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# WHO'S TO BLAME FOR BRITAIN'S FLOODS?

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In the last 15 years, the UK has been devastated by a series of floods that have caused enormous physical and economic damage, seriously affecting people's physical and mental health – the estimated cost, for example, of the 2015 events in Northern England was probably something in excess of £5 billion. Media coverage, of course, has included all sorts of allegations about the incompetence of various people – scientists, weather forecasters, planners, builders, water companies – and there is lots of conspiracy theories, fake news, and alternative facts. I want to explore tonight whether the latest scientific evidence about the causes of recent floods can dispel some of the myths about our ability to control the rising waters.

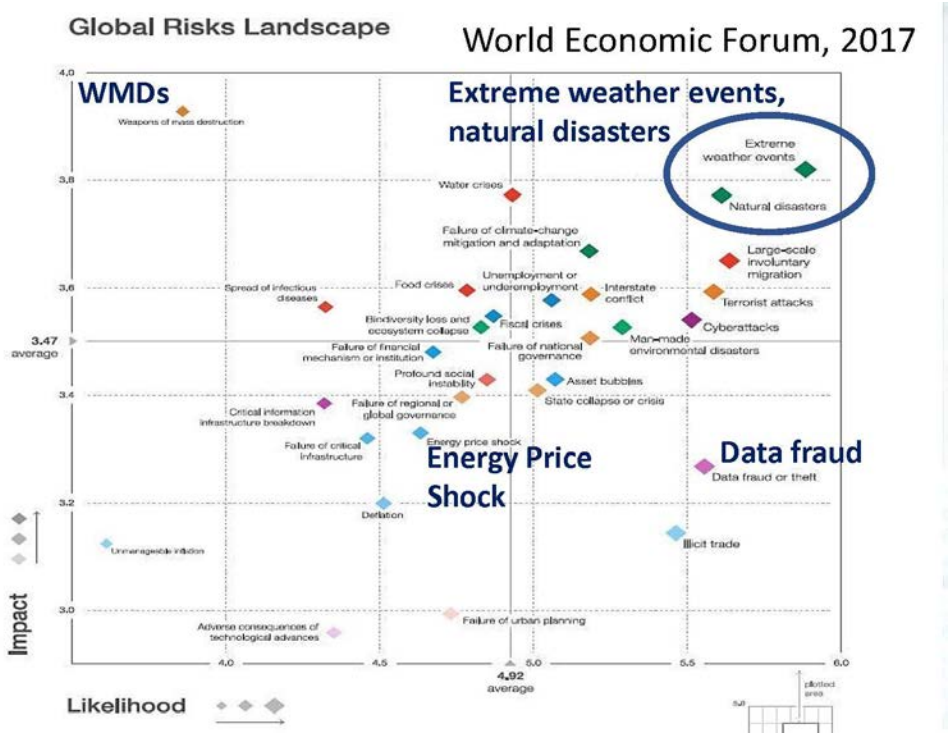
As I wrote this lecture, earlier this week – that is obviously for the benefit of those watching online and catching up later, that is late May 2018 – localised flash-flooding has hit Birmingham in Central England. At least one person has drowned, caught in their car in almost two metres of water, and Edgbaston, part of Birmingham, received 58mm of rain in an hour on Sunday this week, and 81mm in a 12-hour period according to the Meteorological Office. The monthly average for that area of England is 55mm, so it was certainly unusual.

Areas of Northampton and several other parts of the English Midlands have also flooded in the last few days, not to the extent of the flooding there in England in 2012 or 2007, but, nevertheless, sufficiently seriously to create millions of pounds of damage and to make us question again why it happens.

Just to add to the illustrations here, what you are often looking at here is not just water but sewage that is flooding into people's houses, which is obviously very, very unpleasant.

Now, these events make us question whether somebody is to blame and why it is happening. Perhaps the river channels are silted up, perhaps the topsoil has been eroded or baked and it has created more overland flow, or perhaps, as the suggestion here, somebody has mismanaged something, some sluice-gate or a bridge was blocked, or one area was deliberately flooded to save another. Certainly, we say, immediately after the event, that not enough money is being spent on flood-protection, but our memories of course are very, very short. We also observe blame being apportioned, often by very ill-informed politicians, in astonishingly new Wellington boots, in the immediate aftermath, and they say things like, "The Environment Agency need investigating," "The local council is responsible," "The water companies need to do something." Surely, somebody must be culpable for what is seemingly a growing and inexorable challenge.

River and related flooding is a major challenge globally, and in March this year, the European Academics Science Advisory Council and the flood-insurer Munich Re reported that floods and extreme rainfall events have increased by more than 50% in the last decade and they are now four times the rate of the 1980s. You can see this analysis here, suggesting that extreme weather events, of which floods are an important component, are the top-ranked risk of the next 10 years for insurers. Climate-related losses rose 92% in the last seven or eight years, that is a big increase.

