

Towards a History of Ideas on Anthropogenic Climate Change

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Abstract

In this essay we show that the notion of anthropogenic climate change is not novel. Concerns over transformations of the Earth's climate by human activities have been expressed since the 18th century Enlightenment and earlier. It is reasonable, therefore, to speak of a „history of anthropogenic climate changes“. Most of the instances were not „real“. But all cases were associated with the perception of significant discontinuities and in most instances the perceived change was seen as a threat to society. We briefly discuss the possible implications of this „history“ for the functioning of the scientific community in the present debate.

Introduction

Most observers take it for granted that the concept of anthropogenic climate change is of relatively recent origin. The present notion primarily refers to expected climate changes associated with ongoing emissions of greenhouse gases and aerosols from burning fossil fuels. The scientific literature as well as the media in many countries are teeming with analyses related to this issue. The world's governments established the *Intergovernmental Panel of Climate Change* (IPCC) to deal scientifically with the problem of anthropogenic climate change (Houghton et al., 1990, 1992, 1996).

When we speak in the following of „climate change“ we do not mean changes of the local climate by the expansion of cities, clearing of forests and other local modifications of land use. Instead we are referring to changes on a regional, continental and global scale.

We will demonstrate that the notion of anthropogenic climate change is by no means novel. Concerns over extensive transformations of the Earth's climate have been expressed since the 18th century enlightenment and earlier. It is reasonable to speak of a „history of concepts of anthropogenic climate changes“. Most of the cases were not real; as a matter of fact, none of them proved to be associated with significant impacts related to the suggested dynamical link. But all cases were associated with the perception of significant discontinuities; in most recent instances the perceived change was seen as a threat; only in the past sometimes they were welcomed as an improvement over natural conditions.

The following list of cases is not exhaustive. Many of the examples included were encountered almost fortuitously. A more systematic analysis by historians could lead to more illustrative cases.

List of Cases

1. Religious interpretations of climate anomalies, such as the prolonged wet period in England in the early 14th century, explained the adverse climatic conditions as the divine response to people's life-style (Stehr and von Storch, 1995). In medieval times, for instance, it was proposed that climatic anomalies, or extreme events, were a punishment for parishes which were too tolerant of witches. Of course, witches were believed to be able to directly cause adverse weather (Behringer, 1998). It would be interesting to learn what people thought about the cold spells within the Maunder Minimum at the end of the 17th century (Wanner, 1995). This practice is also used nowadays. A recent example has been reported by *Berlingske Tidende*, 11 April 1998 about the religious interpretations of violent tornadoes in Alabama during Eastern 1998.
2. Our oldest case documented by contemporary scientific writing refers to the climate of the North American colonies (Williamson, 1771). The physician Williamson analyzed the changes of climate, and related them to the clearing of the landscape by the settlers. This is a case in which human action was perceived as having a beneficial impact on climate. More cases during the medieval times, related to colonization by monks, are described by Glacken (1967).
3. In many parts of Europe, the summer of 1816 was unusually wet, presumably because of the eruption of the volcano Tambora. However, people ascribed the adverse conditions to the new practice of using lightning conductors. The case is documented in two articles published in the newspaper *Neue Züricher Zeitung* (21 June and 9 July 1816). The

authorities called the concerns unsubstantiated and issued grave warnings concerning violent and illegal acts against the conductors. Interestingly, it is mentioned that some years earlier in Germany, people blamed the conductors for being responsible for a drought.

