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Perspectives of Climate Scientists on Global Climate Change

My presentation here today is based on the perspectives of climate scientists. I am a trained mathematician, and Dennis Bray is a social scientist. Our work is funded by the Thyssen Foundation. One aspect of our project consists of a series of interviews and the distribution of a survey questionnaire to climate scientists in an effort to determine what they think they know, what they think their role is, and what they think their relationship is to the media and policy. I will speak mainly about the results of the survey today, but I will also point out a few other related things I have done with Nico Stehr, namely some work on the relationship of natural science and society.

Nico Stehr and I have recently published a general paper about the role of social scientists in climate research and we have also thought about climatic determinism. It seems that there was an interesting analogy to the present situation about 100 years ago when people discussed whether we were experiencing anthropogenic climate change or natural variations. There were even parliamentary committees discussing these matters. That discussion has been more or less forgotten, but it happened. In addition to this work, Nico Stehr and I have thought about the social construct of climate and climate policy.

All this is based on the experience I was confronted with while I was working at the Max-Planck-Institut für Meteorologie, which is one of the leading centers for climate change research. I noticed again and again that my colleagues appeared in public telling the public what it should do. The standard situation was that someone would appear on television and explain what was going on—will it be warmer, will we have more extreme weather, will we have more storms, will the sea level rise? The next step was to ask, "What does it mean?" It means, for example that we will get sick with some diseases and that there will be climate wars. So in the end they ask "And what do we do about it?" The experts say we have to reduce emissions, of course, and we have to drive our cars less. Obviously, they are way out of their field of expertise when they do this. But why do they do it? They are excellent physicists, they know their field, but then suddenly they appear in public and dare to tell the public what to do in areas in which these scientists have no expertise. And this is not only so at the Max-Planck-Institut für Meteorologie. You can see this behavior from people in all types of institutions throughout Germany. The Americans are also good at this.

So the question is, what do these people think? Dennis Bray and I conducted approximately 50 unstructured interviews with climate scientists from the United States, Canada, and Germany. Of course, we would have liked to extend this analysis also to other countries, but our funding was limited. Three of these interviews have been published, and I will be happy to provide anyone here with a copy. One interview was with a person who was very skeptical, one with a person who was convinced, and the third person believed that something is going on and we should think more about it.

Based on these interviews, we designed a questionnaire with some 60 or 70 questions that I will talk about today. We distributed 460 questionnaires in the United States, 40 in Canada, and 500 in Germany. The respective return rates are 146, 35, and 282. Because our meeting here is concerned with the German-American Academic Council, we will not present the results from Canada. If necessary we could discriminate the German group more finely between the German Meteorological Society in general and the Max-Planck-Institut für Meteorologie compound in Hamburg—that is, the meteorological institute of the university and the Max-Planck-Institut itself.

I will now describe the answers to this questionnaire. First, I will report about what scientists think the capabilities of the climate models are, then what they think about climate change, and finally what they think about the impact of climate on society. The scientists are specialists in the first two fields; in the third field they are not. Next I will look at the relationships among scientists and decision-makers and the media.

We had quite a few questions about the capabilities of climate models, but I will discuss only a few of them. Let me first explain the format of the diagrams. We had seven values, and they varied between "very inadequate" and "very adequate" or something similar. So if a respondent thought that the inference of clouds was very well represented in climate models, this person would have ticked the seven. If a respondent said that it was very inadequate, they would tick a low number. Approximately 18 percent of the American respondents, compared with approximately 10 percent of the German respondents, said that the inference of clouds was very inadequately represented in climate models (see Figure 1). If we forget about the differences between Germany and America, we can see that scientists in general are very skeptical about how the models handle clouds. Even though clouds are considered very relevant for climate change, respondents said that the models do not handle them very well. But more Americans than Germans said "very limited" or "limited." But on the other end of the spectrum, it is the other way around. The Germans respondents were slightly more confident in the models. This difference shows up again and again.

In Figure 2 for precipitation we can see the same result. Precipitation is the key parameter for all types of climate impact studies. The same is true for ocean modeling and how well the models do in terms of heat transport in the ocean. With respect to the coupling of atmospheric and oceanic models, 30 percent of the U.S. respondents said that this is not good, but 5 percent of the Germans said that it is very good. Note that the respondents were rather skeptical overall. If we ignore the differences between the United States and Germany, then it can be seen that the median of this distribution is on the less-confident side.

Now, in regard to the question of whether climate models accurately verify the climate conditions for which they are calibrated, the results are presented in Figure 3. First, the average answer is about four. But looking at the differences between the Germans and the Americans, you can see that they are separated. There was a tendency among the U.S. respondents to say, "No, they do not do their job adequately," whereas there was a tendency among German scientists to say, "Yes, they do."

The next series of questions referred to the climate change rather than the models. "Do you agree with the theory of anthropogenic-induced climate change?" The differences shown in Figure 4 are not statistically significant. However, if we compare "Global warming is a process already underway," we get a slightly different result. Again, there was consensus on both sides of the Atlantic: the majority said, "Yes, it is already underway," with somewhat reduced confidence on the order of 30 percent. But compared with the previous question, then there is a shift. In the previous question, categories 1 and 2 show strong agreement, but here it is categories 2 and 3, so the respondents were a little bit less confident about this.

The next question was again about models: "Climate models can accurately predict climate conditions of the future" (see Figure 5). There is not much of a difference, but it is again shifted to the right. So the respondents said that the theory is right, they have same belief that it is going on now, but their confidence in the models was not very high.