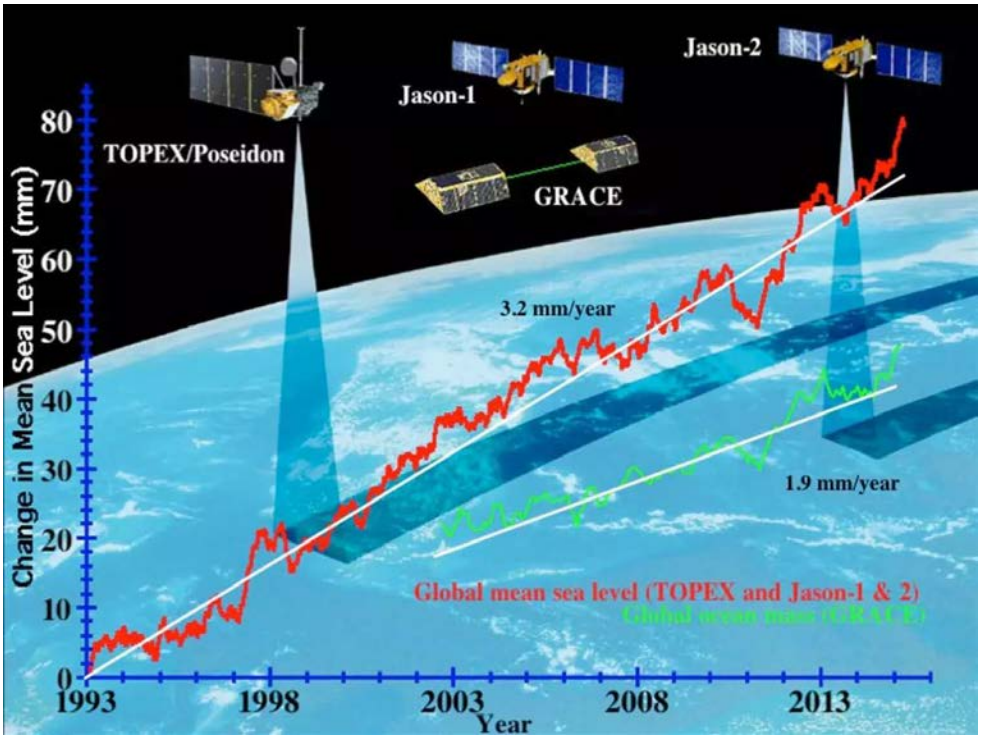



This analysis by the World Economic Forum last year – it is perhaps a bit difficult to see. It is analysis of risk, where we have, along the bottom axis here, we have got the likelihood of something happening, from low, at the left, to very high, on the right, and at the side here, we have got the impact, from low, at the bottom, to high, at the top. So, something like weapons of mass destruction would have a very big impact if Trump goes completely crazy or the inhabitants of North Korea decide they want to make a statement of some sort, but the likelihood, according to this analysis, is very low. We have got other things on here like data-fraud, which we have just seen happen – this was done in 2017 – which the likelihood is regarded as very high but the impact relatively low. Then, if you look at the top right, the most likely, with the biggest impact, is extreme weather events and natural disasters. So, this is done for the insurance industry. This is telling us this issue matters.

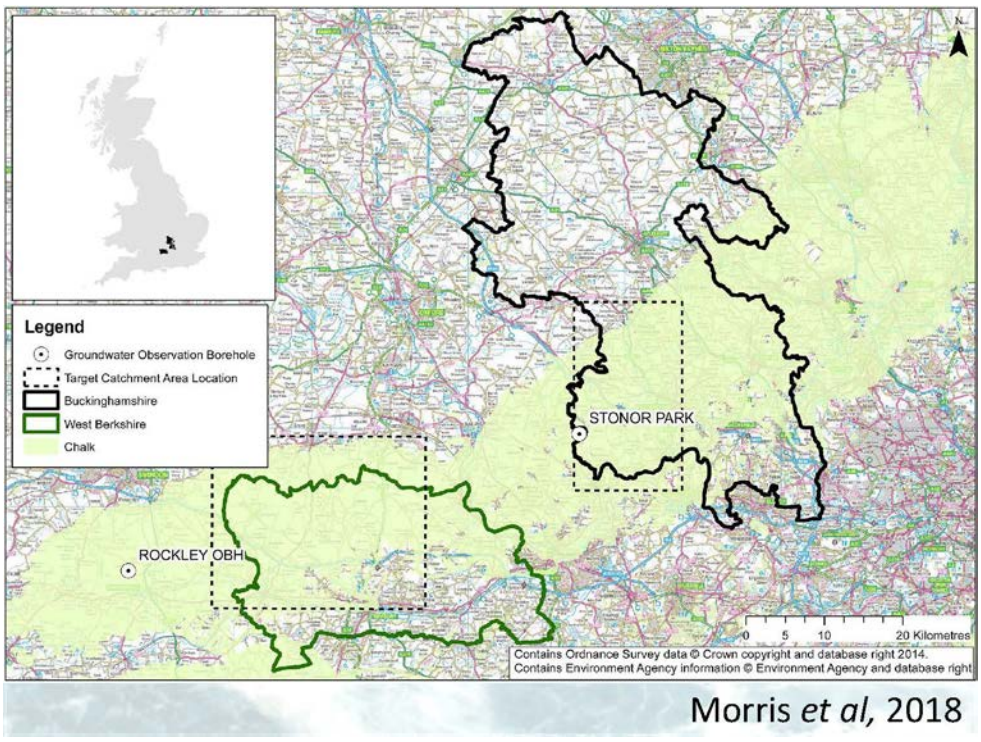
Now, of course, in the 19th Century, there were also concerns about London flooding. Flooding was thought to be significant then and of course, again, internationally, Paris has recently experienced flooding too, in January, in the Seine.

Beyond that, the UK risk is thought, by scientists, likely to intensify. Climate change seems to be increasing the risk of high-intensity flood-generating events, and growing urbanisation has increased the risk, not only by paving surfaces, but also, it is putting more people in harm's way, and those people own more property and more things, so, as people get wealthier, the risk, statistically and financially, goes up. So, what is being said is that our flood strategy is failing, even though events come and go. Public spending, as I said earlier, is intermittent following a flood, but it evaporates very quickly afterwards, and it is skewed now towards dealing with the aftermath of the flood rather than preventing or reducing it or addressing the misery that floods cause.

Today, I am going to pack some science into the beginning of this talk. I am going to focus particularly on flooding that develops over land surfaces, fluvial floods, coming from rivers, streams and sewers, and I am going largely to ignore sea-level change and coastal flooding, but I could not resist showing you something before I do that. This is a diagram that was produced a couple of years ago showing the actual change in mean sea-level, based on several satellites and produced by NASA, and it is showing an increase of 3.2mm a year. Now, that figure is disputed, but sea-level is probably increasing.

