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Climate Research: The Case for the Social Sciences

The present dilemmas brought about by anthropogenic climate change are in many ways unprecedented. Knowledge about the physical nature of global climate changes is not sufficient to move from comprehension to a solution of the problem. The historical record shows that past generations too, have been fascinated and concerned about the impact of climate as well as anthropogenic climate change on society. But these efforts have, for the most part, been informed by the doctrine of climate determinism. We ask therefore what a more realistic form of impact research, as a basis for climate policy, must look like. We argue that the conception of the issue as an "optimal control problem" is inadequate. Impact research has to be cognizant of the dynamic social construct of climate. As a result, climate policies as a form of managed climate change have to draw extensively on social science expertise.

INTRODUCTION

Climate research has thrived within the scientific community for the past decades. To date, climate research has dealt mainly with questions about the physical dynamics of climate understood as a natural phenomenon. For the purposes of policy, accurate numerical and system-analytical answers are considered sufficient answers while the translation of such knowledge into practical decisions in the societal and political realm are taken for granted.

But the success of climate research has not led to the institution of policies by balancing expected damages and abatement costs to mitigate, or even avoid, the detrimental consequences of expected anthropogenic climate change. Instead, the —often misinterpreted—information provided by climate research is responsible for the creation of alarm ("climate catastrophe") among the public, and political inactivity. In everyday life, the magic terms "greenhouse effect and global warming" are now widely known; but equally widespread is confusion about the nature of these concepts. Political actions are mostly limited to verbal announcements and more or less generous funding of climate research.

Natural scientists continue to be as optimistic and well-meaning as most natural scientists have been in the past. To avoid misconception, we consider it imperative that social science expertise is brought into the center of climate research. We present a series of cases which demonstrate how social science expertise can help build a more holistic and realistic view of climate and society.

In this article, we take a skeptical stance towards the relevance of "natural" scientific information about climate and climate change for society. Such skepticism does not imply that we question the reality of anthropogenic global warming (1–3). However, the existence and comprehension of the natural process does not necessarily imply its relevance for society. Whether anthropogenic climate change is socially relevant or not, has to be explored by climate impact research, a field attracting more and more interest. In the following two sections we question two conventional approaches pursued by climate impact research. Specifically, we address two questions:

Is climate impact research a new scientific field? We will show that it is not new but a forgotten "science" that has fascinated countless generations in many societies. However, past climate impact research was mainly of the "climatic determinism" genre, a paradigm which disappeared from the scientific discourse perhaps because of its intimate relation to racial theories. But even if it disappeared from the scientific agenda, climate determinism is still a most vivid concept among the public in contemporary society, and that includes decision makers and politicians.

Is it sensible to consider the social consequences of global warming as an "optimal control problem" which requires the construction of "climate policy" that balances expected abatement costs against expected climate change damage costs? We will assert that this approach is questionable because it disregards the dynamics of social value attribution over time. The costs of climate change perceived by future generations may be radically different from our present measures of value, or social preferences.

While these two questions address for the conventional climate impact research pursued by geographers, ecologists and economists, we see the need for another type of climate impact research which has to do with the public perceptions and beliefs, with the subjective role of natural scientists and decision makers and their interaction with society. In line with this general point, we ask in a later section *Is the public's perception of global warming consistent with the views of natural scientists?* What is the contemporary social construct of climate and climate change? We will demonstrate that this social construct as expressed by the public at large and reinforced as well as dramatized by the media, is often far removed from what natural scientists consider to be the case.

The paper concludes with a preliminary list of research questions which are not only intellectually appealing, but also of relevance for dealing with the threat, or scare, of global warming.

CLIMATE IMPACT RESEARCH

Independently, whether we accept anthropogenic global warming as a reality or, to some degree, as a possible evolution which may take place in the future, the practical implications need to be explored. Thus, climate impact becomes a key research task. We have to ask to what extent and how climate and climate change determine the performance of natural and managed ecosystems and economic and social structures and how any mitigating efforts, i.e. costs associated with the management of climate change, in turn affects society.