Another interesting question, shown in Figure 6, was, "Assuming climate change will occur, will it occur so suddenly that a lack of preparation could result in the devastation of some areas of the world?" There were no systematic differences between the U.S. and German responses, but quite a few respondents believed that this could be the case. In the category of strong agreement, the Germans had the majority. Now we come to the question, "What does it mean—climate and society?" Here respondents left their area of expertise and entered the social science arena. People obviously do not like the statement: "There is enough uncertainty about a phenomenon of global warming, but there is no need for immediate policy decisions"(see Figure 7). The respondents disagreed, but there was a stronger disagreement with the statement in Germany than in the United States. That means that, in spite of earlier answers, namely that the GCMs (general circulation models) do not do a very good job, most of them said that this uncertainty is not an argument for not taking action. So why did they say that we need to do something? Look at the responses to the question: "To what degree do you think climate change will have a detrimental effect on the society in which you live"(see Figure 8)? Here there is a slight tendency for a negative impact, and the responses are about the same in the United States and Germany. However, it can be seen that the number of respondents that said "a great degree" is much greater at 70 percent in Germany compared to approximately 1 percent in the United States. So most respondents expect that something negative is happening, but that it will not be awful.

Figure 9 shows the responses to the question "How much would you rate global climate change as a problem that concerns the social and economic aspects of societies?" Note that there is a large number of respondents that said that this is very much a problem—the Germans more so than the Americans. Responses here show that they are not only concerned about what is going on in their homeland but also what is happening around the world.

With respect to the question as to whether climate change is a really serious problem, we asked "What is the most pressing question facing humanity today?" In the responses (see Table 1) from 87 people from the American sample, 19 from Canada, and 96 from Germany, for a total of 202, the biggest problem was said to be population. There were a few minor ones, such as resource distribution on the German side, and from the American side some things such as the lack of morals were mentioned. But the number one answer was population pressure. We noticed also in the interviews that when we asked people whether they thought there were other problems that were more salient than climate change, they usually talked about population pressure in some way not related to climate.

The next question was "To what degree do you think it's possible for most societies to adapt to climate change without having to make any substantial changes to current societal practices?" The respondents said that this was not possible (see Figure 10), that something would have to be done. Again, there were more German than American responses that noted a greater need for substantial changes.

The next question was "Climate scientists are well attuned to the sensitivity of human social systems to climate impact." This question is at the core of my interests. The answers are shown in Figure 11. For the American responses, there was quite a disagreement with the statement, whereas the Germans showed quite a bit of agreement. I do not understand this. We will see later that it does not necessarily mean that the respondents themselves are better attuned.

All these assessments are made to be seen in light of this result, namely to the question: "Climate science is full of uncertainties and assumptions." Many respondents—30 percent—strongly agreed that climate science is full of uncertainties and assumptions (see Figure 12). The difference between Germany and the United States was not very large. Even though they said that science is full of assumptions and uncertainties, they nevertheless think there is a need for action.

Now for the third block: scientists, decision makers, and the media. The level of involvement of the respondents with policy makers is shown in Figure 13. "How often are you in contact with policy makers?" Here we also see a dramatic difference. The number-of people who are very involved is not very large. But in Germany the majority of scientists never have any contact at all. Organizations are more hierarchical in German science, so seeing this together with the statement that they are well attuned to public needs must mean that they are not speaking about themselves. Rather they mean that spokespersons, the visible scientists, are well attuned to the needs. We got a similar result when we asked. "How often are you contacted by the media?" Again, 35 percent are never contacted by the media (see Figure 14). Interestingly, the people contacted by the media are not necessarily those who are in contact with the policy makers, which I naively would have expected. But that is not the case.

A question I found particularly interesting, because I personally am convinced that it is so, is "To what degree do you think exposure to the media has the potential to change the attitude of scientists?" The answers are indifferent, but quite a few respondents believed that people's attitudes can change when they talk to the media (see Figure 15). If we include the

first two categories, then we have approximately 20 percent. But quite a few respondents also said no, that it didn't matter.

Do the politicians use the information afterward? "How often do policy makers draw on the most current and state-of-the-art knowledge of climate scientists?" Here we again see mistrust (see Figure 16). Most responses were on the negative side; 3 percent of the Americans and 2 percent Germans said that they never draw on the most current, state-of-the-art knowledge. The respondents were not satisfied with the way the information is used by the politicians or by the public.

There is another interesting question. Namely, is it okay to use the extremes? "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?" (see Figure 17). The Germans said that this was acceptable. Remember, most of them never appear in public. But 40 percent said that this is good practice. If you include category three, it is in the order of 60 percent of the German respondents. In contrast, the Americans didn't like it at all.

"How successful are we in influencing policy?" By "we," I mean scientists. "To what degree do you think that the results of scientific inquiry are instrumental in calling the policy makers to redefine the perception of a climate-related issue?" Here, the results are indifferent (see Figure 18). "To what degree do you think climate scientists have control over what information gets transferred to policy makers?" Or do we just deliver it, and then something happens with it. Here again there was a difference in responses. The Germans are more confident that, once the information has passed over to the political arena, there is a certain type of control there (see Figure 19). But the Americans don't think so. It is just taken into the political machinery and then it is transformed into who-knows-what.

The last question, presented in Figure 20, is "To what degree has climate science remained a value-neutral science?" I am not quite sure how to interpret the results. It could be that respondents did not know what value-neutral science is, that they simply felt uneasy about the term, so they gave an answer in the middle. Maybe they have never thought about it. But my interpretation is that they are indifferent to the question. Indeed, if I think about the discussions we have had at the Max-Planck-Institut für Meteorologie, we have never discussed whether there could be something like value-neutral science.