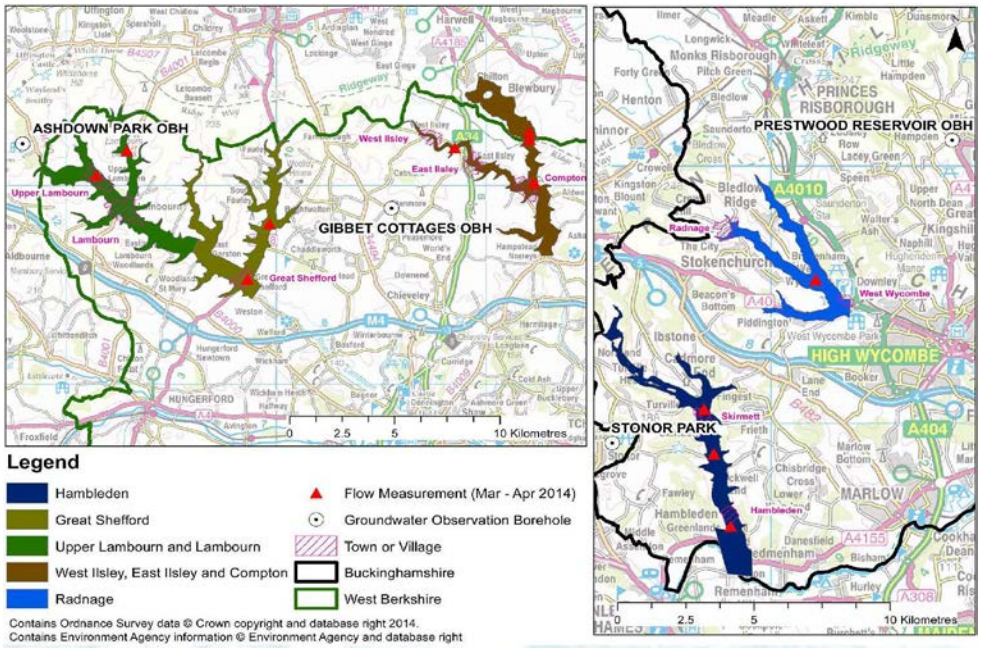



But what I liked particularly was this quote here, from a Republican Senator in Alabama, and he says, "Now, you have got less space in those oceans because the bottom is moving up - what about the White Cliffs of Dover?" What he is saying is, because there are cliffs crashing into the sea, that displaces water, which forces it to rise, does it not? Now, if you think about the White Cliffs of Dover and how much is dropping off them, it is not really, in my opinion, and most scientists', likely to account for 3.2mm of ocean rise year on year. But there is no doubt that – the point I want to make here is that opinions differ, and people say things, some of which may be true, some of which may not be true. In fact, he went on to say that there was no need to do anything about carbon emissions because the Antarctic ice-sheet was growing, and the climate was cooling. Now, whether or not you agree with that, most scientists do not agree with that, and I might even pigeonhole it in a little pigeonhole labelled "lies" and I would start to wonder where his income was coming from.

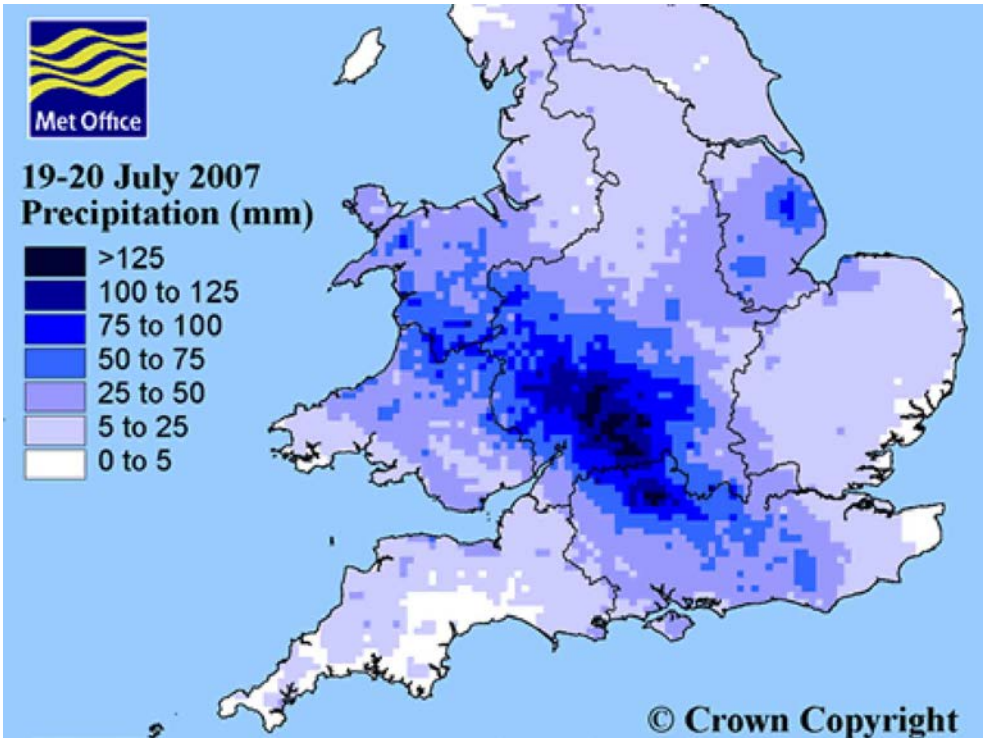



Morris *et al*, 2018

That is all I am going to say about sea-level rise, and I am not going to say very much about groundwater flooding either, though it does happen in some areas, in the UK, and particularly around areas of chalk, such as in the map here. So, you can see, the green area here, this is just outside London, and it is illustrating a research project that is going on now, looking at groundwater flooding in some river basins near High Wycombe. I do not know whether we have got anybody from High Wycombe here tonight, but groundwater does come out on the surface periodically. It is usually very local localised and relatively shallow, although it can be rather persistent, and the results of this research project that has been looked at recently just shows – I think the most important thing to note there is that the areas at the bottom of the valleys, which is where the groundwater flooding occurs, are in turquoise, but the water is 10cm deep, so it is not huge, and it is not moving very fast either. The royal-blue areas, there are some tiny areas of royal-blue, where water might reach 30cm deep. But it is not, in my opinion, a major problem, and the water is quite clean usually because it is seeping out of the ground. So, I would say that is less important than some of the other reasons for flooding.



