Climate science, IPCC, postnormality and the crisis of trust

Hans von Storch
Institute of Coastal Research, GKSS Research Center, Geesthacht, Germany and KlimaCampus, University of Hamburg, Germany
(hvonstorch@web.de)

Abstract: Climate science and its flag ship IPCC find itself in difficult waters; on the one side its authority is contested by alarmist, which add dramatizing detail to a robust and hardly contested core of scientific knowledge, on the other side skeptics doubts the validity of the this core of knowledge. The events at the turn of the years 2009/2010 brought a decline in trust into climate science, which in the framework of postnormal science is not really surprising. For rebuilding the trust in science measures are needed, which recognize the specific postnormal situation; climate services need to be installed, the contract between science and society needs to be revisited, and regional bottom-up efforts should accompany the global efforts of IPCC.

Climate science is a politicized scientific field, in which scientific assertions are used as arguments in a struggle about how to weigh different options for future development. Different forces try to use scientific authority to replace political judgment, be it the metaphor of the climate catastrophe brought forward by alarmists or the claim of a great hoax by fringe skeptics.

We use here the term ”fringe skeptics” to mark those, who makes fundamentally critical choices such as that carbon dioxide

would not be a greenhouse gas, that atmospheric concentrations of greenhouse gases in about 1940 were already higher than today, that the sensitivity of the climate system (as given by the equilibrium temperature increase after a doubling of carbon dioxide in the atmosphere) would be 0.5K and less. These people have to be discriminated from ”normal” skeptics, who question the magnitude of last century’s temperature increase, the reliability of data, the representativeness of data due to limited spatial coverage, the ability of models to describe the influence of carbon dioxide, the role of unknown or little known cosmic processes vis-à-vis greenhouse gas forcing and the like. All these questions are legitimate; many of them are adequately answered in the scientific literature, but often not properly communicated to the public; other questions, such as the correct representation of the effect of elevated greenhouse gas concentrations in the models, presently can to some extent only assessed with indirect evidence until empirical evidence has become available for a strict validation.

In the following we will first (Section 1) summarize a problem with the alarmists – namely to overstate the consolidated scientific knowledge – and then in Section 2 a problem with skeptics – who all too often are overconfident with the informational value of data. The IPCC, as a boundary organization between science and policymaking, should help to overcome this divide, but has not always been very successful in doing so. We address this issue in Section 3. The society-science interaction conditions, which climate science finds in, may be characterized by ”post-normality” – this issue is subject to deliberations in Section 4. The crisis of climate science and its flagship IPCC in the last half year is discussed in Section 5, and an Outlook with possible measures for improving the situation is provided in Section 6

1. Uncontested Core of Knowledge

There are a number of issues, which are hardly contested, apart from

fringe skeptics, while others issues are in the center of the scientific debate about climate. For the outside world, however, the expressions ”the debate is over” or ”the science is settled” is often understood that all alarmist claims together with the undisputed core of the Global Warming is consensually accepted by the scientific community. It is this public-media dynamics of understanding, that if there is a Global Warming caused by ongoing release of greenhouse gases into the atmosphere, then all current extreme events are perceived as related to these releases as well, and that most if not all of the catastrophic perspectives are realistic as well, which causes the problems in communicating the science of climate to the public and the concerns and skepticism of the public to the science. Many climate scientists do not want to publicly oppose such generalizing and dramatizing statements, because it would help ”the skeptics”.

Indeed, climate science is strongly politicized, and some even support the usage of dramatizing statements – according to the surveys among climate scientists done by Bray and von Storch in 1998, 2003 and 2008 (Bray, 2010), about half in 1996 and one third in 2003 agreed (opted for a response of 1 to 3) to the statement ”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” (Figure 1A). In 2008 the question was formulated so that scientists were no longer asked if the agree with the statement but with the practice (Figure 1A): about 1 seventh opted for a 1 to 3, i.e., favorably.