One avenue of inquiry of climate impact research, evident from the earliest time of civilization, has been the speculation about the effect of climate on humans. For example, in classical Greece, Hippocrates, suggested in his treatise on "Air, water and places", that knowledge about climate ought to be used to explain the psychology and physiology of humans. The differences in habits of life and character between East and West were thought to be a result of the differences in climate. During the enlightenment, the educated part of the population of France, Germany and England, spent enormous intellectual energy arguing about the climatic determinants of the civilizational pe-

culiarities of entire nations. Philosophers such as Montesquieu in his influential "Esprit des Lois" and Herder in his "Ideen zur Philosophie der Geschichte der Menschheit" advanced widely discussed ideas about the significant constraint that climate represents.

But even in our century, climatic explanations of history and the theory of significant climatic influences on individuals and societies have flourished. While earlier speculations about the impact of climate were largely derived from casual observation, the American geographer Ellsworth Huntington introduced the quantitative method. In his monograph "Civilization and Climate" (4), Huntington advanced the hypothesis, widely accepted by the public and appreciated by fellow scientists, that the formation of a civilization would be possible only in areas where favorable climatic conditions prevail. His conclusions were based on a statistical analysis of the work records of factory workers and marks of college students. Huntington claimed to have shown that humans are most energetic and productive at a temperature of c. 15–21°C, as well a moderate annual range of temperature and the presence of short-term variability. The latter was thought to be stimulating both in terms of mental and physical energy and health. Not surprisingly, such climatic conditions prevail in modern times in Western and Central Europe, most of North America, to some extent in Japan, and in Australia and some parts of southern South America. Conversely, Huntington claims that both physical and mental activity decline with extremes of either heat or cold. As a verification of his hypothesis, Huntington showed two maps (Fig. 1) displaying the distribution of health and energy as derived from climatic conditions, and the distribution of civilization, as determined by a survey among experts.

Not surprisingly, similar ideas were in fashion in Nazi Germany where the social psychologist Willy Hellpach for instance wrote in an essay entitled "Culture and Climate", published as part of a volume on the general topic "Klima-Wetter-Mensch":

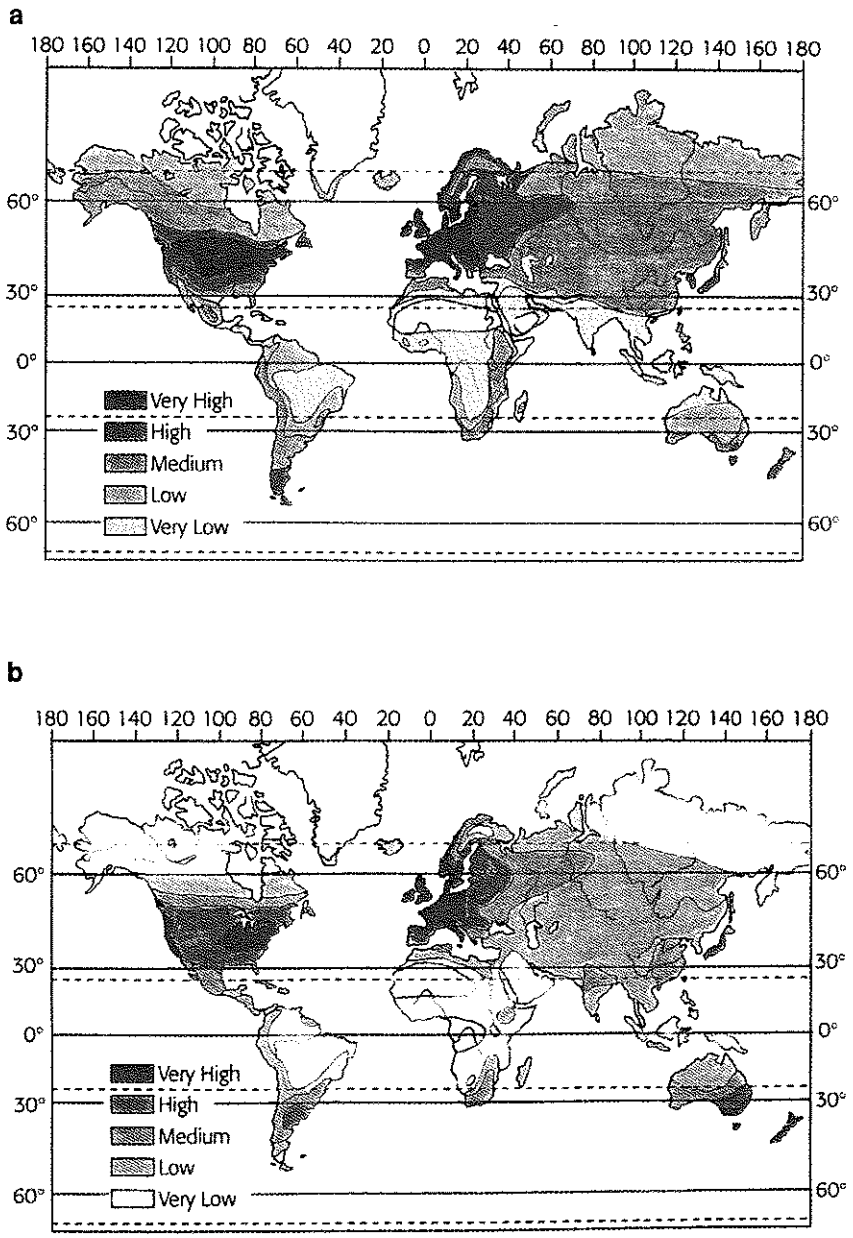
Prevalent in the North ... are the character traits of sobriety, harshness, restraint, imperturbability, readiness of exertion, patience, stamina, rigidity, and the resolute employment of reason and determination. The prevalent traits of the South are liveliness, excitability, impulsiveness, engagement with the spheres of feelings and imagination, a phlegmatic going-with-the-flow or momentary flare-ups. Within a nation, the northerners are more practical, reliable, but inaccessible, and the southerners devoted to fine arts, accessible (sociable, likable, talkative), but unreliable (5, 6).

