



# Brief communication: Climate science as a social process – history, climatic determinism, Mertonian norms and post-normality

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**Abstract.** For ages, the topic of climate – in the sense of “usual weather” – has in the western tradition attracted attention as a possible explanatory factor for differences in societies and in human behavior. Climate, and its purported impact on society, is an integrated element in western thinking and perception.

In this essay, the history of ideas about the climatic impact on humans and society and the emergence of the ideology of climatic determinism are sketched from the viewpoint of a natural scientist. This ideology favored the perception of westerners being superior to the people in the rest of the world, giving legitimacy to colonialism.

In modern times, when natural sciences instituted self-critical processes (repeatability, falsification) and norms (such as the Mertonian norms named CUDOS), the traditional host for climate issues, namely, geography, lost its grip, and physics took over. This “scientification” of climate science led to a more systematic, critical and rigorous approach of building and testing hypotheses and concepts. This gain in methodical rigor, however, went along with the loss of understanding that climate is hardly a key explanatory factor for societal differences and developments. Consequently, large segments of the field tacitly and unknowingly began reviving the abandoned concept of climatic determinism.

Climate science finds itself in a “post-normal” condition, which leads to a frequent dominance of political utility over methodical rigor.

## 1 Caveat

This essay is submitted for publication in a journal devoted to nonlinear dynamics. This is certainly puzzling, but the editors have encouraged the author to do so – and indeed social dynamics is certainly most nonlinear and high-dimensional – but it is different from most textbook cases of nonlinear dynamics; there is neither a statistical frame nor a set of differential equations framing these dynamics. But the system is definitely not linear. The material presented in this paper, as well as the conclusions, is not new. Instead, it is a compact compilation of what the author, as a natural scientist, has learned in the past 30 years. The paper does not claim to cover the wealth of discussions in social science studies but insists that two key issues, the reanimation of climatic determinism and the post-normal character of contemporary

climate sciences, have been identified in collaborations involving the author. One could rightly argue that the claim of climate science being a social process is a trivial assertion – but among many natural scientists and in the public discourse, which treats scientific knowledge claims as “truth”, climate science is usually not perceived as such. Thus, it makes sense, in particular in a journal aiming at physical scientists, to make this trivial assertion.

## 2 Introduction – climate as a natural and social object

The “usual weather”, i.e., climate, has attracted attention everywhere and always as a matter for planning and preparing a reliable basis for life and economy. In earlier times, this interest was – at least in the tradition of western thinking

– directed towards the question of if these weather conditions would have an impact on how people and societies fare. In classical Greek and Roman times, the dominant cultures were thought to be favored by benevolent weather, while the barbarians suffered from adverse weather. This went so far that some scholars claimed that a development of an advanced culture in less benevolent climates, for instance in England, was made possible by the invention of suitable technology for heating houses, i.e., by creating a favorable indoor climate.

In this way, climate, and its purported impact on society, has become an integrated element in western thinking and perception. These perceptions and theories may be seen as being part of the general concept of “Climatic Determinism” (Stehr and von Storch, 1999, Sect. 3).

When more robust and in particular quantitative knowledge about the regional differences of climate became important for trade and colonialism, beginning since the 18th century, a main task of climatologists was to construct maps of regional climate (e.g., Köppen, 1923). This “modernization” is expressed by the early quantitative geographer Alexander von Humboldt, who defined it in von Humboldt (1849):

The term climate, taken in its most general sense, indicates all the changes in the atmosphere, which sensibly affect our organs, as temperature, humidity, variations in the barometrical pressure, the calm state of the air or the action of varying winds, the amount of electric tension, the purity of the atmosphere or its admixture with more or less noxious gaseous exhalations, and, finally, the degree of ordinary transparency and clearness of the sky, which is not only important with respect to the increased radiation from the earth, the organic development of plants, and the ripening of fruits, but also with reference to its influence on the feelings and mental condition of men.

Later, more and more, climate was understood as a global entity, such as in Arrhenius’ famous analysis of the greenhouse effect (Arrhenius, 1896), and climate became a field of physics. After the catastrophe of racial determinism and colonialism, with the end of World War II, climate determinism lost its reputation, and the significance of geography and its approaches declined. Climate became a subfield of chiefly meteorology, understood as “physics of the atmosphere”, and later of oceanography (Sect. 4). As such, a normative change also took place when the norms (such as the Mertonian norms named CUDOS; see below), common in physical sciences, were adopted in climate science. A late recognition of this approach was the Nobel Prize in Physics in 2021 for Suzuki Manabe and Klaus Hasselmann (e.g., Franzke et al., 2022).