Let me now present some conclusions. First, there is no fundamental difference in opinions concerning the capabilities of the models. I would say, by and large, that there are not very many differences. There are some differences, but the first order of information would be the same. But there are significant differences with respect to details. For example, with regard to the capability of the models, it seems that the Americans are somewhat more skeptical. There is more feeling of the need of action in Germany. Germans are more optimistic in thinking there is a rational link between the various components. There is considerable doubt about the capabilities of models, particularly concerning processes—clouds, for example. Also, there is little faith in the predictive power. But there was one question concerning the ability of models to deal well with time scales of tens and hundreds of years. There is an agreement about the reality of future possible changes and the impact on society in the

sense that something will happen. But there are different assessments about the timing, the certainty, the severity, and the urgency. There is more concern in Germany, less in the United States. The scientists are dissatisfied about the interaction of science and politics. I think that many scientists have not thought about this problem or the social process at all. And we had a different assessment about the use of extremes to convey the message to the public and the politicians.

To summarize briefly, culture plays a significant role in the structure and process of climate science, and the knowledge about climate change impact is in part a socio-scientific construction. Perhaps this is trivial for many of you, but for me it is not.

Table 1–The area in which I conduct most of my research is

Count	USA	Germany	Count	USA	Germany
impact assessment	8	1	biochemistry	1	0
geosc. instruments	0	0	physical chemistry	1	0
oceanography	2	3	chemistry	2	3
observations	22	34	atmospheric processes	2	9
bio-geo cycles	0	1	climate theory	1	2
climate science assessment	0	1	air-sea interaction	1	2
modeling	38	48	diagnostics	3	0
measurement	4	1	convection	1	0
nutrient cycles	0	0	turbulence	1	0
administration	5	2	engineering	1	0
fluid dynamics	13	1	cloud physics	2	5
monitoring	0	0	stratospheric dynamics	1	1
boundary layers	0	0	solar influences	1	1
ecology	0	2	snow ice	1	0
ecosystems	0	0	public forecast	0	2
physical processes	17	23	agrometeorology	0	1
radiation	1	1	regional climatology	0	6
nonlinear dynamics	1	1	thermodynamics	0	1
computer applications	1	0	flight meteorology	0	2
ocean modeling	1	0	economic geography	0	2
environmental change	1	0	stochastic processes	0	2
physics	1	1	forecasting	0	3
remote sensing	2	0	data systems	0	2
global policy	1	0	synoptics	0	2
experimentation	2	11	climate change	0	14
atmospheric radiation	1	0	meteorology	0	2
interseasonal climatology	1	0	meso climatology	0	1
biometeorology	1	0	hydrodynamics	0	4
paleoclimatology	1	0	missing	4	24
fluid dynamics	1	0	other	0	6
science policy	1	0	Grand Total	149	228

Figure 1—How well do you think atmospheric climate models deal with the influence of clouds?

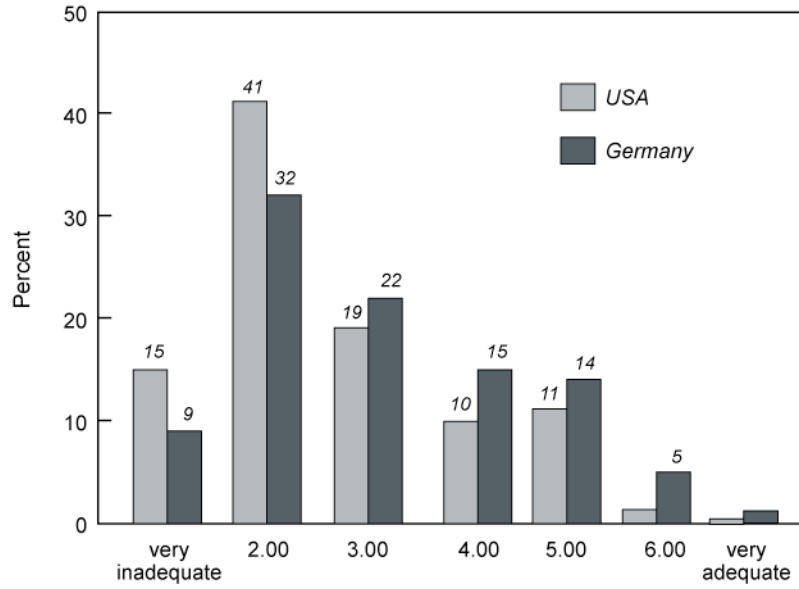


Figure 2—How well do you think atmospheric climate models deal with the precipitation?

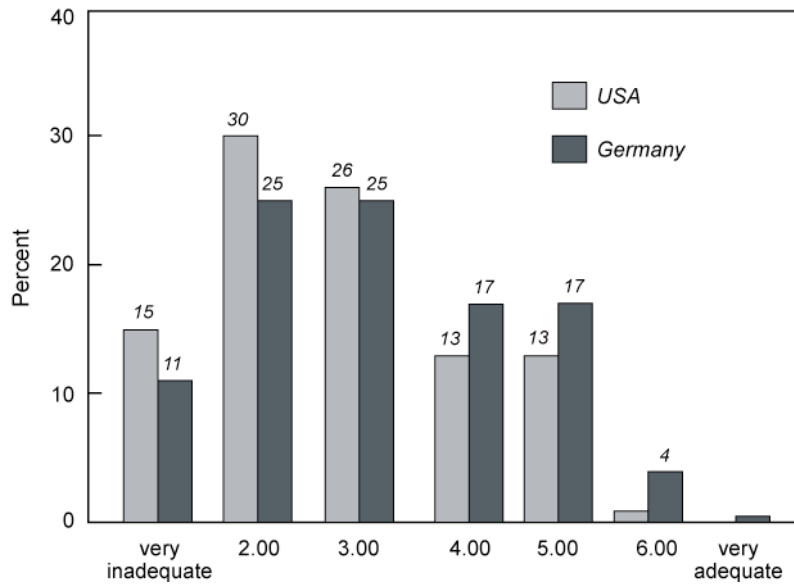


Figure 3—Climate models accurately verify the climatic conditions for which they are calibrated.