After racial theories, which are essentially a kind of racial determinism, were discredited, their intellectual siblings geographic determinism and climatic determinism were also rendered obsolete in the social sciences. Today, the incorporation of environmentally determined impacts on human behavior is almost considered taboo within most social science discourse. In the natural sciences, the concept has survived, to some extent. Such a scientific perspective is pursued by biometeorologists, investigating, for example, the effects of heat waves on domestic violence or mortality rates.

In the natural and social sciences, the relation between climate, social conduct, attitudes and abilities is examined if at all in a most cautious manner, the general public still accepts the concept of climatic determinism as illustrated for example by an article in the journal *Weather* (7), in which the author claims:

... on apparent correlations between the character of the people of a region and the climate prevailing there ... intolerant acts have often been conducted by people from areas in mid-latitudes where seasonal temperature extremes are large .... In the 1930s, fascism took over in Spain, Germany, Italy and Austria; all [have a seasonal temperature range] about 20 deg C ... It may never be possible to prove absolutely that a mild climate in mid-latitudes helps to foster a tolerant society or that an extreme climate may predispose people towards intolerance ...if this is recognized it could help to identify potential problem areas in the field of human relations so that timely action can be taken to mitigate threats to peace. ... Perhaps the absence of seasonal extremes helps to foster a relaxed attitude because there is no

Figure 1. Huntington's (4) key argument for his "climate hypothesis of civilisation". a. Huntington's analysis of climatically determined "health and energy", and b. the distribution of "civilisation" derived from a survey among contemporary "experts". From the two maps, Huntington concluded that favorable climatic conditions would be a necessary condition for a civilisation to form.



need to make elaborate plans to cope with the rigors of a cold winter and/or a very hot summer. However, where [the seasonal temperature range] is large, the pace of life is driven by the seasons, enforcing discipline of timely preparation for the extremes; here, less relaxed mental attitudes may develop.

Also, a survey among college students from 26 countries conducted by Pennebaker et al. (8) finds support for the persistent resonance among the young and educated segment of the population for Hellpach's ideas and, therefore, for the stereotypical image of different Northern and Southern personality types.

In decision-making processes on climate matters and in possible conflict with the hard information provided by natural sciences, one should not underestimate the relevance of the widespread belief in "climatic determinism" as well as other relevant cultural climate-related doctrines, for example, the notion that climate is constant.