A consequence of this “scientification” of climate sciences was that natural scientists consider statements as scientific when they have been derived by employing a scientific method, have survived falsification, have outcompeted

alternative explanations, can be reproduced by independent researchers and when it is clear that the statements do not represent truth but explanations, which for the time being are consistent with observations and theories considered valid and are better than other alternative explanations. At a later time, a re-consideration may be needed if new data and theories lead to contradictions or make better-fitting explanations possible.

When scientists speak to the public, scientific statements are expected to present the truth. Scientists enjoy authority based on their objectivity. Society presumes that something like Merton’s norms (CUDOS) are employed. This is so to a large extent (Bray and von Storch, 2017). But assertions formulated by scientifically educated people who do not employ the scientific method (for instance, do not consider alternative explanations or opt for an explanation because of consistency with a specific school of research) are not considered “scientific”.

When the overarching question, i.e., if humankind would change climate through its ongoing and intensifying emissions of greenhouse gases, began dominating the arena of scientific and public attention, the role of climate science changed again. With the question answered positively, the impact or the expected adverse consequences of anthropogenic climate change began guiding climate science, with a re-entry of geographical sciences and a tacit climatic determinism (Stehr and von Storch, 1997). In this present period, the public is asking for action, and the output of science is considered to be determining needed political measures. Climate science is no longer considered a curiosity-driven effort, where quality is given by its methodical rigor and serious falsification efforts, but a key argument in a political challenge driven by different value cultures. In such a situation, science ends up in a post-normal situation (Sect. 5).

The development of climate science and its embroilment with societal issues, such as constructing superiority of the own people and the exploitation of others through colonialism in earlier times, as well as present political activism among climate scientists in present days, demonstrate the basic fact that climate science is a social process. This does not disqualify the achievements of climate research, but it does ask for an analysis of the ongoing cultural conditioning of actors and results by the zeitgeist. The fact that scientific progress is conditioned by social dynamics, that it is in a post-normal phase, is nothing bad, but it should be kept in mind when scientists communicate with society.

In the following, the different issues mentioned above are deepened a bit.

### 3 Climatic determinism

The old and powerful narrative of climatic determinism may be summarized like this:

Climatic determinism is the understanding that knowledge about the state of the climate, be it stationary or changing, provides significant insight about socially relevant processes, such as economic efficiency, physical energy and health of people or social and civilizational aspects and achievements. In the classical climatic determinism, the success of certain people in attaining ‘high levels of civilization’ was attributed mostly to climate. (Stehr and von Storch, 1999)

Stehr and von Storch prepared an inventory of the purported impacts of climate – they include alcoholism, crime, cleanliness, mortality, life expectancy, fertility, temperament, stupidity and work attitudes, to mention some.

The best known “modern” representative of climatic determinism was Ellsworth Huntington, who drew the following significant conclusion:

Thus, if all other influences were eliminated, we should expect civilization to advance most rapidly in climates which have few or no months with temperatures above the optimum and many below, but none too far below the optimum. As a matter of fact, the actual distribution of civilization approaches this pattern but departs from it in some respect because mean temperature is only one of the climatic factors of environment, and the effects of physical environment are modified by cultural environment (Huntington, 1925).

This purported coincidence of “climatic energy” and “level of civilization” was based on two global maps, which shared some similarities. Thus, it was claimed that there was a difference between “advanced” people, mostly in Europe and some European settlements at mid-latitudes (USA, Australia), and less favored people mostly in the tropics. The differences were thought to be mostly due to the different climates. It was speculated that this difference in living conditions and challenges would not only manifest in economy and civilization but also in bodily characteristics, such as the form of noses (Davies, 1932).

Thus, climate allowed the discrimination between “us” and the “others”, when seen with European eyes. The others were unable to develop reasonable levels of civilization and would not be able to exploit the potentials of their lands and resources. Obviously, they were also unable to withstand the military power of the European powers, which was based on technological advancements (see also von Storch and Gräbel, 2018).

Climate was considered a major, if not the dominant, cause for European “superiority” and the others inferiority, which was a property of the people, and their races, which had formed consistently in the different climates.

Such theories formed a basis for colonial activity, since the local population would purportedly be unable to develop ef-

ficient governance, economy and finer culture because of the natural barrier of adverse regional climates. This may have led to two conclusions, namely, that the advanced Europeans may use the resources of the others, as they were incapable of using them for themselves, and that the retarded others may need special support and treatment for mitigating the adverse effects of a non-inspiring and non-challenging climate. The former served as a legitimization for colonialism, whereas the other explanation may have been a motivation for widespread evangelization, which often enough seems to have been a pre-form of colonization.