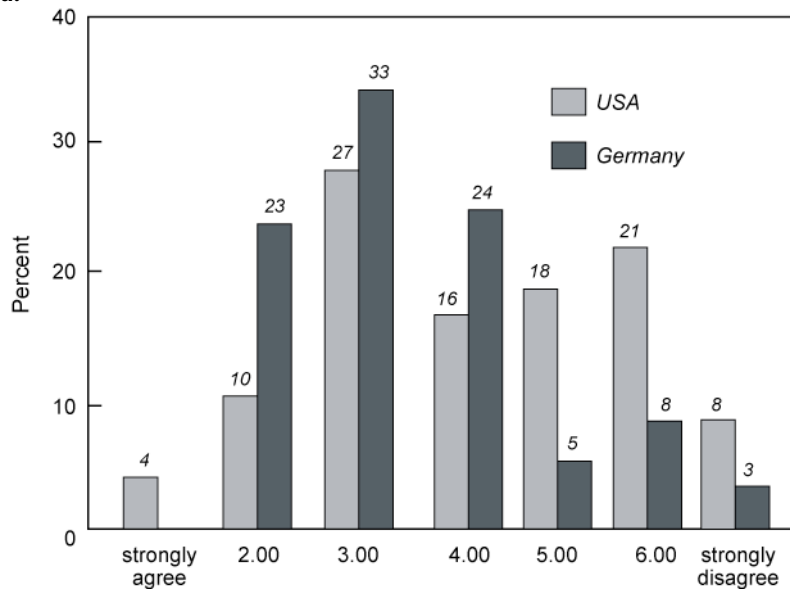


Figure 4—We can say for certain that, without change in human behavior, global warming will definitely occur some time in the future.

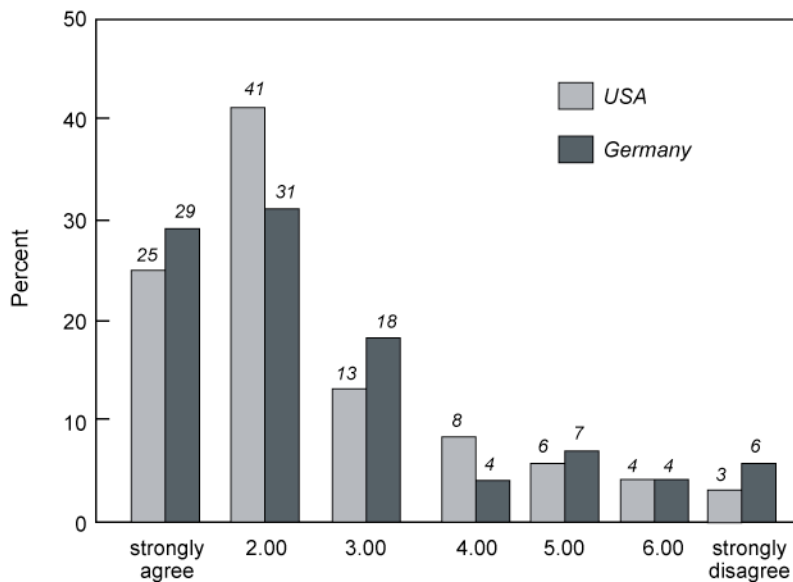


Figure 5—Climate models can accurately predict climatic conditions of the future.

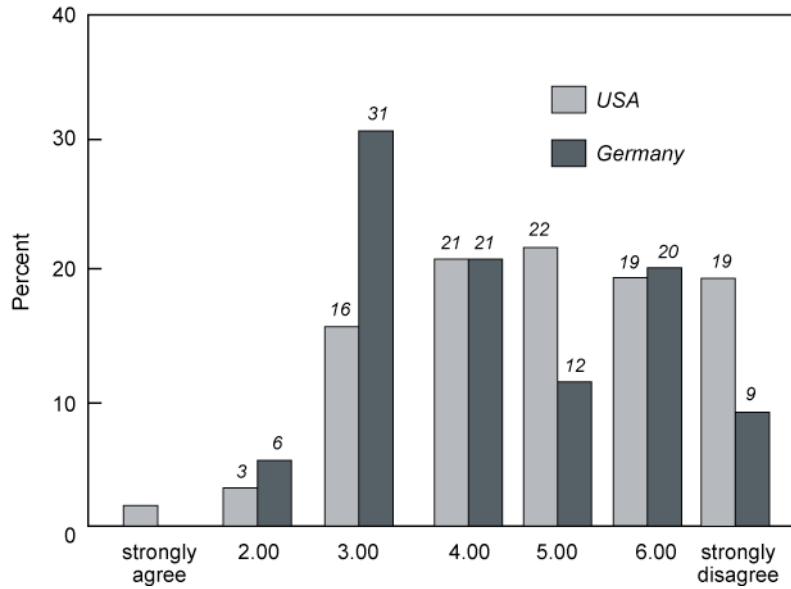


Figure 6—Assuming climate change will occur, it will occur so suddenly that a lack of preparation could result in devastation of some areas of the world.