Another course of inquiry of earlier climate, and climate impact research has concerned the variations or changes in climate. Attentive observers detected already in the 18th century that climate is not constant, and researchers speculated about the reasons for such changes. As a result, the dichotomy of natural and anthropogenic climate change was introduced. In 1770, the American physician Williamson described a change in climatic conditions in the North American colonies, and linked this favorable change to the ongoing settlement that produced increased drainage and deforestation (9). Similarly, the saying "The rain follows the plough" describes the idea of a beneficial climate change caused by the transformation of the North American prairies into agriculturally-managed farmland.

In the 19th century, widespread discussions took place in Europe, in Australia and in North America, about climate change due to deforestation and, sometimes, reforestation (10, 11). This debate was not confined to the scientific community of the day, but found considerable echo in the media and in politics. Moreover, the discussion was rather similar to the present one about the interpretation of the current warming trend, that is: are we faced with just another long-term swing in the course of natural variability or is it becoming warmer because of anthropogenic modifications of the environment?

The conviction that the changes were anthropogenic led in several countries to the establishment of governmental and parliamentarian committees for the purpose of designing proper response strategies.

The opposite point of view, i.e. that climate change is a matter of natural processes, was advocated by other researchers, such as Eduard Brückner (10), who documented that climate would vary for natural reasons on decadal time scales and continental spatial scales. Interestingly, after his analysis of the climatological data, he turned his interest to the impact of these climatic variations on health, transportation, international trade, migration patterns, etc.

On the basis of the historical record, we conclude:

i) Climate research and climate impact research is not a new line of research. It has been pursued for centuries. However, present-day scientists are mostly unaware of these earlier discussions, hypotheses and theories.

ii) Historical climate impact research maneuvered itself into a blind alley by trying to attribute most or even all social facts, such as health conditions as well an endless variety of patterns of social conduct to climatic and other geographical factors. At the same time, there has been no systematic discussion (12, 13) leading to a public discrediting of the doctrine of climatic determinism, or perhaps this discussion did not have much of an impact and has been forgotten.

The significance of these conclusions is that there are strong indications that present day climate impact research has tacitly returned to the old concepts, and there is a real danger that it eventually will end up in the same blind alley as its predecessors, who certainly were no less intelligent, educated, and careful than contemporary researchers.

THE CLIMATE ISSUE: AN OPTIMAL CONTROL PROBLEM?

So far, we have dealt with climate as a factor affecting humans, who respond to climate and its variation in a mostly passive manner. However, people seem to have thought about actively changing climate, either to reverse adverse evolutions, or to directly improve it; e.g. the Soviet plans of rerouting Siberian rivers. In that sense at least, there is a history of managed, and even planned climate change. In the case of the anthropogenic greenhouse effect, most members of society and governments consider it a worthwhile goal to limit the expected anthropogenic climate change, in order to ensure that expected damages remain within acceptable bounds.

From a macro-economic perspective, climate change may be understood as a situation in which the creation of economic welfare has the secondary effect of causing damage to the environment. In the case of anthropogenic climate change, the harmful side effects are, for example, damages such as rising sea levels. These damages create the need for a number of adaptation measures; e.g. the construction of dikes which exploit economic resources that could alternatively be used for the creation of welfare.

The problem is related to the tragedy of the commons (14): All actors together exhaust a common resource, namely the atmosphere as a dump for gaseous by-products of energy generation. By doing so, individual profits are gained. The effect for the common good, however, results in adverse effects for everybody, independently of the amount of emissions by each individual.

Assuming no intervention at all, economists expect a monotone increase of greenhouse gas emissions, the so-called "business as usual" policy. The alternative would be that the world's governments agree on a joint policy aiming at limiting damages on the basis of regulating emissions. The social optimum would be an emission plan for the entire world, balancing the costs associated with the reduction of emissions with the expected cost of damages in the foreseeable future. In strictly economic terms, a time-dependent emission path is aimed for, so that the marginal abatement costs equal the marginal adaptation costs. This idea was pioneered in economics by Nordhaus and in climate research by Hasselmann (15–18). Cast in these terms, the climate problem reduces itself to an optimal control problem, with the emission path as control variable and climatic conditions as state variables (19).

Hasselmann has condensed his approach into the Global Environment and Society (GES) model, in which two dynamical entities, namely the climate system and the economic system interact (Fig. 2). The economic system affects the climate system by wastes such as carbon dioxide (CO_2), and the climate systems responds with a change of, say, sea level. Any waste reduction is associated with costs. Climate changes incur costs as well. The role of public policy is to minimize the total costs, the exact measure of which is left to society.