4. In the 19th century scientists in Europe and in North America were confronted with the concept that the climate would be constant on historical time scales; however, scientists found significant differences between mean precipitation and temperature when averaged over different multi-year periods (e.g. Brückner, 1890). Also, scientists claimed that the water levels of rivers would fall continuously. This led to questioning of the assumption of constant climatic conditions — in modern terms: interdecadal natural variability — and, alternatively, to the hypothesis that the observed changes are caused by human activities, mainly deforestation or reforestation. It seems that the majority adopted the concept of man-made causes over the natural variability hypothesis. (Brückner, 1890; Stehr et al., 1995).
5. There are reports that both the extensive gun-fire during the first World War and the initiation of short wave trans-Atlantic radio communication were blamed for wet summers in the 1910s and 20s (Kempton et al., 1995; Hinzpeter, pers. comm.).
6. In the first part of the 20th century a remarkable warming took place in large parts of the world. In 1933, this warming was documented, and the uneasy question „Is the climate changing?“ was put forward in *Monthly Weather Review* (Kincer, 1933). Some years later, Callendar (1938) related the warming to human emissions of carbon dioxide into the atmosphere, a mechanism described some 40 years earlier by Arrhenius (1898). Interestingly, Arrhenius himself stated that anthropogenic emissions of CO₂ would cause a significant climate change only after several hundred years (Arrhenius, 1903). Flohn (1941) also brought this line of reasoning into the scientific debate. In the 1940s global mean temperatures began to fall – which eventually led to claims that Earth was heading towards a new Ice Age. Today the risk associated with increasing concentrations of greenhouse gases such as carbon dioxide and methane is the overriding concern. There is no doubt about the increasing atmospheric concentrations. In a survey of 412 North American and German climate scientists, a majority of 70% out of 412 respondents were convinced that „*global warming is a process already underway*“. Yet the respondents had some difficulty in specifying what the impacts of expected climate change would be and how they would be harmful: Only 34% responded positively to the question „*To what degree can we explicitly state the detrimental effects that climate change will have on society*“, but only 1% answered with „*a great deal*“ (Bray and von Storch, 1999).
7. After World War II scientists noticed a cooling and some speculated about whether this cooling was the first indication of a new Ice Age, possibly brought on by human actions, mostly emissions of dust and industrial pollution. It was speculated that human pollution would increase by a factor of as much as 8 which could increase the opacity of the atmosphere within hundred years by 400%. This in turn would significantly reduce incoming sun light causing the global mean temperature to sink by 3.5 C. Such a cooling would almost certainly be enough to force Earth into a new Ice Age (Rasool and Schneider, 1971). The prospect was illustrated with the words: „Between 1880 and 1950, Earth's climate was the warmest it has been in five thousand years. ... It was a time of optimism. ... The optimism has shriveled in the first chill of the cooling. Since the 1940s winters have become subtly longer, rains less dependable, storms more frequent throughout the world.“ (Ponte, 1974: 89).
8. After World War II, the new practice of exploding nuclear devices in the atmosphere caused widespread concern about the climatic implications of these experiments.

According to Kempton's analysis, even nowadays many lay-people are concerned about this link. (Kempton et al., 1995; see also Kimble in New York Times 8 July 1962).

9. In Russia, plans for re-routing Siberian rivers southward have been discussed since the beginning of this century. The plans visualize benefits in supplying semi-arid regions with water, and an improved regional climate. A byproduct was thought to be an ice-free Arctic ocean because of the reduced fresh water input from the rivers. This would shorten the winters and extend the growing season; the increase of evaporation from the open water would transform the Arctic climate into a maritime climate with moderate temperatures and busy harbors along the Soviet Union's North coast (Ponte, 1974: 136). Such plans were formally adopted in 1976 at the 25th Assembly of the Soviet Communist Party. Scientists from the West as well as from the Soviet Union opposed these plans and warned that the formation of an ice-free Arctic could significantly affect the global ocean circulation and thus global climate. Eventually, the plans were abandoned although a more careful analyses indicated that the probability of melting the Arctic sea ice associated with a rerouting of the rivers was overestimated (Lemke, 1987; Micklin, P.P., 1981; Semtner, A.J., 1984; Aagard, K. and L.K. Coachman, 1975; Cattle, H., 1985).
10. The concept of engineering or manipulating the climate system became popular in the first half of the 20th century. Re-routing Siberian rivers was one such scheme; another was put forward by the New York engineer Riker, who in 1912 suggested changing the Gulf Stream with the purpose of improving the climate not only in North America but also the Arctic and Europe. Riker's idea was: „The Gulf Stream travels up along the American coast without any problem, ... but when it turns east to cross the Atlantic Ocean it collides with the Icy Labrador Current coming down from the Arctic. This collision in relatively shallow water weakens the Gulf Stream ... But this would change ... if a simple jetty 200 miles long could be built from Cape Race on Newfoundland to a point just beyond the underwater Grand Banks. The jetty would keep the two currents apart ... Off the tip of Greenland ...the more powerful Gulf Stream would divide. Half would throw increased warmth against Northern Europe, and half would thrust into the Arctic... The benefits of this would be enormous ... Fog would disappear, ... all ice in the Arctic would melt. The melting of the Arctic would improve the world climate in two ways. ... Europe and North America would be freed of chilling storms and icy ocean currents... And without the North Polar ice, the surviving ice pack at the South Pole would become the heaviest part of our planet. Centrifugal force would then tip the Earth ... With the Northern hemisphere tipped more towards the sun, Europe and North America could expect warmer climate.“ (Ponte, 1974: 138). It is interesting to note that Riker thought of warming as an improvement of climate. The same view is put forward by H. Lamb (1982). Also, the idea of modifying ocean currents was later pursued by scientists from the USA, USSR and other nations. In most cases, these schemes revolved around the building of a dam, which would for instance block the flow through the Bering Strait.
11. Close to the idea of climate engineering is the military use of climate modifications. The idea to change the course of the Gulf Stream had been put forward already in the 18th century by Benjamin Franklin, who envisaged a northward diversion of the Gulf Stream as a powerful weapon against the British Empire (Ponte, 1974:137). A perceived attack using climate as a weapon is a purported Soviet plan in the 1950s to build a „jetty 50 miles or more long out from near the eastern tip of Siberia. The jetty would contain several atomic powered pumping stations that would push cold Arctic waters down through the Bering Strait. This would ... inject increasing amounts of icy waters into the ocean current that flows down the west coast of Canada and the United States. The result would be colder, more stormy weather throughout North America and enormous losses to the American economy in agriculture, work days and storm damage.“ (Ponte, 1974:169-170). Concern about the development of climate weapons lead to a series of diplomatic discussions.