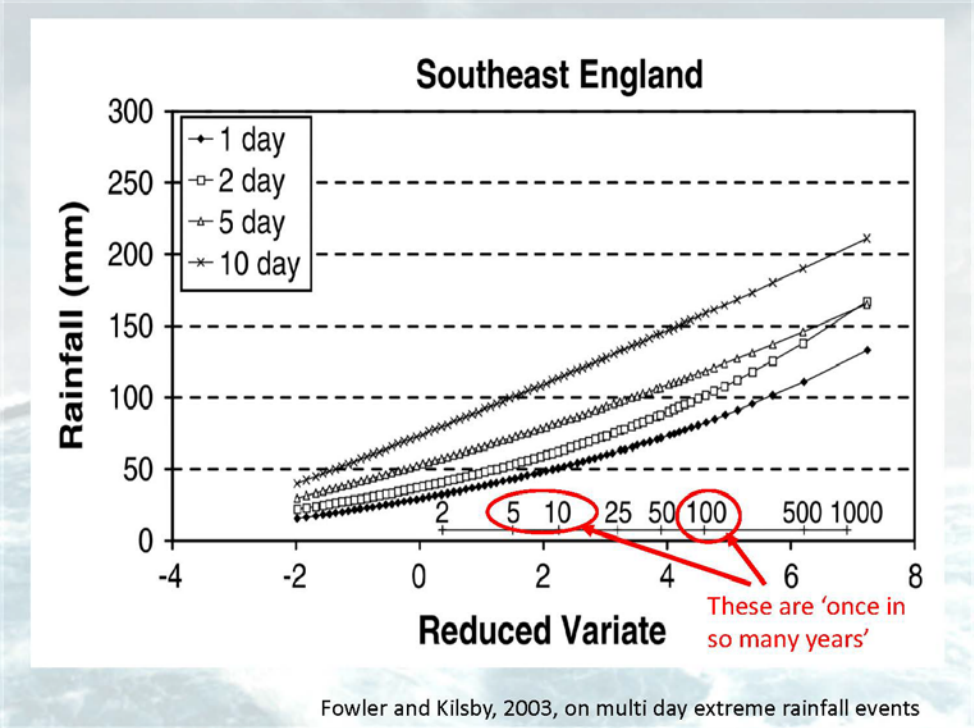

Research catchments visited during groundwater flooding in 2012/2013 and 2014, around High Wycombe



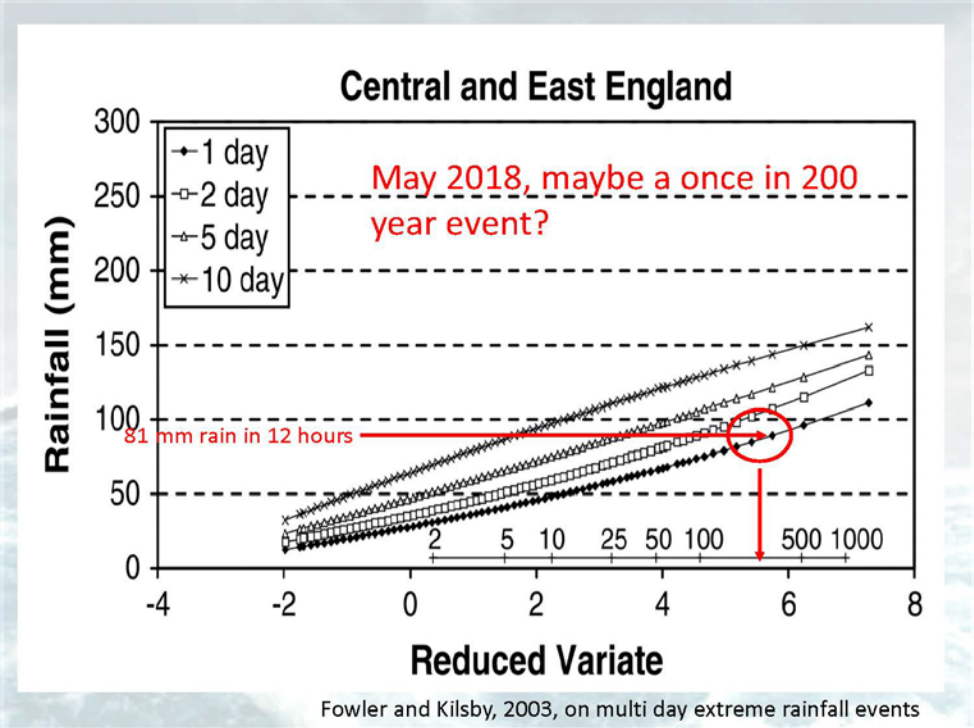

Let me turn to those land areas that flood. Now, land areas flood for several reasons, and I just want to start by talking through what happens. Firstly, and self-evidently, before a flood, it rains, usually heavily. I have got a diagram here showing the rainstorm that was responsible for the very serious flooding in Gloucestershire in the River Severn in 2007, in July 2007, where you can see there, based on radar information, the intensity of that rainstorm. It is a belt of rain, rather like what we have going on now actually across Central and Southern England. You can see, in the middle of it, we had over 125mm of rainfall in that two-day period, a lot of rain. More importantly, in this particular case, the rainfall was very widespread, and it was also sitting over the River Severn Basin for a long time. It is almost aligned with the River Severn Basin, so the whole of the area was rained on.

Rainfall is a statistical function, so we can cite an average amount for a particular location in a day or a month or an hour based on past records, when we have them, but it is always possible that, in an exceptional event, there could be more than ever previously recorded – that is, the storm might be very unusual but nevertheless possible. When we do this statistically, we assume that there is no upper limit on what we could see.

One of the reasons for that is that recent research on the Jetstream and the upper atmosphere is showing what are now being called atmospheric rivers in the sky, and we have got a couple of examples here. These are modelled, these are based on observations, atmospheric observations, physics and so on, radar observations too, and they show water vapour tracking across the Atlantic in different configurations, at a high-speed river, if you like, that may drop its rainfall - you see, on this particular example, may drop its rainfall on the UK. Now, that has only just started to emerge as one of the influences on heavy rainfall in Britain.