This optimal control approach is not only intellectually tempting, but may also appeal to policy makers. Undoubtedly, it represents a rewarding and informative perspective for discussing the problem at hand. On the other hand, it functions only on the basis of various assumptions, some of which are not explicitly stated. Some simplifications, such as the absence of natural climate variability, could easily be accounted for by modifying the involved dynamical models. Other static assumptions are more difficult to justify. For example, a major assumption of the model is that future generations will accept our values and our concept of a healthy environment. The macro-eco-

nomic models assume that the assignment of value is mostly constant, perhaps with a discounting element, but without a significant change in the relative designation of values for, say, healthy forests and religious prescriptions. But we know that societal values undergo complex and barely predictable transformations. What is of utmost relevance for significant segments of the general public today, may be irrelevant only a few years let alone decades hence. In other words, models like GES lack a module describing the dynamics of social value assignment. Given the state of our knowledge, it is hardly imaginable that such models may be reliably set up to be used in integrated assessment models.

To illustrate the general point, we offer an example from medieval times (20). In the years 1315 to 1319, parts of Europe suffered from severe weather-induced shortages of food; the problem was severe in England, among other countries. The reconstructed air-pressure distribution for the summer 1315 illustrates the situation (Fig. 3). A persistent anomalous cyclonic circulation over Central Europe brought unusual cold and rainy conditions for the summer with disastrous consequences for the harvests.

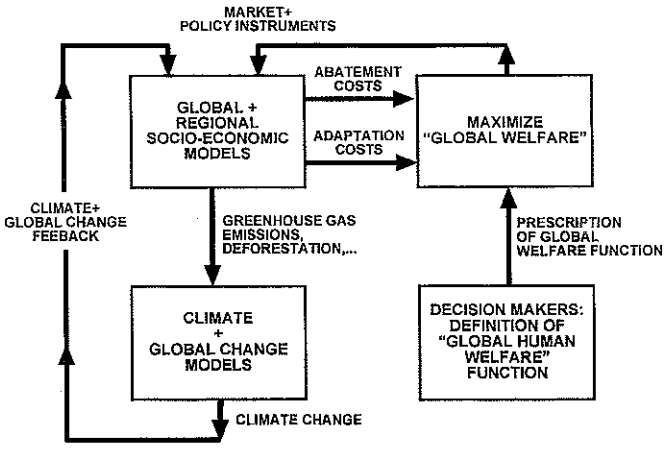


Figure 2. The Global Environment and Society (GES) model (16).

The hostile climatic conditions were interpreted by the contemporary authorities, i.e., the church, as an control problem. The adverse climate was seen and understood as being brought upon society by God in response to sinful conduct. In a sense, society was confronted with anthropogenic climate change. Any business-as-usual response would be associated with unbearably high damage costs—famine, epidemics, high mortality apart from unfavorable perspectives such as the purgatory. Thus, the damage, or adaptation costs, were assessed as being infinite.

Abatement measures considered, were related to a closer adherence to Christian life styles. Analogous to the present situation, such an abatement policy was considered as generally benevolent apart from the immediate harvest problems it might remedy. The costs of such a course of action were perceived as considerably smaller than the expected damages. Consistent with such a perspective, the authorities advised their flock *"to atone for their sins and appease the wrath of God by prayer, fasting, alms giving, and other charities"* (22).

Later, climate conditions returned to normal. These developments must have counted as strong evidence to the public and the authorities alike that their climate policy was entirely successful.

