CHRISTIAN BRECHOT

President of the Institut Pasteur

I will briefly present some points regarding the effect of climate change on health. The first point I want to make is really about the present, and we really need to analyse the present to figure out what will happen. A number of current predictions are hampered by uncertainties, because we do not take sufficiently into account the major shift in paradigm that we are experiencing nowadays. What I mean is that we have seen, and we are all aware of this, a major increase in the so-called non-communicable diseases, such as chronic disease, cancer, metabolic disorders, neurodegenerative disease and chronic pulmonary disease, and these are the leading cause of death. What is important is that this does not just hold true in developed countries but is a major shift also in low- and middle-income countries.

Looking at the major increase in non-communicable disease in developed countries as compared with infectious disease, what is very striking is that infectious disease is of course much more present in low-income countries, but you do have an increase in non-communicable disease, and we know that overweight, cancer, diabetes and neurodegenerative disease are increasingly a problem in countries such as China, India and many others.

It is more complicated than this. Infectious disease is still obviously a major threat, and it is interesting that a few years ago Ebola and haemorrhagic fever was present and nobody paid attention to it, but now it is much more popular. However, the point is that you have to envision the effect of climate change on health in the perspective of global and one health. One health means that you can only understand what is happening and what is going to happen if you always simultaneously, and simultaneously is the key word, analyse the status of humans, but also obviously of animals and the environment.

Secondly, you have infectious disease and you have non-communicable disease, and until recently these have been seen as distinct problems. When you look at the prediction from the IPCC in their recent report, which is very good and which is based on literature and analysis, something is lacking, which is the fact that you cannot really separate this. 25% of cancers, for example, are due to viruses or bacteria, and we will have increasing prevalence of pathogens associated with cancers with the new methods for detecting the pathogens, which means that climate change, which will impact on the pathogens, beyond influencing the chemical effects and pollution, will also influence the patterns of disease.

The impact of the intestinal microbiota, the bacteria of the intestine, our second genome, on obesity, diabetes, inflammation on cancers but also possibly neurodegenerative and psychiatric disorders is a growing science. When we want to foresee the impact of climate change on health, we have to take this evolution into account.

The second point is how climate change impacts health. We are well aware of this around this table, and the complexity of this problem really implies a variety, a diversity of mechanisms. There is obviously a direct impact. We have ecological disruption, and we have the effect of the social response to climate change, for example, but not exclusively, the displacement of populations. That is one point. We know that, when you go from climate change to health impacts, you have to go through a number of parameters, such as environmental conditions, some of which have been discussed, social infrastructure, which obviously will be key, including the impact on economic and social disruption, and another major problem, the capacity of public health and adaptation. We were talking about mitigation and adaptation, such as warning systems, health and nutrition status and primary healthcare, which in any case will remain at the forefront of the discussion.

Regarding the main effects on health, these are well illustrated in the report of the second group of the IPCC, which reported last March. We will firstly have an increase or exacerbation of existing health challenges which will target existing populations and individuals who are already challenged by the present climate changes, namely the negative impact on food security, increase in infectious disease, infectious emergence and re-emergence, and this will combine

with the direct impacts from the climate, such as heat-related mortality and illness, the effects of floods and storms on health, and ultraviolet radiation.

Eco-epidemiological impacts are extremely important and well analysed. There will be increasing health risks from natural disasters and increasing health challenges linked with human displacement. These different factors have been well analysed and are well-known, and they have led to some modelling by this panel, but we always need to be very careful with modelling, because they have a common characteristic in epidemiology, that so far they have generally turned out to be wrong. I remind you that we were predicting sub-acute encephalitis in 2001 with a peak in the world population, and nothing happened, and a few months ago there was a modelling analysis of Ebola which concluded that we would have 1.5 million at the end of December, and fortunately this was absolutely untrue. It does not mean that Ebola is not a problem.

This is not to diminish the impact of these analyses but just to temper them. What they have summarised is that the first scenario, which you are very well aware of, the impact of the so-called 1.5 degree Celsius increase in the mid-century, focus on the existing problems, under-nutrition due to food reduction, the effects of heatwaves and fires, and also the shift in timing and spatial distribution of events related to infectious pathogens.