During a summit meeting 1974 the United States and the Soviet Union issued a Joint Draft Treaty: „Each State Party to this Convention undertakes not to engage in military or other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury ... the term ‘environmental modification techniques’ refers to any technique for changing – through the deliberate manipulation of natural processes – the dynamics, composition of the Earth, including its biota, lithosphere, hydrosphere and atmosphere ... so as to cause such effects as ... changes in weather pattern, ...in climate patterns, or in ocean currents.“ (Ponte, 1974: 259-263)

12. In the 1960s and 70s aircraft industries in the USA, Europe and Soviet Union designed supersonic civil air planes. These plans provoked substantial criticism. Scientist argued that the exhaust from such planes would damage the ozone layer in the stratosphere and the climate in general. In the USA the plans were stopped, but in Europe the Concorde was built and in the Soviet Union the TU 144. Of course, numerous military supersonic aircraft are nowadays cruising the lower stratosphere. For many years, the discussion about the impact of air traffic on the climate ceased. But in the early 1990s the topic re-entered the public debate, this time regarding high-flying conventional jet liners. The focus of concern is the effect of contrails and exhaust gases on the radiative balance of Earth. Scientists (e.g., Sausen and Schumann, 1998) regard present effects from these sources as minor compared to other effects. However, some argue that with present projections of future passenger numbers and technology the effect maybe or will be significant.
13. A popular, but for natural scientists somewhat surprising mechanism links space traffic to a deteriorating global climate. In Kempton et al.'s (1995) interviews with lay people, this mechanism is mentioned several times. 43% of the respondents in Kempton's survey considered the statement „*there may be a link between the changes in the weather and all the rockets they have fired into outer space*“ plausible.
14. The ongoing deforestation of tropical forests is of great concern to many people, who are afraid not only of reduction in the variety of species but also of changes in global climate (Kempton et al., 1995; Dunlap et al., 1993). Model calculations indicate that these land use modifications cause significant local and regional changes whereas in most model calculations global effects are marginal. Interestingly, similar results were obtained for the climatic implications of the transformation of the North American wilderness into agricultural land (Copeland et al., 1996).
15. Anthropogenic aerosols are considered powerful agents for changing the global climate. One scenario deals with the emission of aerosols mainly from burning forests and fossil fuels. A dramatic version is that of „nuclear winter“ – in which it was assumed that the explosion of a multitude of nuclear bombs in a future war would create a high flying veil of soot particles which would effectively shut off solar radiation and cause a collapse of the biosphere (Cotton and Pielke, 1995). Support came from a number of computer simulation. The ignition of the Kuwait oil wells in the aftermath of the 1991 Gulf War led some scientists to expect a minor nuclear winter, particularly with respect to the Indian Monsoon. It turned out that the effect was severe locally but insignificant on the larger scales (Cahalan, 1992; Bakan et al., 1991).
16. A new line of concern, especially in Europe, refers to the stability of the Gulf Stream in the Atlantic Ocean. Ocean models exhibit a markedly nonlinear behavior of the Atlantic circulation with two stable states, one with an active Gulf stream and another with a weakened northward transport moderating the European climate. Both states are stable within a certain range of conditions, but when the system is brought to the margins of these ranges, it can switch abruptly to the other state (Rahmstorf, 1995). Paleoclimatic