Within the context of our contemporary knowledge about climate dynamics, the 1315 case appears to be almost absurd. But we cannot really be confident that our own comprehension of many present environmental crises, and their management by society and governments will not appear to future generations equally incongruous. Indeed, what can be learned from this case, is that the GES model is overly simplistic because it implicitly assumes that the costs refer to actual processes. What happens in reality is, however, that the costs are estimated for the perceived processes, and that this understanding is subject

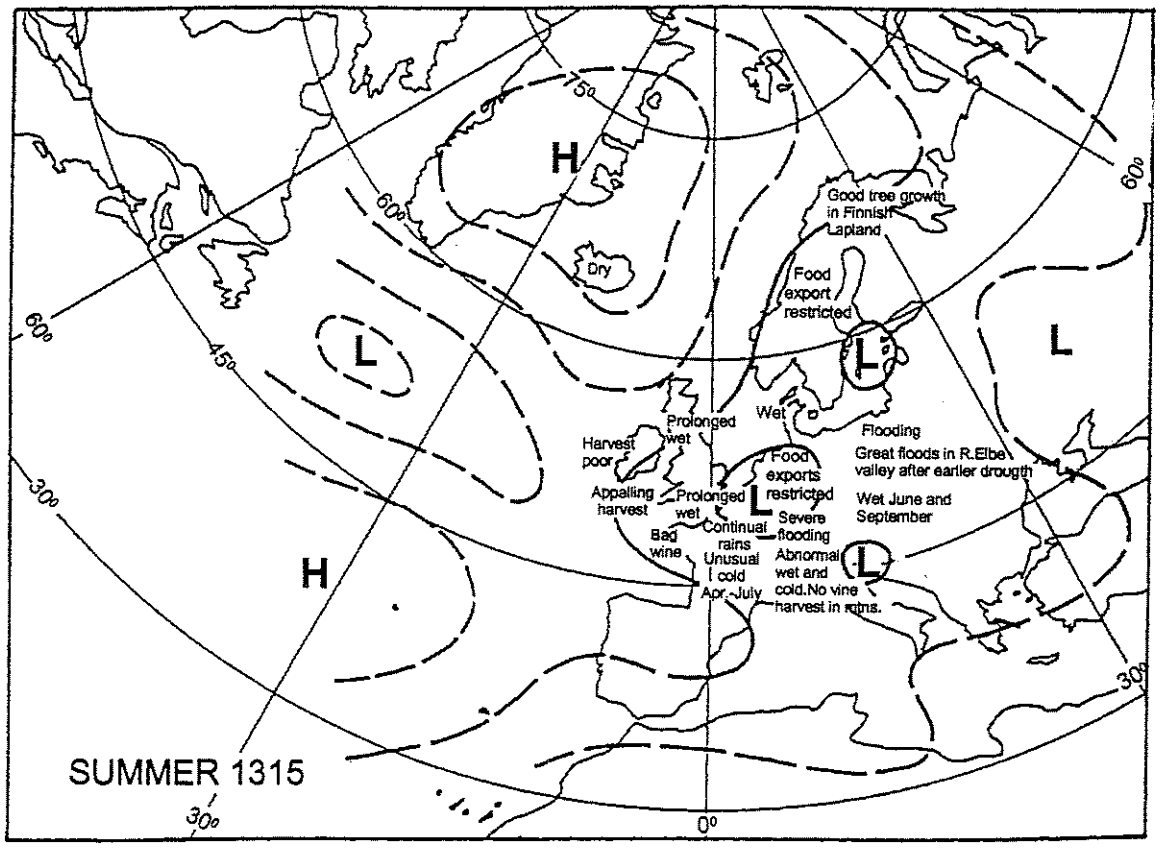


Figure 3. Reconstructed summer mean air-pressure distribution in the year 1315 together with reports about the prevailing weather anomalies (21).

to its own dynamics, largely independent of the real processes.

Therefore, the GES model should be modified to the Perceived Environment and Society (PES) model, by adding two processes which transform the hard information about economy and environment into their social constructs (Fig. 3). The effects of human activity on the environment are first explained to the public by certain authorities, which nowadays are mainly scientific advisory committees such as IPCC. The authoritative interpretation is helpful, but not decisive for the public understanding of climate. Instead, stakeholders confront the received interpretations with their own cognitive models and doctrines, i.e. their understanding of many processes and interests that may or may not be related to the problem at hand. The resulting complex social construct ultimately determines the design of, and the compliance with, climate policies. Thus, the mapping of the social construct, in different times and societies, is of utmost importance for a successful solution to the climate problem. Also, the dynamics involved in the process of forming the social construct of the climate need to be examined and understood.