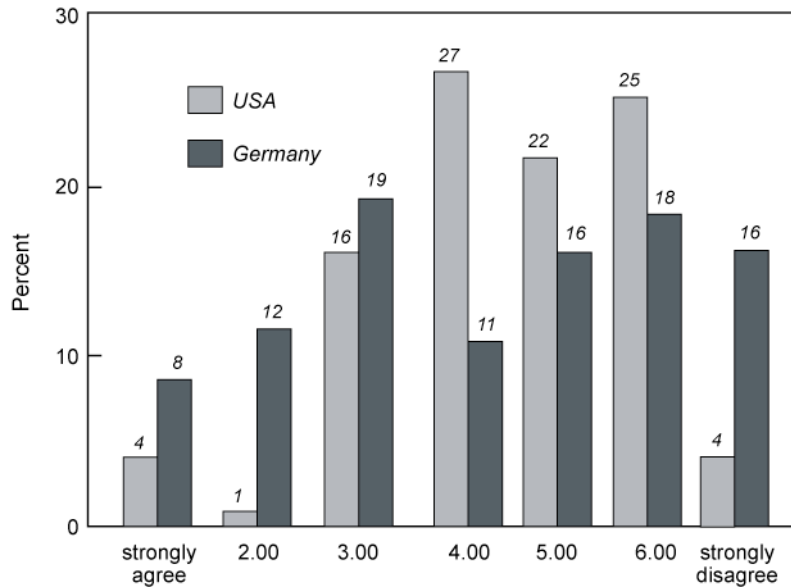


Figure 7—There is enough uncertainty about the phenomenon of global warming that there is on need for immediate policy action.

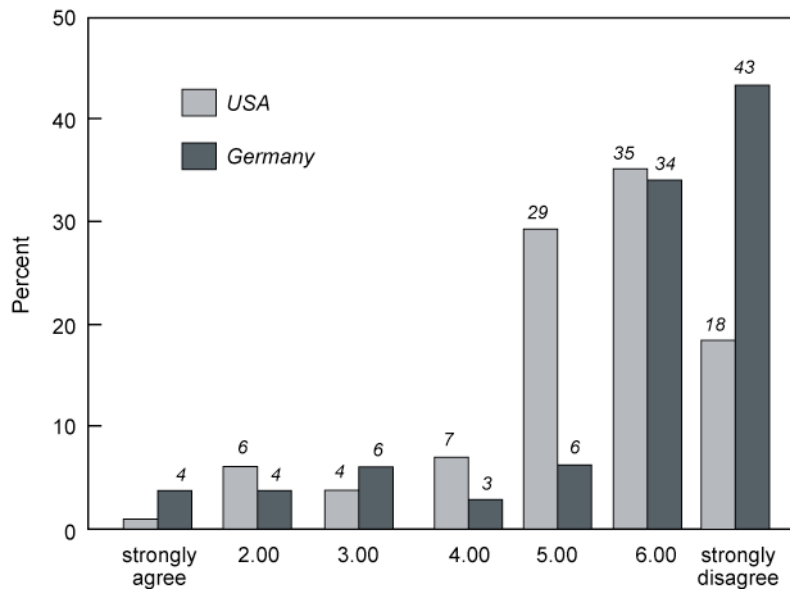


Figure 8—To what degree do you think climate change will have a detrimental effect for the society in which you live?

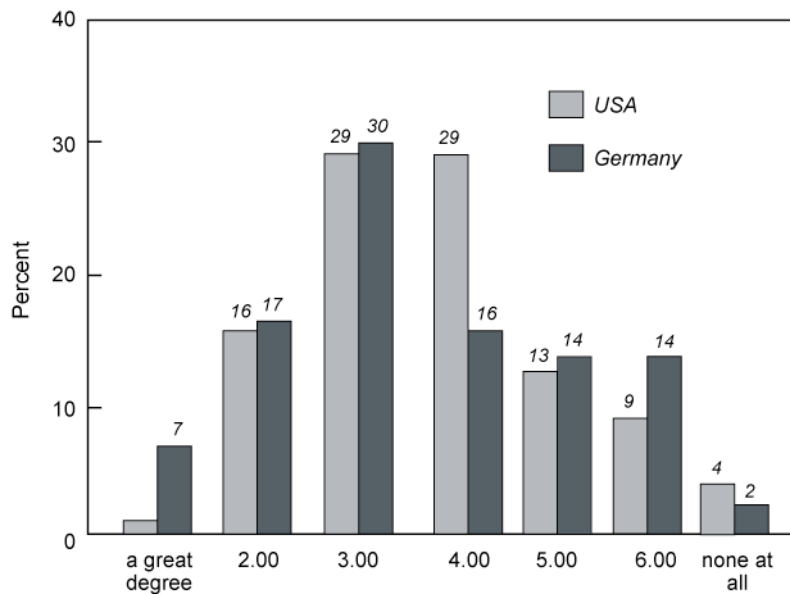


Figure 9—How much would you rate global climate change as a problem that concerns the social and economic aspects societies?

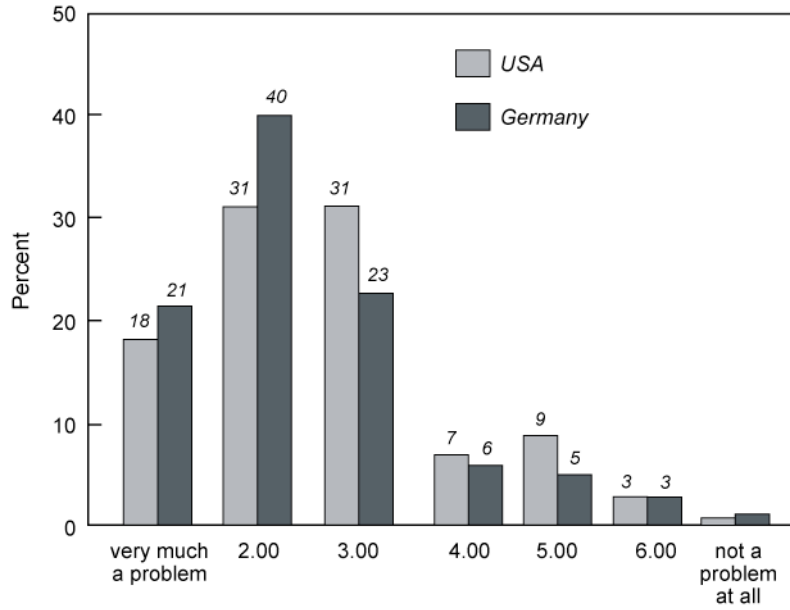


Figure 10—To what degree do you think it would be possible for most societies to adapt to climate change without having to make any substantial changes to current societal practices?