Working Group I of the IPCC, on the ”Physical Science Basis”, has done a good job in identifying this among climate scientists hardly contested core of knowledge about climate and climate change – which in a nutshell is

1. the existence of ongoing increases in greenhouse gas loads in the atmosphere, in the globally averaged near surface air temperature and in the global mean sea level;
2. the need to include elevated greenhouse gas concentrations as dominant factor in the mix of known possible factors, when

deconstructing the increase in temperature – given the present knowledge encoded in contemporary climate models (see Figure 1B: almost all agree that recent climate change is real, with almost 70% answering positively with ”very much”; less than 10% have serious doubts about the anthropogenic cause (Bray, 2010));

3. projections of possible future climate developments conditional upon plausible, internally consistent scenarios of future emissions of greenhouse gases into the atmosphere.

Other issues, such as tropical storms, the climatic history of the last millennium, the role of land-use change, clouds and aerosols, and the fate of the ice sheets are at this time still under discussion, and observational evidence extending across longer times, better climate models will help to sort out the remaining controversies about these issues.

From a societal point of view, the main conclusion is that man is changing climate and given the projections of future emissions,

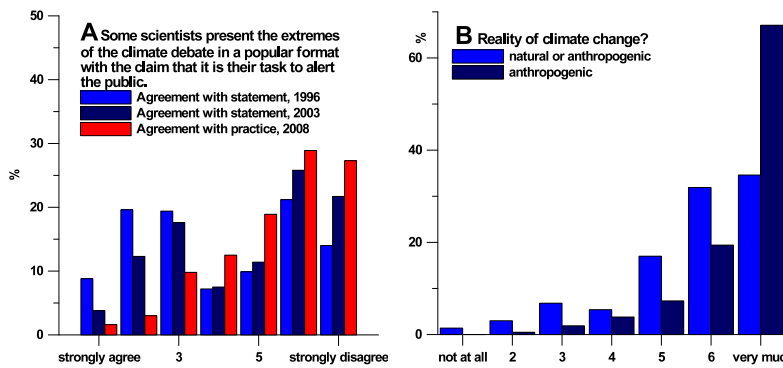

Figure 1. Results from a series of three surveys by Bray and von Storch among climate scientists in 1998, 2003 and 2008 (for reference, see Bray, 2010).
A: Agreement that usage of extreme positions is common (1998 and 2003, in blue), and agreement to the practice of using extreme positions (in 2008, in red).
B: Agreement to reality of climate change, whether natural or anthropogenic, or anthropogenic (in 2008);

will continue to do so – so that either massive reductions of emissions or interventions into the carbon cycle or into radiative balance (geoengineering) are needed to constrain this future changes. Investments reducing the vulnerability of societies and ecosystems to climate change are mandatory as well. Likely, in the end, a mix of such measures will emerge in the course of the coming decades.

2. Homogeneity of Data – A Critical Requirement

After the ClimateGate episode, suspicions were voiced particularly in the blogosphere that scientists would have tampered with the data; part of the problem was that scientists were not willing to share their data with the critics. The honest but entirely inadequate and by now infamous answer ”Why should I make the data available to you, when your aim is to try and find something wrong with it”, which a prominent scientist gave to a skeptic, who asked for data, made this problem obvious to everybody.

Indeed many if not practically all data sets are somehow ”corrected”, simply because the observational practice, the instrumentation, the immediate environment of instruments as well as the eventual analysis procedure has changed over the course of time, which ideally extends over a century or better more (e.g., Peterson et al., 1998). Such data are called *inhomogeneous*. For demonstration, we display two examples in Figure 2.

The first shows annual statistics from East Asian tropical cyclones (von Storch et al., 2010a) since 1951, as given by so-called best track data, which were compiled at the time of the typhoon. According to these statistics, the number of cyclones remained stationary, while the largest pressure fall and the smallest air pressure – both indicators for the severity of the storms, point to much weaker storms in recent decades. Very likely, this is not really the case, but the changes reflect, among others, the usage of reconnaissance flights and satellite recordings.

The second example (Lindenberg ~~and Mengelkamp, 2010~~) shows the largest (specifically: 99%iles) wind speeds, recorded during a year at six meteorological stations in Northern Germany. Three of them are taken in coastal harbours, three others on islands. The former three should be similar, and the latter as well. As one can see, the data do show these similarities during extended episodes, but then the similarity is abruptly coming to an end – which is often related to a relocation of the instrument.