We conclude therefore that models such as GES:

i) are informative and useful to discuss the general format of the problem;

ii) lack a crucial module, namely the module that would assist in describing the evolution of social value assignment, or social preferences including conflicts and contradictions in values within and among societies. For a few years, such a figuration of preferences may be taken to be constant but beyond that time scale this process is likely to exhibit significant variations created by social, economic, political and cultural processes.

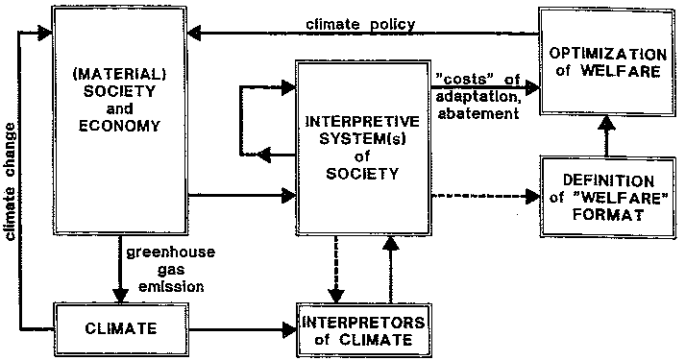


Figure 4. The Perceived Environment and Society (PES) model, which deviates from the GES model in Figure 2 by two additional boxes representing societal processes.

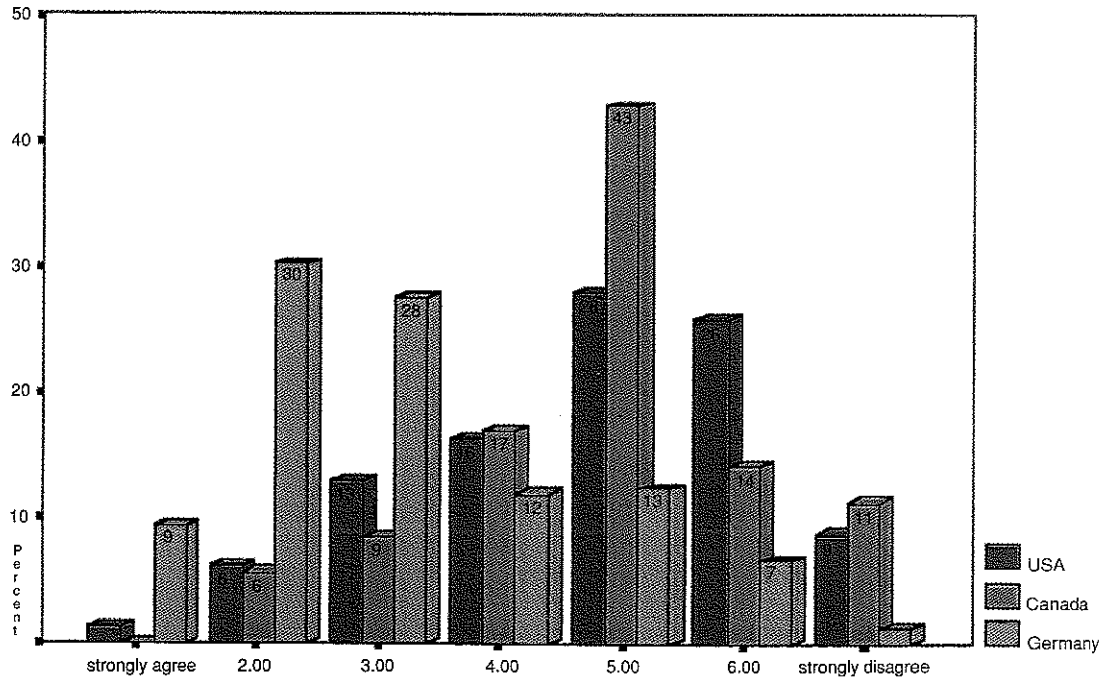
THE SOCIAL CONSTRUCT OF CLIMATE

We know of only a few studies that try to describe the prevalent social construct of climate and climate change. In the following, we present some results from an interesting study carried out in the US by Kempton et al. (23). This study offers ideas and observations which we consider promising starting points for future research in this direction.