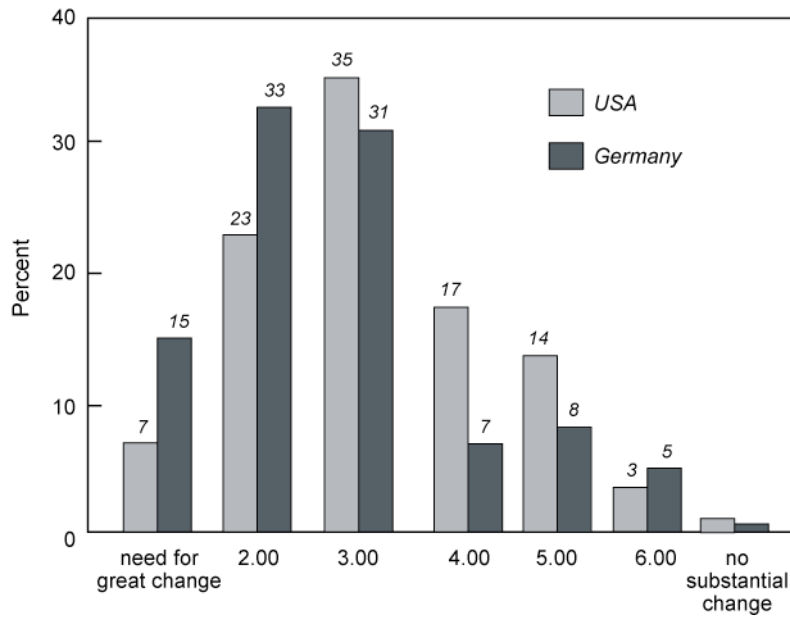


Figure 11—Climate scientists are well attuned to the sensitivity of human social systems to climate impacts.

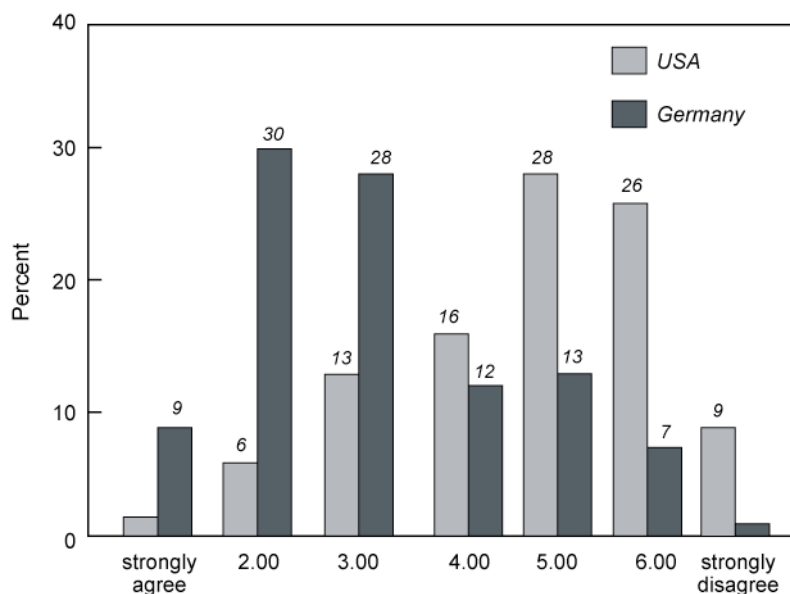


Figure 12—Climate change is an extremely complex subject, full of uncertainties, and this allows for a greater range of assumptions and interpretations than many other scientific endeavors.

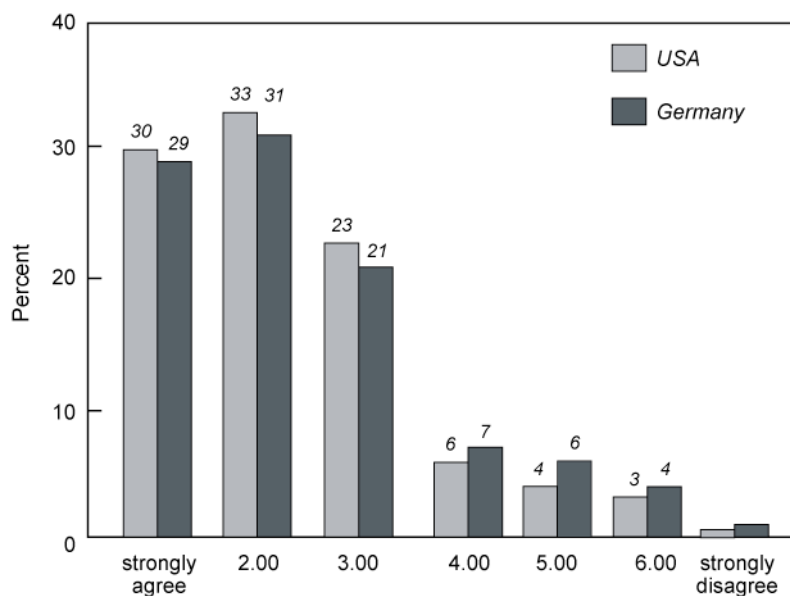


Figure 13—How much have you been involved with those people who make climate related policy decisions?