Both cases are pretty obvious, but in many case, inhomogeneities are much less easily detected, in particular, when the changes take place gradually and not abruptly as in the case of coastal wind shown above.

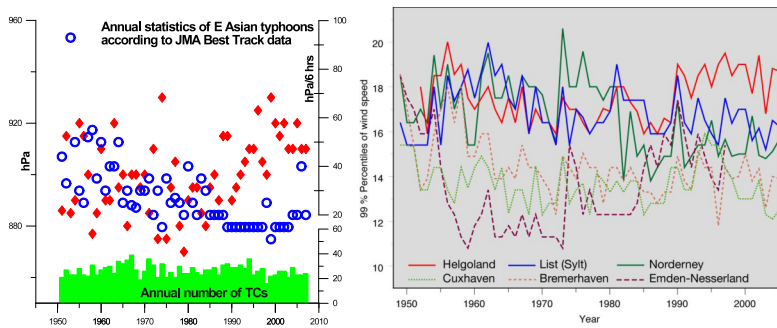

Figure 2. Examples of *inhomogeneous* data sets.
Left: Time series of annual number of East Asian typhoons, annual maximum air pressure fall within 6 hours along all tracks of E Asian typhoons, and annual minimum of air pressure along all tracks of E Asian typhoons according to JMA best track analysis. While the number is stationary, the maximum pressure fall show massive decrease, which can not be explained by changing typhoon properties; equally, the increase of minimum pressures must be related to the analysis process. (After von Storch et al., 2010a).
Right: Time series of annual 99%-tiles of local wind speeds (based on 3-hourly measurements) at six meteorological stations along the German North Sea Coast. ~~The three island stations Helgoland, List and Norderney should show similar values, and the coastal stations Cuxhaven, Bremerhaven and Emden. For extended periods they do, but after sudden jumps, the data deviate. Causes for such jumps are, among others, relocations of instruments~~ (Lindenberg ~~and Mengelkamp, 2010~~).

Other cases refer to satellite data, the heat content of the ocean as derived from XBT sondes. These corrections are entirely in order, indeed they are mandatory – and working with uncorrected data would lead to false conclusions, because changes related to changing observations and recording would falsely be attributed to climate change. After correction, the data are hopefully homogeneous, as they describe only changes related to the geophysical change of interest, i.e., regional temperature or sea level.

For lay people, who find time series on the internet, the changing informational contents of numbers is not obvious (e.g., Chrichton, 2004). They sometimes contradict the published assessment of long-term change and, surprisingly, such inconsistencies then lead to conspiracy theories that certain mainstream groups, such as CRU, would have manipulated the data to have a stronger warming showing up.

This is not an excuse to not release data, but demonstrates the need to archive the procedures of correcting, or homogenizing, so that independent group can repeat and critically examine what has been done. Only after replication by independent groups, which may very well have a critical attitude to the original work, the homogenised data attain their authority to be used by many other groups or to serve as a backbone for assessment reports like IPCC.

Indeed, when communicating with sceptics – many of these people are highly educated with massive academic credentials (professors in physics, geology, chemistry, for instance) – one finds that the main problem for most of them is that they have questions, like the correction of the raw data, or the role of models in the detection and attribution of anthropogenic climate change or in the radiative mechanisms involved – and the became skeptics because they did not get convincing and serious answers, when they examined the various often exaggerated claims in the media.

3. The IPCC

Before discussing the role of the Intergovernmental Panel on Climate Change (IPCC), it may be worth to pay attention to the mission statement of the IPCC, which reads (IPCC, 2010):

> *"The Intergovernmental Panel on Climate Change is the leading body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences.*
>
> *The IPCC is a scientific body. It reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters. Thousands of scientists from all over the world contribute to the work of the IPCC on a voluntary basis. Review is an essential part of the IPCC process, to ensure an objective and complete assessment of current information. Differing viewpoints existing within the scientific community are reflected in the IPCC reports.*
>
> *The IPCC is an intergovernmental body, and it is open to all member countries of UN and WMO. Governments are involved in the IPCC work as they can participate in the review process and in the IPCC plenary sessions, where main decisions about the IPCC workprogramme are taken and reports are accepted, adopted and approved. The IPCC Bureau and Chairperson are also elected in the plenary sessions.*
>
> *Because of its scientific and intergovernmental nature, the IPCC embodies a unique opportunity to provide rigorous and balanced scientific information to decision makers. By endorsing the IPCC reports, governments acknowledge the authority of their scientific content. The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive."*

In other words, the mission of the IPCC is to determine the *present* status of scientific knowledge, and its consensus – not: to discover "truth" about climate change.

