Brief Communication: Climate science as a social process – history, climatic determinism, CUDOS und post-normality

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Abstract. Since 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 lecture, 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 time, when natural sciences instituted self-critical processes (repeatability, falsification) and norms (CUDOS @Merton), 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, the 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.

Caveat: This essay is submitted for publication in a journal devoted to nonlinear dynamics. This is certainly puzzling, but the editors have encouraged me to do so – and indeed social dynamics is certainly most nonlinear, and high-dimensional – but 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, are 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 cooperations 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.

1. Introduction: Climate as 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 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 favourable indoors 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; Section 2).

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 in 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, 1898), and climate became a field of physics. After the catastrophe of racial determinism and colonialisms, 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 (Section 3). As such, also a normative change took place, when the CUDOS-norms, 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 (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 out-competed 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 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.
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, 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 determining needed political measures. Climate science is no longer considered a curiosity driven effort, which 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, a science ends up in a **post-normal** situation (Section 4).
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, demonstrates the basic fact that climate science is a **social process**. This does not disqualify the achievements of climate research, but it asks for an analysis of the ongoing cultural conditioning of actors and results by the Zeitgeist. That the scientific progress is conditioned by social dynamics, that it is in a post-normal phase, is nothing "bad", but should be kept in mind, when scientists communicate with society.
In the following the different issues mentioned above are deepened a bit.

2. 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 range from alcoholism, crime, cleanliness, mortality, life expectancy, fertility, temperament, and stupidity to work attitudes, to mention some.
The best known "modern" representative of climatic determinism was Ellsworth Huntington, who drew the 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, 1945)

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 as 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 efficient 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 seem to have been a pre-form of colonization.

3. Climate as physical science challenge

The concept of climate has undergone significant changes in the past 100 years. In modern time, natural sciences instituted self-critical processes (repeatability, falsification) and norms: These "CUDOS" norms are (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" (Giorgi et a., 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 focusses 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, 1898) 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 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 (Franzke et al., 2022). In the 1990s, the observational evidence had matured and allowed the conclusion by the Intergovernmental Panel of Climate Change 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 out-competed 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 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.

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When scientists speak to the public, then scientific statements are expected to present "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).

4. 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 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 to 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.[1]

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 worldviews. 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/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" (Tichonor 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 marked" with other forms of knowledge (pre-scientific, outdated; traditional, morphed by different interests). Scientific knowledge does not necessarily "win" this competition (Stehr and Adolf, 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 a state that some *facts uncertain, values in dispute, stakes high and decisions urgent.* In this state, science is not only done for reasons for 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).

[1] 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 (2007), while exploiting their public authority as scientists. Different knowledge claims, among them "alternative facts", emerge.

Postnormal 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).

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