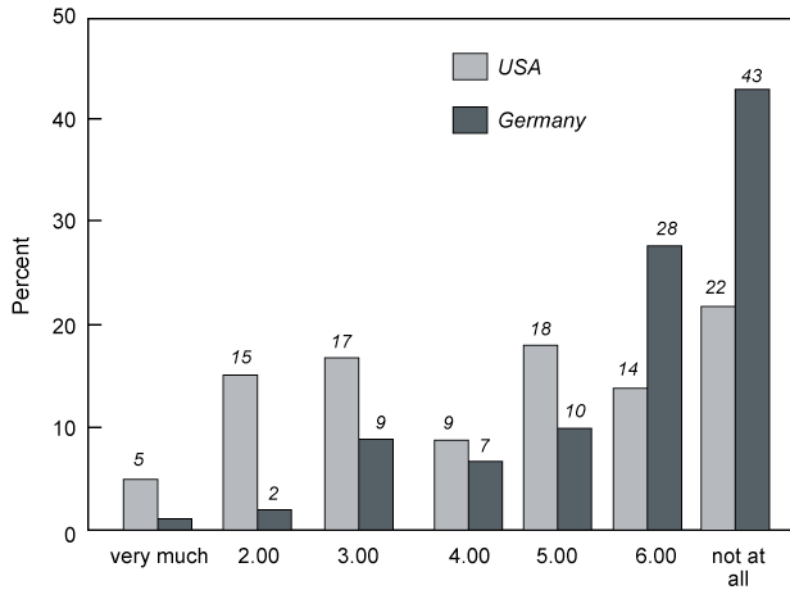


Figure 14—How often are you contacted by the media for information pertaining to climate chance?

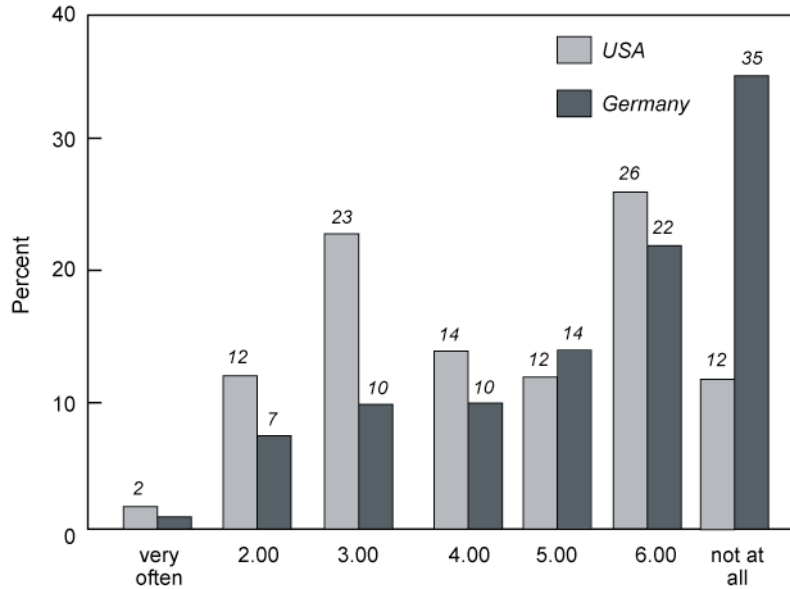


Figure 15–To What degree do you think exposure to the media has the potential to change the attitude of the scientist?

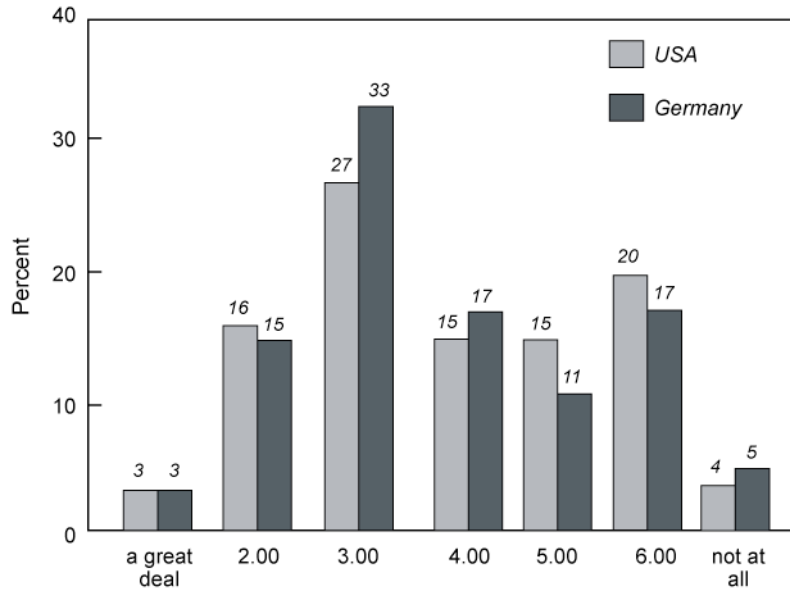


Figure 16–How often do you think policy makers draw on the most current and state-of-the-art knowledge of the climate sciences?

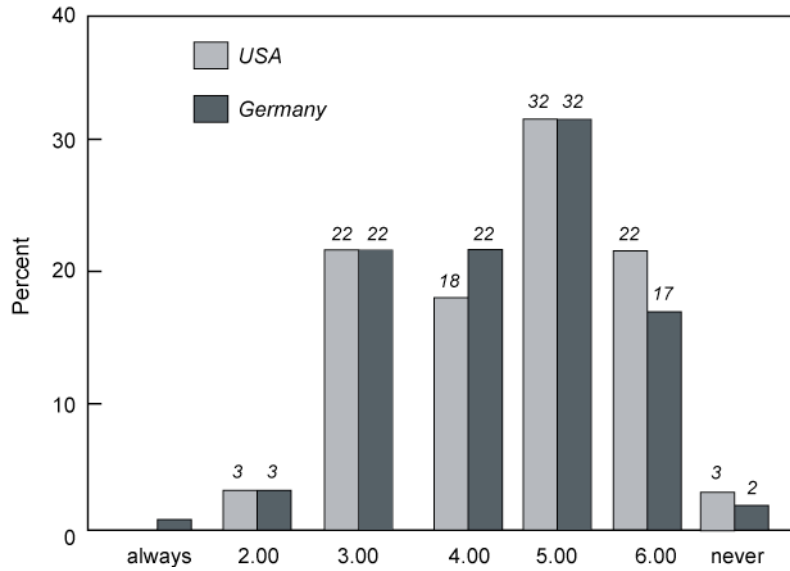


Figure 17—Some scientists present the extremes of the climate debate in a popular format with the claim that it is their task to alert the public. How much do you agree with this practice?