Fowler and Kilsby, 2003, on multi day extreme rainfall events




Fowler and Kilsby, 2003, on multi day extreme rainfall events

But the statistics are complicated. I have already mentioned the issues about intensity and length of storm, but I want to horrify you by showing you graphs, and I hope you will bear with me for a second. This is designed to be relatively straightforward. Now, what we have got on this graph, at the side of the graph, we have got rainfall, in millimetres, an amount of rainfall, and across the bottom, I want you just to look at the numbers where I have put the rings, so just look at the figures where it says 2, 5, 10, 25 and so on. That is how frequently you might expect that amount of rainfall. So, where it says 2, you might expect that amount of rainfall every two years. It means once in two years. On the right, you can see we have got a figure of 1,000, which means we might expect that rainfall once in a thousand years.

For London, we have got different lengths of rainstorm. Now, we tend to get serious flooding when we get – in big rivers certainly – when we get a period of days of flooding. So, the top line there is 10 days, a 10-day

rainstorm, how much rain would that generate? Then, the bottom one there, is a one-day storm, which would obviously generate less rainfall.

Let me illustrate that with the Birmingham event that we have just seen, and I want to say this is not really very scientific, this is a rough and ready calculation. We have 81mm of rainfall in 12 hours, so you can see that at the side here, 81mm of rain in 12 hours. Now, let us assume it was over a day, let us assume there was not any more rainfall that day. If you go across to the line for the one-day event, which is the bottom line, it suggests that that amount of rain might occur once in about 200 years, okay. Now, that sounds relatively unusual. It is an event that we might expect once in 200 years, and people said, "We have never seen anything like this before!" Well, that is why. But the point is that, somewhere in the UK, that unusual event is going to occur much more often – there is going to be an event somewhere, of some length, perhaps longer, perhaps shorter, anywhere in the UK, almost every day if not very, very frequently. So, that is a statistical function, and of course, it is a very preliminary analysis, and it is based only on rainfall data that we already have.

The point is that the underlying analysis for this, which was done about 10 years or so ago, has separated out data from before and after 1990, and what they have done, actually, is suggested that those lines – and I have not put the other diagram up, but for the North and the West of the country, particularly in Scotland, those lines have gone up, those fuzzy lines have moved up, so since 1990, we are getting more wet period of days than we had in the past. Now, what that means is that the chances of that occurring is more likely. So, if we looked at something like a 50-year event, where I have got those figures at the bottom there, in the East of Scotland, that is now going to occur once in eight years, not once in 50 years, for the South of Scotland, it is going to occur once in 11 years, not once in 50 years, and in the North of Scotland, it is moving less, maybe from 50 to once in 35 years. In Northern England, the recurrence interval, the frequency with which it is occurring has doubled. So, these are very serious shifts in changes.

That is based on very dodgy statistics. We only have a short period of record. We talk about non-stationery series.

Things can shift further, as with any situation, and if you look at what happened in the North of England. This is a picture of Calderdale. It flooded in 2014, 2015 and 2016, and they were all exceptional events statistically. Now, the recent for that is that the atmosphere is very complex, and although we have very good forecasting in this country – we have some of the best meteorological science and the best hydrological science anywhere in the world – we are still not able to deal with this completely. What we know is that wet years and dry years come in clusters. The intense rainstorm does not come once every 20 years, it comes in a group.

Some of you will remember 1976 as being a very dry year, 1975/76. We are in a wet phase at the moment. Now, maybe that shift from 1990 onwards will not persist. Maybe it will shift back to a dry period. We just do not know. But there are clusters.

So, when we calculate the chances of rain of particular amounts, we are actually assuming things are operating the same way as they always did, and that might be wrong.

Let me turn my attention to what happens when it hits the ground. Rain falls, clearly, and every part of our land surface lies within a catchment area or a river basin, and water hits the ground and it starts to seep through the soil, or sometimes, if the soil is very shallow, it is going into underground rocks. From mountains and hills, it starts to seep towards low points in the ground and emerges in stream channels at some point. If there is an awful lot of water, it can get squeezed upwards out of the ground. That is why we get groundwater flooding, because a lot of water is trying to get through a small area, a small depth of soil, and therefore it gets squeezed up onto the surface. If the ground is saturated, completely soaked, all the little spaces in the ground are full up, then some of that rain will flow over the surface of the ground, or if the surface of the ground is baked or compacted, that will happen as well. So, after a few hours - sometimes it is only minutes, in an area such as the one in the picture here – it arrives at a river channel, and funnily enough, we know very, very little about the process of how water actually emerges in a river channel. We do not very often see it running over the surface either. But, somehow, it gets into the channel. So, that is future research, I suppose.

But once it is in the channel, the flow then is more complicated again than you might think. So, the water is going downhill. It is going fastest in the channel in the centre, and slower by the bed of the channel, and it is gathering velocity and volume as it progresses downstream. Now, natural channels in the UK are normally adjusted to something like the peak flow that occurs once every two or three years. That occurs because the river channel erodes and sediments, and they tend to assume a form which accommodates just about the flow that might be expected once every two to three years. How it does that is beyond the scope of today's talk, but, obviously, following very heavy and unusual storms, greater than that – the peak flow that comes down the channel will be bigger than the capacity of the channel to accommodate it.

So, what happens then? Well, it overflows onto what is called the flood-plain, and I am sure you all know this anyway. The press always describes this as "rivers bursting their banks". I mean, rivers do not burst their banks. They overflow onto the top, onto the flood-plain, and they take sediment with them and they deposit new features. Rivers are naturally mobile. The rivers normally would shift around and so on. If the rain falls mainly on the hills, as opposed to the plains, as the water flows downstream, the height of the flood-peak actually drops. This is something called attenuation. So, up in the hills, the flood-peak, over time, rises, and then it falls away. Further downstream, the flood-peak is lower. The amount of water might be the same, which would be the area under the curve, it would be less, but the flood-peak would be lower because the channel will be bigger – it would be accommodating a larger flow. So, that is called attenuation.