reconstructions using evidence from ice cores and other indirect sources support the existence of such stable states and frequent rapid changes from one state to another. During the present interglacial period from about 10,000 years ago to the present, such rapid climate changes have not been detected and quasi-realistic climate models featuring interactive ocean and atmosphere models have not exhibited such behavior (Manabe and Stouffer, 1996; von Storch et al., 1997). In the global warming debate the risk of a „collapse“ of the Gulf Stream is put forward (Rahmstorf, 1997). While the globe is becoming warmer, Europe and Northeast America would experience colder conditions with the possibility of a new ice age. However, most scientists regard such an evolution as unlikely, at least as long as carbon dioxide concentrations are not increased by a factor of four and more (Morgan and Keith, 1995). Not only global warming is presented as a human lever for terminating the Gulf Stream. Another hypothesis was published by the Transactions of the American Geophysical Union *EOS* (Johnson, 1997) with a significant reaction in the public media. This time the human culprit was the Assuan Dam in Egypt which would reduce the flow of fresh water into the Mediterranean Sea. This reduction along with enhanced evaporation caused by global warming would result in a saltier outflow from the Mediterranean Sea into the Atlantic eventually causing the Gulf Stream to flip over. Subsequent quantitative analysis revealed that the impact of the Assuan Dam would be much too small to have this effect on the Gulf Stream (Rahmstorf, 1998).

Conclusion

It is interesting to speculate about the social and cultural processes which made and make the concept of anthropogenic climate change not merely an episodic but an almost permanent issue that challenges scientists and alarms non-experts. It would also be interesting to find out why the notion of an anthropogenic challenge to large-scale climate has been repeatedly forgotten and re-invented.

Under present circumstances, such social processes likely include subjective, non-scientific factors on the side of the researchers. First, scientists are part of society, and thus are loaded with the same traditional non-scientific knowledge as everybody else. Secondly, specific aspects apply, as is explored by the survey among North American and European scientists (Bray and von Storch, 1999). The question „*How often do you think experts frame problems so that the solution fits his or her area of expertise?*“ was answered positively by more than 70% of the 412 questioned scientists. 80% answered positively to „*To what degree do you think there is growing pressure for climate research to be justified in terms of policy relevance?*“. The question „*To what degree does exposure to the media have the potential to change the attitude of a scientist?*“ was answered positively by about 50% of the respondents. More than 30% (in Germany even a majority) of the respondents agreed to „*Some scientists present the extremes of the climate debate in a popular format with the claim that it is their task to alert the public. How much do you agree with this practice?*“ That is, scientists feel the need of framing their problems so that the solution fits their area of expertise. Some members of the scientific community are willing to engage in public agenda setting with a certain bias toward more dramatic scenarios. Others are led by ideological elements such as genuine general concerns about the state of the natural environment. A minority of scientists seems to be driven by the desire to have a presence in the media. Thus, there is a definite possibility that the scientists for entirely subjective reasons exaggerate the dangers associated with anticipated climate change (see also the concept of rainmaking in the 1960s and 70s; Cotton and Pielke, 1995). In that sense climate change is a social construction, consistent with the traditional knowledge and professional needs.

On the other hand, the concept of anthropogenic climate change is hardly a purely scientific construction like that of ether in the 19th century. In the past decades a variety of evidences have been collected. The key processes, like clouds and oceanic circulation, are better understood. The detailed process based climate models describe now many components like the ocean and sea ice and sometimes even vegetation and cycles of carbon, and have shown their skill in several applications. A multitude of proxy data about paleoclimatic conditions supports the concept that varying greenhouse gas concentrations are associated with different climatic regimes. Quality controlled collections of instrumental data with global coverage have identified the latest changes of globally distributed temperature as likely being not within the range of natural variations. After examining the evidence in great detail (Houghton et al., 1990, 1992, 1996), the IPCC made in 1995 its famous statement that "the balance of evidence suggests that there is a discernible human influence on global climate." In fact, one could argue that „there has been a shift from absurd statements to uncertainty at the edge of knowledge of complicated systems“ (Berger, pers. comm.). There are good reasons to consider the present prospect as more real than the earlier cases, and our list should not be mistaken as an attempt to belittle the presently voiced concerns about anthropogenic climate change.

To sum up, we should view the prospect of anthropogenic climate change as both, scientifically and socially constructed as well as underpinned by hard evidence. As common in postnormal science (Funtowicz and Ravetz, 1985; Bray and von Storch, 1999), solid scientific knowledge is blended with lay understanding, and political concepts. In fact, now as in the previous cases, political bodies act upon scientific warning. Contemporary examples are not only the partly political IPCC process but the Enquete Commission of the Deutscher Bundestag (1988). Historical examples are committees set up hundred years ago by parliaments and governments in Europe (e.g., Prussia, Italy, and Russia) to deal with the reality of anthropogenic climate change related to deforestation (Brückner, 1890; Grove, 1975).

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