

**The Geneva Association:**

## Climate change – How much do we know?

On the largest scale, the climate change problem is at least qualitatively simple – the burning of coal, gas and oil releases carbon dioxide (CO<sub>2</sub>) into the atmosphere. The overall warming effect resulting from this emission is a subject of key importance for the world, affecting the existence of its species. In this article, which was first published as a Guest Editorial in the Risk Management Newsletter no. 44, November 2008 of The Geneva Association, **Professor Reto Knutti** from the Institute of Atmospheric and Climate Science in Zurich, explains why the world must take action now and not continue with a “business as usual” attitude or our children will be the ones facing numerous climate catastrophes in the future.



**C**arbon dioxide is the most important of several greenhouse gases which, together with other substances like aerosols, affect the radiation balance in the atmosphere. Like an insulating blanket, the greenhouse gases trap long-wave radiation emitted from the surface of the earth and lead to warming, a process known as the greenhouse effect.

On time scale of centuries, the overall warming is, therefore, determined essentially by how much of the CO<sub>2</sub> emissions remain in the atmosphere, and how sensitively temperature reacts to the CO<sub>2</sub>.

### Business as usual

So if we continue our business as we did in the past, how much CO<sub>2</sub> will the atmosphere contain in the future, and how much warming will it cause? Atmospheric CO<sub>2</sub> rose from about 280 part per million (ppm) before the industrialisation to 380 ppm today. Simply extrapolating the recent growth rate of about 2 ppm per year suggests that human influence will double the pre-industrial atmospheric concentration before the end of this century. Scenarios with strong economic growth and without policy intervention predict an even faster increase. The best estimate of the equilibrium global warming for a CO<sub>2</sub> doubling is near

3°C, with an uncertainty range of about 2-4.5°C and a small likelihood for even larger values.

Defining a threshold temperature of how much warming is dangerous partly involves value judgements, but many countries, politicians and scientists consider a warming of 2°C as having serious impacts that should be avoided. A ‘business as usual’ emission pathway with a CO<sub>2</sub> doubling would thus very likely exceed such a 2°C global warming threshold.

### Nobel peace prize publicity

The first estimates for the effect of CO<sub>2</sub> on temperature go back more than a century, and scientists have long argued that climate change is a serious threat, but it took four assessment reports of the United Nations Intergovernmental Panel on Climate Change (IPCC) and a Nobel peace prize for IPCC together with Mr Al Gore until the media and the public broadly acknowledged the facts that climate change is real and man-made.

### Better than back of the envelope?

Climate science today knows, of course, more than what the above back of the envelope numbers suggest. Complex computer models simulating the atmosphere, ocean, land and ice are used to understand physical, chemical and biological processes, to quantify the human contribution to the observed changes and to predict climate change for the future. The models predict a wide range of changes in the climate system that will result from the warming, such as rising sea levels, melting snow and glaciers and changes in rainfall.

### Extreme weather events

The most disturbing effects, however, are probably the changes in extreme weather events. Warming leads to more heat waves and droughts, but it also leads to an intensification of the water cycle, resulting in more floods and heavy rainfall events. A look at climate and weather related damage estimates from insurance companies confirms that the climate impacts and damages are dominated by a rather small number of such events and that climate related damages are increasing.



### Better observations and computing power needed

Unfortunately, these extreme events are also the hardest ones to predict, as they often involve very small scale processes. Heavy rainfall events over mountains or hurricanes are just two examples that are dominated by processes on spatial scales of a few kilometres. While weather forecast models are able to resolve such small scales, global climate models for predictions a century into the future still have to use coarser resolution (typically 100 kilometres) to make the problem computationally feasible.

Future increases in computing power will solve some of the current limitations, but a better understanding of local processes, along with better observations is also needed. Heat waves and droughts for example require an accurate simulation of the effect of vegetation and soil processes, a research field where observations are sparse and where knowledge from different research communities needs to be integrated into better models.

### The economic perspective

While some may benefit from climate change, there is a general agreement that the overall impacts will be negative, in particular for global temperature changes above 2°C. The risks and damages include flooding of coastal areas, water stress in many regions, negative impacts on food production, extinction of species, increased damage from floods and storms and a substantial burden on health services resulting from extreme weather, malnutrition and diseases.

Assuming that we agree on the severity of climate change, is it better to avoid it by mitigation, or to invest the money and pay for adaptation and damage later when impacts are negative? If a standard cost benefit framework with large discounting (several percent per year) is adopted, then climate change beyond a century or so is found to be essentially irrelevant in terms of cost. Large discount rates mean that damages for future generations are discounted to near zero, and money should better be invested to maintain high economic growth.

### Cost-benefit analysis not appropriate

In his famous 'Stern report' in 2006, the British economist, Sir Nicholas Stern, took a different point of view. In his opinion, the consequences of a climate catastrophe such as water shortage, flooding of land inhabited by millions of people or the extinction of species cannot be solved with money, and action must be taken now. He argues that cost benefit analysis with large discount rates is not appropriate in the climate change context, and finds that mitigating climate change by reducing emissions now is much cheaper than paying for the damages later.

Different people have different views, but the thought of causing extinction of a quarter of all species, melting most glaciers and deliberately inundating huge areas of land just because it was economically beneficial seems disturbing, and hard to justify to our children.




### Too uncertain to act?

The expected large scale climate change over the next few decades is quite well constrained, the long-term predictions as well as changes in variability and extreme events, however, are more uncertain. How will the frequency of heavy rainfall events change? How often will they coincide with high water runoff from snow melt in spring?

Uncertainties in the frequency of local weather events are arguably a problem, as local adaptation measures require a relatively detailed and accurate prediction of the expected changes. They are also a problem for the insurance industry interested precisely in how these low probability high impact events will change. While scientific research is addressing these questions with refined models and more detailed observations, there is no doubt however that emissions of greenhouse gases need to be reduced dramatically in order to stabilise climate change at an acceptable level.

### Insurance's risk-management approach can help

A "business as usual" scenario is inconsistent with the declared aim of the United Nations Framework Convention on Climate Change of stabilising greenhouse gas concentrations in the atmosphere at levels that would prevent dangerous interference with the climate system. Delaying the mitigation efforts will make it more difficult to achieve low CO<sub>2</sub> stabilisation targets in the future, and some options may become prohibitively expensive if we wait too long.

Climate change ultimately is a problem of managing risks. The insurance sector has been quite successful in dealing with risk and making decisions under uncertainty, and has shown that uncertainty and risk does not prevent us from making decisions; that should also apply for the steps we need to take to solve the climate change problem. 

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