If we want to understand more about the movement of flood-peaks, I am afraid we have to go into something even more complex, and I want to involve you in a little thought experiment. So, I want you to imagine that, on this lectern, I have got a very large rectangular block of jelly. Let us say it is blue, for sake of argument, and I have also got in my hand a very large hammer and what I am going to do is I am going to hit the side of the block of jelly. Now, you can probably imagine in your head what is going to happen to that block of jelly. The block of jelly does not move much itself, but if you look at the top surface of it, you see a ripple going down it from left to right. Now, it's a shockwave. The jelly-block itself is not going anywhere much, but there is a shockwave passing through it, and that is exactly what happens in a river channel. We have water arriving at the top of the channel, it flows into the channel, it sends a shock down the channel, and the flood-wave, the peak of the water, travels faster than the water itself. So, the flood-wave is travelling at one mile an hour, more than probably, one metre per second but the flood-wave might be travelling half as fast again, because there is a shockwave. So, rather than the block of jelly, which is stationery, our water is already moving, but the flood-wave is moving faster than that. This is where we get problems in trying to model what is happening, because not only is that water, the flood-wave, travelling faster than the water, there are bits and pieces of it overflowing onto the flood-plain all over the place as well, and coming back in again, and it makes it very, very difficult to model what is actually going on, to understand what is actually going on. We have altered the courses and the sizes of river channels over millennia, not least of course by trying to control the flooding, and beyond that, of course, when we try to start understanding what is happening, every flood is influenced by a different set of circumstances -- different weather, different channel, different gradients, different vegetation, different soil moisture and so on.

When we meet the model of a river channel, the lower courses of a river, things become even more complicated. Flood-plains are very popular places for things like high-value agriculture and building, and in our towns and cities, we have put in walls and sluices and bridges and mill-leats and landing stages and all sorts of other structures, like the Docklands, at the Isle of Dogs, along the Thames. We have also encroached on the river channel. We have made it narrower in lots of places. So, we do all these things, and then we complain that the structures are being flooded, on the flood-plain, by unstoppable events. We say, "Well, why isn't somebody doing something about this?" And, traditionally, we have tried to do something about it. We have built dams and flood barriers to hold the water back. We have built walls and diversion channels, and we have dredged and straightened to try and get the water away downstream faster.

Today, there is a much greater interest in a variety of other kinds of approaches, including intervening to try to disrupt that downstream flow of water, at every stage, from the hills in the upstream parts of the flood-plain, everywhere in the channel, we are trying to encourage it to evaporate or infiltrate into the ground, and those are

called catchment-based or natural flood management techniques, and they are said to be more holistic. So, they are not just an engineering solution, they are supposed to be kinder to nature, for example, and probably they are. But it is not proved very easy to establish the extent to which those approaches have actually reduced flood risk or flood damage. Arguably, we have not yet tried at sufficiently large-scale and for long enough but experimenting of course with what may be people's lives is not a very popular stance for a politician and those who vote money for these projects. They often prefer something more traditional, where a wall or a diversion channel can be seen.

We also know that politicians are not the only people with views on what should be done. There are a great many stakeholders in flooding and flood management. We are all stakeholders, and we have different perspectives. We might even disagree about what we are trying to do. So, some people would say the goal of the enterprise is to stop the flooding – that is usually what a politician will say, for example. Or somebody else might say, "Well, we're trying to reduce the frequency of the flooding," and somebody else might say, "We're trying to reduce the cost of the damage," an insurance company, for example, might say that, because perhaps we expect that there will always be floods, they are going to continue, but we will try and reduce the cost of it. Or we might say, well, we are trying to ensure that the right people will pay to sort it out – i.e. not us, somebody else will sort it out. Or we might say it is going to be a cost on society generally, like education or defence, and just accept that. Another possibility is that our principal target might be to stop people drowning, that would be fairly important. But those are very, very different goals, and at present, we are spending approximately, according to a Green Alliance report 18 months ago, we are spending about £613 million a year dealing with the after-effects of flood – that is public money, and only £216 million on hard flood defences, as they describe. Now, of course, we then might have to say, well, is that the right balance? We are spending more on dealing with the aftermath than putting in walls or reservoirs or whatever it might be to hold water.

Some of you will have heard me talk before about something that is a wicked problem, and I am going to come back to that at the end of my talk, but what I want to take you through, for a few minutes, is a kind of Chaucerian pilgrimage towards a solution.

I am going to start off with the tale of the farmer or the myth of the farmer. Now, we spend, in this country, about £1.5 billion a year on subsidising farmers, on land management methods that might actually increase the vulnerability to flooding, and we only spend, probably – the figure is £416 million, so that is a third of that, on land management that reduces flooding. We are funding farmers actually to farm intensively, principally through the Common Agricultural Policy. Now, I am not going to talk about Brexit at all but there is no doubt about it that the Common Agricultural Policy, environmentally, has been something of a disaster in the case of flooding.

People talk about what farmers should be doing. What we see when we look at upland areas, and George Monbiot writes very ably about this, in places like the Brecon Beacons, gullying. As soon as that water gets into the gullies, it starts flowing a hell of a lot faster than it would have done when flowing through soil, and this is the sort of thing that happens. This is the sort of thing that we see in some of our uplands. Now, farmers are not setting out deliberately to enhance flooding. They have been incentivised to produce cheap food. That has been their objective. Things like chemical fertilisers and large tractors that compact the soil and decrease the infiltration have generated runoff over the surface of the ground, and it is eroded out gullies and it has reduced the soil depth, and there is a positive feedback there, so now we get more flooding. So, what we are doing with our farmers is actually increasing the flooding downstream by encouraging them to use large tractors, and here is where the topsoil goes: you can see it running out onto roads if you drive round agricultural areas after heavy rainfall, and it blocks up drains and it silts up river channels, if there is a lot of it, and, again, that increases the chances of flooding further down the catchment, because the river, although it will adjust to this sediment, eventually, in due course, and the water, temporarily, there will be a lot of sediment in it, and that's not good for flooding

The other thing is that upland farming, we are encouraging sheep, high-density sheep-farming in the British uplands, and those sheep are compacting the soil, so they are part of the problem. We are encouraging high-intensity sheep-farming.

There are some organisations trying to do something about this. South-West Water, one of the water companies, for example, has had a whole programme called Upstream Thinking where they have started paying farmers to try and hold the water back on the land, blocking up drains, which farmers also have been encouraged to put in, blocking up what, in the North of England, are called grips to hold the water back. There has been experiments done on looking at whether this is effective. The truth of the matter is we do not know whether it is effective or not because it has not been done at large enough scale or for long enough to find out.