There is now a third scenario, which is the so-called high-end climate scenario, with a forecast of an increase of between four and seven degrees. Further to the exacerbation of some of the problems which were already listed, you see the occurrence of major issues in terms of occupational health and mental health, for example how to maintain unprotected outdoor labour, how to balance the heat energy in the case of physical exercise, and you really come to some extreme situations for human beings which would really call for the adaptation of our species. However, this is a short time, 2080, in which to have an adaptation by humanity.

I will close by stating a specific case, vector-borne diseases, because two points are under appreciated in this otherwise extremely good analysis. Firstly, there is a disassociation between infectious disease, on the one hand, and non-communicable disease on the other, and I made the case that there should be a global view. Secondly, there may be an under-appreciation of the impact of climate change on vector-borne disease. This is a fascinating story where you have three major players, a pathogen, the host and the vector, and it does illustrate the complexity of the effect of climate change, acting both on temperate and humidity, and also leading to the colonisation of newly affected areas.

There are a very large number of emerging viruses and vectors throughout the world. We are facing the Ebola crisis, which is a major crisis. I was in Guinea two weeks ago, and we all know that this is something which will change our mentality. It is nothing new; we had so many crises before and will have many crises after this, but this crisis has led us to a more accurate perception of what happens when you live in countries such as Guinea, Sierra Leone and Liberia without any sanitary system.

We cannot tell whether the Ebola crisis is due to climate change; we do not know exactly what has happened and why bats, which were mostly confined to the Democratic Republic of Congo, went to Guinea and infected a two-year-old baby, but we know that the major cause of propagation was deforestation and a change in the bats' habits, and that is at least part of the problem. How has climate change influenced this? We feel that it makes sense that it has an influence, but we do not know exactly how.

Looking at the effect of climate change of the transmission of a virus by a mosquito, the more you increase the temperature, the more you increase the efficacy of transmission, and the important point, which is more recognised, is that this is acting both on the vector and on the pathogen, whereas before the studies were more focused on the pathogen. Looking at one of the climate's complex activities, the more you increase the temperature, the fewer varieties of mosquitos you have, which in a way is good, because you have fewer mosquitos. However, this is outweighed by the fact that, during the rainy seasons and humidity, the heat will promote greater numbers of mosquitos. Therefore, at the end of the day, the end result will be an increased number but also an increased efficacy of transmission.

Finally, the famous Aedes albopictus, also called the tiger mosquito, well illustrates the combination, because it is not just about climate change, but also social changes including population displacement, travel and so on. Initially located

in Asia, this mosquito moved to many parts of the world, including Europe and North America, and this has led to the emergence of the Chikungunya viral infection. We do not hear so much of Chikungunya because of the Ebola crisis, but it is still disseminating and it is a very important public health problem, and I could cite many other examples.

The Arbovirus is one example of a number of viruses that are increasing in terms of dissemination and efficacy and are directly or indirectly influenced by climate change. I am the President of the Institut Pasteur, and this is where I believe our Institut should be working closely with the other components of the fight against the consequences of climate change. It is an international institute, based in France, with 32 institutes in 25 countries, and this already allows us to appreciate these types of problems. We are entering a new era in terms of the organisation of research, and we need to maintain curiosity-driven research. One day, some scientist will make a discovery which will change everything; we will have the before and the after, and we should never forget this.

However, and this is not contradictory, we are in the era of networks of scientists, but beyond scientists, we have to design novel models for science, for medicine, for public health organisations, where we really engage a number of actors, including obviously those with experience in economics, and I find this kind of roundtable very interesting in this respect. I was appointed President of the Institut Pasteur one year ago, and we have created the Centre for Global Health, which merges these different components. Data sharing and preparedness will be key for addressing the future of climate changes. We need to determine how to really share information. This is a major challenge which we are addressing. Finally, you need an outbreak investigation task force, and preparedness and awareness of the different problems will be key.