#### 4 Climate as physical science challenge

The concept of climate has undergone significant changes in the past 100 years. In modern times, natural sciences instituted self-critical processes (repeatability, falsification) and norms. These CUDOS norms are the following (Grundmann, 2012; Stehr, 1978):

- Communalism – the common ownership of scientific discoveries, according to which scientists give up intellectual property rights in exchange for recognition and esteem.
- Universalism – according to which knowledge claims are evaluated in terms of universal or impersonal criteria and not on the basis of race, class, gender, religion or nationality.
- Disinterestedness – scientists, when presenting their work publicly, should do so without any prejudice or personal values and do so in an impersonal manner.
- Organized skepticism – all ideas must be tested and are subject to rigorous (peer review) scrutiny,

Geography, the traditional host for climate issues, lost its grip, and physics took over. This led to a more systematic, critical and rigorous approach of building and testing hypotheses and concepts of the functioning of the climate system.

Since about the 1970s, climate is conceptualized as a global object, which is determined chiefly by the amount of solar radiation arriving at Earth, the rotation of the Earth, and the radiative properties of the atmosphere and of the Earth surface (e.g., Peixoto and Oort, 1992). Regional climates are in this concept the regional manifestations of the global climate, which in principle may be considered the results of “downscaling” (e.g., Giorgi et al., 2001). Thus, regional climates are interesting chiefly because of the impacts of climate on georisks, ecosystems, economy, and health and less so because of a significant contribution to the dynamics of the global climate system.

The regional manifestation is a key aspect in dealing with adaptation to man-made climate change, while most of the

political debate focuses on limiting the amount of greenhouse gases in the atmosphere, i.e., the mitigation of global climate change.

The issue of anthropogenic climate change was proposed already in the 19th century (Arrhenius, 1896) but lost scientific attention for an extended time until it was re-detected in the 1970s. For instance, the Max Planck Society decided in the 1970s that there would be the need for an elite institution to study climate change – and it invited Klaus Hasselmann to establish that institute: the Max Planck Institute of Meteorology in Hamburg. In 2021, Hasselmann's achievements were recognized by the Nobel Prize in Physics (e.g., Franzke et al., 2022). In the 1990s, the observational evidence had matured and allowed the conclusion by the Intergovernmental Panel on Climate Change (IPCC) that a global warming is ongoing, that it is related to emission of greenhouse gases and that the consequences are serious – not only for the geophysical system but also for societies and ecosystems.

Natural scientists consider statements as scientific when they have been derived by employing a scientific method, have survived falsification, have outcompeted alternative explanations, can be reproduced by independent researchers and when it is clear that the statements do not represent truth but explanations, which for the time being are consistent with observations and theories considered valid and are better than other alternative explanations. At a later time, a re-consideration may be needed if new data and theories lead to contradictions or make better-fitting explanations possible.

## 5 The climate knowledge market

In earlier times, and still in some parts of the world, significant parts of the public hold doubts about the reality of anthropogenic climate change. However, these voices are steadily declining. Instead, a more catastrophic discourse is emerging in western countries. Many scientists feel that the purportedly resulting irrefutable political consequences of their findings are not “followed” by society and policymakers. Indeed, quite a few demand that climate policy must “follow the science”. In surveys, a substantial number of young climate scholars considered “motivate people to act on climate change” as the main task of the climate science community (von Storch et al., 2019).

This apparent divergence between public policy and scientific suggestions is based on the “dual face of climate”: On the one hand, climate is a concept of natural sciences, which works with the statistics of weather (in atmosphere and ocean). These statistics are named “climate”. The many components of the climate system interact with each other in complex ways. The almost infinite number of potentially chaotic components makes the climate a stochastic system. As such it is an exciting research field for physical scientists,

who succeed in understanding the natural world. This understanding is a scientific construction<sup>1</sup>.

But besides scientific constructions there are social, or cultural, constructions, which compete in decision-making with scientific constructions (Stehr, 1994). A traditional construction is part of religious world views. A popular construction describes a catastrophic vulnerability of societies and ecosystems to changing climatic conditions. Another operates with the view that in the end it is the well-being of economy which matters for people and their decisions (as amply illustrated when the usage of coal is intensifying as a response to threatened global energy supply due to the Russian war against Ukraine).