We have also been experimenting with tree-planting. People say let us plant lots of trees, let us re-create the Bronze Age woodlands of Britain. I like trees, and I know lots of you in the audience are very fond of trees as well, but, actually, trees do not always reduce runoff. It is absolutely right that pristine forest will generate less runoff and less peak-flow than, say, grassland with sheep all over it, but as soon as you allow people into the forest, for recreation - and that is when people make money out of forests, it is not out of the timber these days, it is out of recreation, like cycling and all of that kind of stuff – you compact the soil and you reduce the infiltration. If you put ditches in, as the Forestry Commission used to do with coniferous trees to get them to grow, you can increase the flooding massively downstream. So, it is not as simple as just saying let us put in trees on farms, let us replace intensive farming with trees – that is not going to work.

Here is our next Chaucerian character, the engineer myth, and there is a little variance on this which is the Highways Agency myth. Now, what do we see when we imagine engineering and flooding? We see opportunity. We see opportunity for building big things. If you are going to do something that protects a power-station, like this one, you need perhaps to think about a big scheme.

We have already fiddled with a lot of our channels. This is in the middle reaches of the Severn. When it was looked at, people found, in the red dots there, points where some kind of drain or other was coming into the river from somewhere, probably unknown, because we do not know where a lot of these drains actually are, where they run. They are feeding water into the river. So, engineers have already been at work, probably for hundreds of years. This is in the centre or the middle reaches of the River Severn, and lower down the river, this is what we see of course. This is in Hereford and Worcester. We see lots of water, and it needs dealing with.

Now, you can deal with things in a number of ways. One solution is we are going to dredge the channel, make it bigger. This picture is taken in Kent. But we are going to make the channel bigger by dredging, water will go faster on downstream and it won't be our problem.

In the Somerset Levels case, the Environment Agency said it had spent £45 million in the previous year alone on what it called "improving river-flow", which is dredging, basically, and taking mattresses and shopping trolleys out of the rivers. Very complex, very controversial, and most specialists would say that is not going to be the answer because the rivers will simply adjust again to what they are expecting, and over a period of years, they will adjust to this two to three-year event. In fact, the rivers in the Somerset Levels are largely not natural phenomena at all.

It is a pretty thorny problem, and different people have different views. So, obviously, a farmer says, "Get the Environment Agency to dredge – that is what we need to do. This is the second year in a row, and we have been banging on to the Agency to clean the rivers. They are 42% silted up." I do not know where that figure comes from, but the National Farmers' Union were saying the same thing: significant and consistent river maintenance, urgent action required by the Environment Agency, more resources, or we will not trust anybody in Government anymore.

You might remember the chap at the top there. Remember that Forage Aid? There was a big programme of bringing in animal food because some of these people had stock that was stuck in places and they could not feed them. Forage for them, hay and stuff, was brought from all over the country in a huge kind of operation.

Some of the professional bodies said something different. The Chartered Institution of Water & Environmental Management said the channel can never carry enough water when compared to the size of the flood-plain because building up riverbanks and dredging is very old-fashioned – it works to a point, but when we get these

big events, it is not enough, so the authorities should give farmers incentive to help to keep a portion of their land as flood-plain. What nobody dared to say – upland farmers are partly responsible for this because they are producing cheap food, because that is what we have told them to do, and that is reducing the amount of soil and increasing the flooding.

When we bring in a politician, Ian Liddell-Grainger, he said that is pathetic. These rivers have never flooded to this level ever in living memory, and we have got people who have been here for a long time. Now, I do not know what the average lifespan is in Somerset, but it is not going to be several hundred years, clearly, and even if you look back into the mists of time, you do not have this. In fact, it is completely untrue, because, in the mists of time, Somerset was largely underwater.

This is Warrington, £34 million flood defences from the Mersey to protect various things. It was funded by you and I, grant and aid – the borough council, Scottish Power, the Environment Agency and so on – a big wall. Of course, if we have that extreme event, that wall is going to be a disaster because the water is going to be over the top and then it cannot get back into the river, so the flood is going to be there for longer, and at some point, it will be overtopped because of that statistical function I talked about.

So, what next then? We are encouraging some farmers to give up a bit of land to store water to stop Kidderminster being flooded. That is one way of approaching it.

We have also got temporary flood barriers. On the River Severn at Bewdley. So, when there is a forecast of rain, hundreds of men rush out with big steel posts and they drop barriers in. In 2007, they tried to do it, and the barriers were in the wrong place, and the road was flooded, and they could not get there. So, it is problematic – it is not a perfect solution. But it is certainly a technical engineering solution.

What is the next myth? Well, you have probably been reading in the paper about beavers, beavers are going to sort out this flooding problem. Now, beavers are an interesting phenomenon. There used to be lots of beavers in Britain and a lot of our rivers were very messy, with lots of wood in them and lots of beavers, and those blockages in the channel held the water back, temporarily. We have started experimenting with this, the re-introduction of beavers. There is a little experiment going on at the moment in Devon, and there has been a longer one in Scotland, about which not much has been said because they were worried about people hunting the beavers. But my understanding of this is two beavers were introduced into a fenced-off area in Devon, and what it showed was in the river above where the beavers were, when it rained, the flood went up and down quite quickly and very significantly, and below the beaver, the flood-peak was much lower because the water was being held back in little ponds and behind little dams that beavers build. So, the flood-peaks have been reduced by the beavers. But we do not know anything about the significance of this at large-scale. It would be lovely to think we could have loads of beavers beavering away on our behalf to solve flooding, but at the moment, there is only two, right, and that's not going to do it!

So, what is the next myth? The council will sort it out. The council is not going to sort it out, I am afraid. In Leicestershire, the council are finding flooding very problematic because they have to deal with the Social Services for people who get flooded and it is very expensive, but they alone are not going to be able to sort it out, and they put very small amounts of money, relatively, into sorting it out. They have some specific responsibilities for things like bridges, to stop bridges getting in the way of flood-water, by this sort of thing. This was the Boscastle flood in Cornwall in 2004, and one of the things that happened, you can just see, buried under that debris, a bridge. It was blocked up, and it was blocked up by timber and cars and all sorts of things. People have started to do research on this, we know next to nothing about it, and I just put this in to say that councils, in my experience, are sharks, that is all – they probably will not do very much that is helpful.