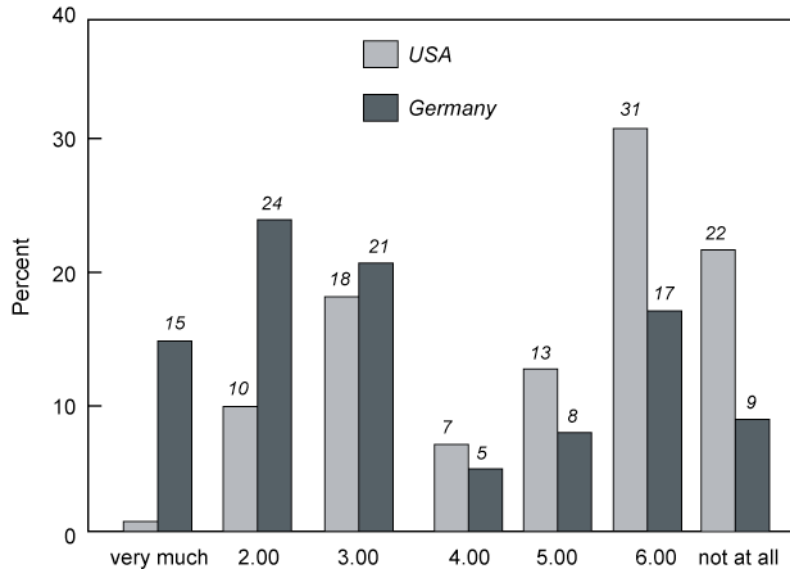


Figure 18—To what degree do you think that the results of scientific inquiry are instrumental in causing policy makers to redefine their perception of a climate related issue?

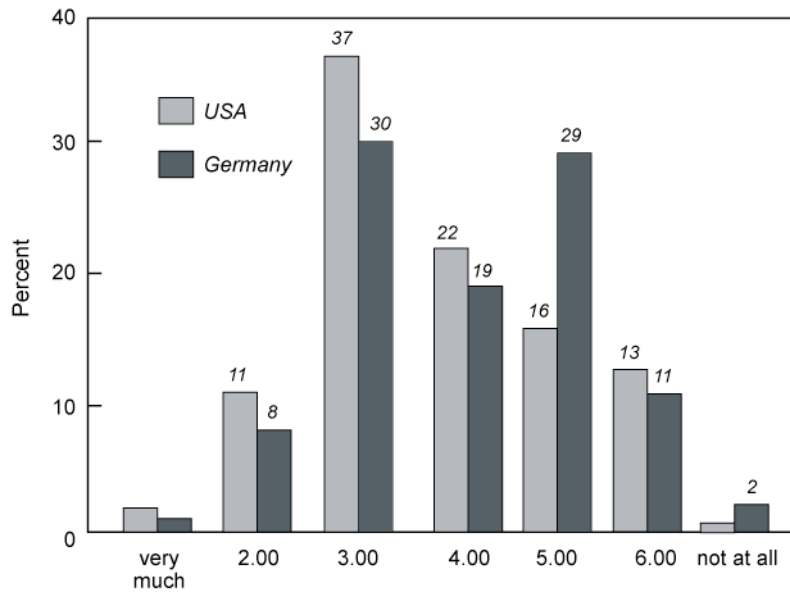


Figure 19—To what degree do you think climate scientists have control over what information gets transferred to the policy makers?

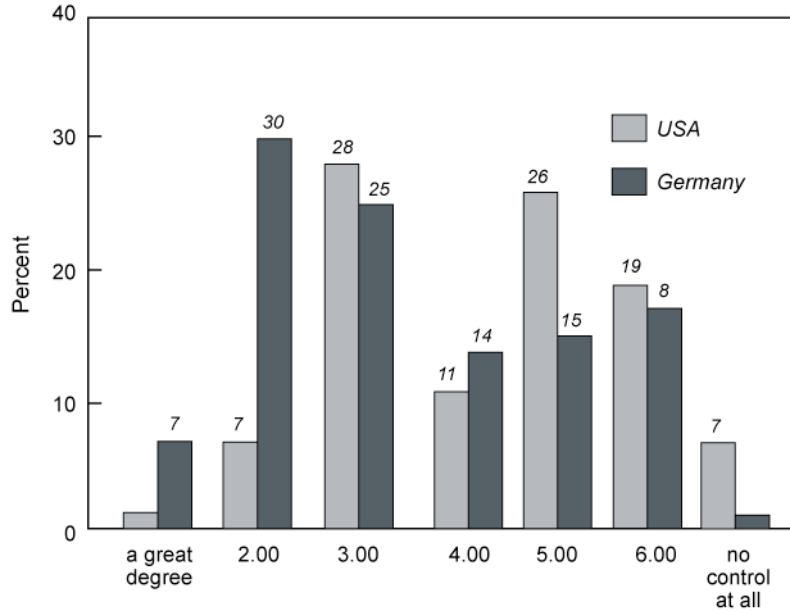


Figure 20—To what degree do you think climate science has remained a value-neutral science?