They first interviewed individuals from various social groups in order to identify what lay people think about climate and climate change. Certain ideas were found to be rather widespread, namely that the climate problem is essentially a pollution problem, similar to SO_2 emissions. Thus, an adequate strategy would be to force industry to set up filters. Another frequent (mis)conception was that the emission of CO_2 into the atmosphere would be harmful because it would lead to a depletion of atmospheric oxygen, so that people would suffocate. The natural scientific view of the climate problem was only grasped by a small minority of respondents. On the other hand, preposterous statements such as "I don't know what they're doing up on the moon and shooting those things up there. I think they're disturbing the atmosphere" were voiced by more than one respondent.

These interviews assisted in constructing a questionnaire that was used in a survey of five different groups of respondents, ranging from radical environmentalists to workers who lost their jobs because of environmental legislation. The opinions obtained did not vary much among the different groups. All groups are seriously concerned about the climate problem, and almost all respondents held plain misconceptions about climate, as already found in the initial interviews. For example, 79% of those surveyed agreed with the statement "the weather has become more variable and unpredictable recently" while 43% accepted the possibility of a causal link between changes in weather and the space program.

Figure 5. Relative frequencies of answers to the question "Scientists are well attuned to the sensitivity of human social systems to climate impacts." from US, Canadian and German scientists, who were asked to answer on a scale from "strongly agree" to "strongly disagree" (24, 25).



Obviously, much more research is needed to document what kind of conceptions, and why people have specific conceptions of climate and the climate problem. A relevant line of research in this context would deal with some of the producers of the social construct of climate. In our age, this would certainly include scientists, novelists, journalists, meteorologists, the mass media, and others.

The opinions of climate scientists in the US, Canada and Germany have recently been examined empirically. First results have been published by Bray and von Storch (24, 25). One of the initial conclusions is, "the perception of the risk(s) of global climate change are a product of scientific practice; and the specific hazards variously associated with the event have a close affinity to the scientist's personal belief system." Significant differences by country of residence were found, as exemplified in Figure 5, in which the answers from about 200 North American and German scientists to the statement "Scientists are well attuned to the sensitivity of human social systems to climate impacts" are summarized. The Germans display greater pessimisn that their US counterparts while the relative optimism of Canadian scientists must be related to cultural factors that need to be explored.

We conclude that much more attention and analysis should be specifically devoted to social processes which help or resist, transformation of scientific knowledge into popular beliefs and mental models, and generally to the nature of the social construct of climate and its impact on shaping climate policy to indifferent societies.

SUMMARY

The three cases presented in our discussion underscore the need to bring the social sciences into climate research. Social scientists could help in understanding the role of climatic determinism and other popular perceptions, the process of social construction of climate-related knowledge and beliefs, and the dynamics of social preferences. Also, the role of natural scientists, who claim to represent "pure" knowledge, but are controlled by various subjective and social mechanisms should be explored in relation to their bringing climate and climate change to the public and political arena. In future, we will need not only future climatic scenarios, but also scenarios of coping with scientific predictions of climatic change as well as scenarios of coping with actual climate change.

Specifically, the following aspects should be studied:

i) What has happened to the doctrine of climate determinism and what climatic events influence under what conditions societies? How far has and can society emancipate itself from climatic conditions? What are the fundamental errors made by Huntington and others?

ii) Do the discussions from the last century about natural and/or anthropogenic climate change represent a useful analog for the understanding of the present debate and the present decision process on national and international levels?

iii) How can we incorporate the dynamics of social value assignment to transform a GES model into a more realistic PES model?

iv) What is the nature of the contemporary social construct of climate and climate change in a comparative perspective, and what changes have this construct undergone in the past years?

v) What is the role of climate scientists in the process of forming the social construct of climate and climatic change?

vi) What is the role of other social agents—media, religion, education, the state etc.—in the formation of the social construct of climate and climatic change?

vii) How do we successfully combine social and natural science discourse in the area of climate research?

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26. This essay is the result of an extensive cooperation between the two authors, one of which is a social scientist and the other a natural scientist. This cooperation was made possible by several visits of Nico Stehr to the Max-Planck-Institut für Meteorologie in Hamburg and the Institute für Gewässerphysik in Geesthacht. We are indebted to the Max-Planck-Gesellschaft, the GKSS Forschungszentrum and the Thyssen Foundation for their generous support of this cooperation. The comments of the two anonymous reviewers were most helpful. Hans von Storch thanks Klaus Hasselmann and Dennis Bray for many stimulating discussions.

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