In Western Paris, if you look really carefully, in the middle, on the bus-shelter, there is something called a green-roof. It is a roof covered in vegetation and it is being trumpeted by the Parisian Government as being a major contribution to flood management. Now, that is what the Seine looked like in January. I do not think green-roofs like that are going to solve it.

But there are other techniques, sustainable drainage systems, and these are a bit more promising. People are designing housing areas and industrial areas to trap water into ponds and channels and so on, and this is an example of what can be achieved. It looks quite attractive. Designing with permeable paving – this is a project done by British construction company, Arup. Soft paving and some nice flowers, so the water can infiltrate. That is a solution.

But, on the other hand, we have got the myth of the front drive. Probably, in the newspapers, you have seen a lot of shouting about people paving their front drives. I am guessing if you have a front drive, it is probably paved, and it is your fault that we are flooding, apparently. Because it is paved, it is not permeable, and it is causing runoff, and research is going on into that., front gardens covered with impermeable paving in residential areas and the research is showing, first of all, the Horticultural Society got statistics about how many front gardens are paved, so at least 75% paved. London, actually, is very low, which is rather odd, and I found that rather challenging to believe. The worst offenders are North-East England. If you completely pave over a garden, it will make a difference to flooding – not very much, but some, and it is going to make a difference with different soil types.

Here is another myth, the scientist myth. Scientists are going to sort this out, say the scientists. Well, actually, the scientists are not. The scientists may do the research, and some of the research is fascinating. This is ground settlement, in millimetres a year, in London, and where it is red, around Canary Wharf there, the ground is settling at quite a rate – I think it is something like in excess of two millimetres a year, which does not sound much, but actually, over a period of time, that is quite a lot, and it is because, around all these skyscrapers, we are pumping water out of the ground, and so the ground is actually going down, and that is not good for flooding.

**IMAGE**

The little red line there is actually Crossrail. That is not the hole in the ground that is Crossrail, that is also de-watering – the ground is sinking, according to Imperial College research.

Scientists are always doing work on flood modelling as well, and we will come back to that in a second, but here is another myth – the point about scientists is we will not solve the problem, we can only give the information, and it is not all good because only some research is funded.

The Environment Agency is responsible. I have got a quote from one person, who described it as "…bloated and inefficient, with a budget of £1.2 billion and 11,000 staff, but it could not find £4 million to dredge the Somerset Levels, but it did find £31 million to flood acres of farmland on the Somerset Coast to create a bird habitat." Well, okay, that was a choice that was made. Actually, that bird habitat was going to stop sea-incursion.

Here is my last but one myth, the water company – the water company is responsible for flooding and should sort it out. Now, water companies are mainly responsible for sewers, and when you get a sewer blockage, water companies come in and have to try and do something. Now, some of you may be interested in the Thames Tunnel, which is supposed to have an impact on flooding, at least in part. It is mainly put there for water quality reasons. It is going to cost everybody who pays water rates in London £25 a year on your bill forever to pay for it, and it is going to intercept water coming down from paved areas on the edge of London and take it away under the River, and it is a huge project. It is very, very expensive, and if we just reverted for a minute to engineers, we would say this is a vanity project. Why are they doing it? Engineers love it because, for them, it is great, but Thames Water may not have their principal interest on flooding. Their principal interest is probably their shareholders, and they have not paid corporation tax in the UK, according to the Observer a few days ago, ever. So, they have banked a lot of money, so maybe that is not their focus.

Now, lots of flooding, lots of problems. Some technological solutions - suds, let us make it sink into the ground. Let us persuade individual householders to put a door-guard in to keep the flooding out of their house. There is a wonderful advert on the internet that shows a row of terraced houses with one of them who has got a door-guard to stop the water going in the front door, but it does not explain what happens to the ones either side that could not afford one and then the water just comes in through the wall either side. So, individual property solutions are probably not going to give you the right answer, even if technologically they work.

In fact, none of those catchment management and local management solutions are going to solve the problem of flooding. Some of them might make a marginal difference. All of them are perhaps worth experimenting with, but none of them is going to solve the natural problem, not even the climate scientists, because we know that shifting rainfall patterns are already happening, to a certain extent. But, interestingly, the towns and cities in the UK expecting more flooding are quite a long way away from London, where the decision-makers sit, and I was kind of vaguely hoping today that we would get a nice sharp, intense rainstorm over Chelsea where a lot of politicians live, because that might actually prompt some action on this. But places like Carlisle are expecting 79% more water per flooding event because of climate change and various other shifts. There is no timescale given on here, but it is over a period until 2050.

These are wicked problems, really complex problems, where we do not understand the problem, we do not agree what the solution is. We have got people, we have got science, we have got physical things, sociological things, and so on. We do something one place, and we trigger off something happening somewhere else. Diverting the water downstream is great if you do that in Bewdley, but they will not thank you in Gloucester. Lots of different people who do not agree what is important, who talk in different ways about it, and they could not probably even agree if the problem had been solved. Now, that phrase, "wicked problems", has been based on work done in the 1970s, it has been around for ages.

But we have now got another category called super-wicked problems, where time is running out, and the people who are supposed to be providing a solution, like Thames Water, say, are actually partly causing the problem. There is no central authority. We do not have anybody responsible for managing river basins as a whole anymore in this country. Politicians have a time horizon which says, "Am I going to get elected next time?" not the 200-year event. So, super-wicked problems are something that has popped up recently.

I want to end with a third category, hyper-wicked problems, where some of the stakeholders are being very economical with the facts, for some reason unexplained, probably personal or professional gain.

Flooding is a real hyper-wicked problem, and we are going to conclude by saying: who is to blame? Everyone and no one. It is a natural process. We live with it. We know what we have got to do, but we are not doing it at the moment because we are not even really talking about it because we had forgotten until this week about it.

Thank you!