The science policy and public interaction is not an issue of “knowledge speaks to power”. The problem is not that the public is stupid or uneducated. The idea of the “knowledge gap model” (Tichenor et al., 1970; Winter, 2004), according to which people simply do not understand the problem but will draw the right conclusions when taught accordingly, is false (Viswanath and Finnegan, 1996; Lind and Boomgaarden, 2019). The problem is that the scientific knowledge is confronted on the “explanation market” with other forms of knowledge (pre-scientific, outdated; traditional, morphed by different interests). Scientific knowledge does not necessarily “win” this competition (Adolf and Stehr, 2016). Even worse, the social process “science” is influenced by these other knowledge forms. Science cannot be objective but should nevertheless strive to be so.

Climate science is in a state where some facts are uncertain, values are in dispute, stakes are high and decisions urgent. In this state, science is not only done for reasons of curiosity but is asked for as support for preconceived value-based agendas. Climate science is in a “post-normal” phase (Funtowicz and Ravetz, 1985; Bray and von Storch, 1999), which is often associated with a frequent dominance of political utility over methodical rigor. Climate scientists transgress regularly into policy-prescribing – with a uniform bias. They trivialize social dynamics and try to model the world, including the social sphere, as if its dynamics would be governed by a set of deterministic (or stochastic) equations.

The overall effect of post-normal science is that the different societal characters of science (striving for best self-consistent explanations) and of policymaking (negotiating acceptable policies across a variety of social interests and perceptions) is blurred, with science being “de-scientized” and “politicized” and policymaking being “de-politicized” and “scientized” (Beck, 2011).

<sup>1</sup>The word “construction” does not imply arbitrariness. Instead, it is alluding to the process of building knowledge by exploiting past explanations, new data and peer review but also to the possibility of a need for modernization of the construct, when new, conflicting data emerge.



Policy decisions are framed as being “without alternative” – scientific knowledge claims are presented as leading to unique “solutions” which need to be implemented without further democratic influence on the substance. Some scientists act as policy activists (“stealth advocates” in the “honest broker” terminology of Pielke Jr. (2007), while exploiting their public authority as scientists. Different knowledge claims, among them “alternative facts”, emerge.

Post-normal conditions lead to changes in the scientific organization – programs, perceived leading scientists – which feed back into societies to support a priori world views (climate catastrophe and fake news).

## 6 Epilogue

This article is based on the extensive research and knowledge appropriation which took place in my scholarly neighborhood, at the Max Planck Institute of Meteorology and at the Helmholtz-Zentrum Geesthacht since the early 1990. This effort was special in that it brought together natural climate scientists and social scientist – by having the latter as extended-time visitors of Hans von Storch. The focus of this essay is on the linkage of climate science and societies, with the joint view from within the natural science and from social sciences. As such, many significant scholars are not explicitly considered, in particular if they had not this personal presence in natural climate sciences. Other significant fields have also not been considered, such as the history of climate (e.g., Brázdil et al., 2005) or the role of media (such as Weingart et al., 2000; Boykoff and Boykoff, 2007; Schäfer, 2015).

The most important of these visitors was certainly Nico Stehr with many publications, and the joint work has now been documented in an anthology, which will be available soon (Stehr and von Storch, 2023). Other significant visitors were Dennis Bray, Reiner Grundmann and Sheldon Ungar. Also, there was frequent interaction with Roger Pielke Jr. Later in this process, the Hamburg Cluster of Excellence “Integrated Climate System Analysis and Prediction” was expanded to include significant contributions of social scientists, in particular but not only Anita Engels and Simone Rödder. The latter compiled a most useful compendium of “Schlüsselwerke der sozialwissenschaftlichen Klimaforschung” (Key contributions of social science to climate science” (Ibrahim and Rödder, 2022).

Mostly independent of this process, another key contributor, also rooted in both communities, arose, namely, Mike Hulme. An extensive interview including a complete bibliography of Mike Hulme is presented by von Storch and Claussen (2021) with many significant contributions on the history of climate science, including climatic determinism, the IPCC process and more. Another significant scholar is Jerome van der Sluijs (van der Sluijs, 2012), who contributed in particular to the issue of post-normal science and climate policy.

But, all in all, the present paper is by no means a comprehensive overview of what has been studied in this field. The essay is biased towards European thinkers, and, for course, to the academic milieu of the author. However, the compendium of Ibrahim and Rödder indicates that authors who had done their work with direct interactions with the engine rooms of natural science seem to be really rare.

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