can put in place for quick wins, the medium term and the long term. I am trying to ascertain if Professor Stott has any suggestions or advice around that. If he does not and it is not his remit, I accept that.

Professor Peter Stott: It is fair to say that I do not have particular expertise on that. I do not wish to stray into an area in which I do not have specific expertise.

Chairman: We will ask Teagasc about that.

Deputy Tom Neville: My second question was about Professor Stott's comment on dust.

Professor Peter Stott: Yes.

Deputy Tom Neville: Will he elaborate on that?

Professor Peter Stott: I was alluding to the issue of geoengineering. Faced with these challenges, one proposition being made is that perhaps there is another way to keep global temperatures from increasing by 4° Celsius or 5° Celsius. One suggestion is that if dust were to be put very high in the atmosphere, it would cool climates. This is basically mimicking what happens naturally when there is a big explosive volcanic eruption. There was one example of that in 1991 when Pinatubo exploded. That temporarily cooled the climate for a year or two before the dust fell back down out of the very high atmosphere. One could say that perhaps that could be done artificially, but there are a couple of issues to think about with that. The one I alluded to is that it would not deal with the fact that we are continuing to pump carbon dioxide into the atmosphere and, therefore, continuing to make the ocean more acidic. The second point is that it has major impacts on rainfall patterns. Doing such a massive thing to the climate has massive impacts.

Deputy Tom Neville: Can Professor Stott see any scenario where we can succeed in carrying out the reductions over the next ten to 20 years globally and where there would be an acceleration of a cooling down process as opposed to a slowdown of a heating up process? Professor Stott can correct me if I am wrong but it would be similar to the hole in the ozone 30 years ago. When CFCs were banned, the hole started to close up. Is there any evidence based around that or anything on the flip side?

Professor Peter Stott: The ozone is an example of where scientific evidence and international co-operation have shown that such a global challenge can be solved in collaboration with the relevant industries and so forth. The ozone hole is starting to recover so we have seen how we turned the corner on that. The thing about the global temperatures is that due to the long timescales in terms of how the climate works and in terms of this thing called "commitment", the scenario we are looking at is stabilising temperatures, at least over timescales of decades. To reduce temperatures, one is in the scenario of trying to take greenhouse gases out of the atmosphere. The analogy of the ozone hole, where the ozone hole recovered, for the climate change problem would be that potentially humanity would succeed collectively in stabilising temperatures. If they were stabilised at a sufficiently low level, that would be an achievement comparable to the ozone hole. The reason for that in terms of stabilisation is the long timescales and the long commitment that past emissions have made to our warming. The issue with climate change is that our emissions cumulatively lead to an overall level of warming, so that would be the analogous success there.

Deputy Tom Neville: My final question might be superficial but are there any studies on using chemical reactions or chemistry for extracting gases such as methane and nitrous oxide from the atmosphere, similar to what one does with re-afforestation to take carbon dioxide out of the atmosphere?

Professor Peter Stott: I am not aware of any magic bullet that will fix the issues short of

a general reduction of emissions through a range of measures that collectively will bring the emissions down.

Chairman: Deputy Pringle has a final question.

Deputy Thomas Pringle: My question is probably stupid but is it correct that if we halt climate change now, things will stay as they are and the extreme weather events we have had so far will continue?

Professor Peter Stott: Yes. The point is that there are changes we must adapt to no matter what happens. The adaptation issue is important and real. We do not live in the climate we used to have. We have lived in a changed climate that brings additional challenges so we must adapt. However, we must also mitigate emissions to prevent those high levels.

Deputy Thomas Pringle: Basically, the more mitigation we can do now the less adaptation we will have to do.

Professor Peter Stott: In broad terms, yes.

Chairman: I thank Professor Stott for travelling to Ireland to appear before the committee. We appreciate the very productive engagement with the members.

As there is no other business the meeting is adjourned until 2.15 p.m. next Thursday, 4 October.

The joint committee adjourned at 8 p.m. until 2.15 p.m. on Thursday, 4 October 2018.