The following assessment necessarily contains subjective assertions.

The four main IPCC reports, in 1992, 1995, 2001 and 2007 have been received by both the scientific community and by the public at large with great respect – the first three reports met mostly opposition by "skeptics", but the most recent one finds itself criticized by two groups, namely traditional skeptics, but on the "other side" by activists, who consider the situation more serious than described by IPCC's review of present knowledge (Bray, 2010).

In the first two reports and in particular in their influential policy maker summaries (SPMs) only few errors were found. "Error" here refers to incorrect assessment of the spectrum of scientific views at the time up to the assessment, not findings which had to be corrected at a later time in the light of new insights. In the third assessment report (TAR) two issues were problematic, first the premature[1] presentation of the "hockeystick"-reconstruction of the last millennium's temperature development, without properly reflecting "*differing viewpoints existing within the scientific community*". The other case was the display of a diagram which seemed to indicate a causal link between damages due to extreme weather and man-made climate change.

In November 2009, after the publication of the stolen personal e-mails from CRU servers, the situation developed very ~~differently~~. A number of partially absurd errors were detected, related to a very rapid melting of the Himalaya glaciers, on the disappearance of the

1 In the ClimateGate (2010) files, a mail from Keith Biffa is contained, which says "I know there is pressure to present a nice tidy story as regards 'apparent unprecedented warming in a thousand years or more in the proxy data' …" (Sep 22, 1999)

South American rain forest, of additional pressure on agricultural conditions in Africa and – a silly detail – the area of the Netherlands potentially affected by sea level rise. These problems had several things in common, namely they took place in Working Group II, on "Climate Change, Impacts, Adaptation and Vulnerability", and they were based on sloppy research; often the problem was the reliance, and inadequate generalization, of just one analysis, which was sometimes done superficially and often under the auspices of interested parties.[2]

A specific case, the indication of a causal link between extreme weather damages and climate change, which was repeated in the Fourth assessment report, will be dealt with below.

People argued in defense for the IPCC that in such a large volume of statements, errors would be unavoidable. However, these errors were all in the realm of Working group II, and they all represented exaggerations of the severity of the situation, often involving material provided by interested parties. Such a pattern of errors can not be explained by random errors, reflecting the enormous load of work, but point to a problem of the organization of the work. Specific vested interests had made their way into the assessment report, and the IPCC had either turned a blind eye or otherwise unable to defend itself against this intrusion.

---

2 The PBL (2010) review in the Netherlands on the quality of the IPCC Forth Assessment reports asserts mildly: *"... in some instances the foundations for the summary statements should have been made more transparent. While acknowledging the essential role of expert judgment in scientific assessments, the PBL recommends to improve the transparency of these judgments in future IPCC reports. - In addition, the investigated summary conclusions tend to single out the most important negative impacts of climate change. Although this approach was agreed to by the IPCC governments for the Fourth Assessment Report, the PBL recommends that the full spectrum of regional impacts is summarised for the Fifth Assessment Report, including the uncertainties. - The PBL believes that the IPCC should invest more in quality control in order to prevent mistakes and shortcomings, to the extent possible*."

Working Group I, on the ”Physical science basis”, lead by a very competent chair, has seemingly free of such problems, even if some complaints were raised that the assessment of the role of land-uses change would have been imbalanced (Pielke sr., 2010).

Indeed, a major problem was that the IPCC had no mechanism implemented to deal with such errors, once detected and reported to the IPCC secretariat – it even happened that a vice chair presented as late as on 3 November 2009 a talk ”Policy-relevance of the Working Group II Contribution to the IPCC AR4” to UNFCCC in Barcelona, which contained the false Himalaya claim: ”*the total glacial area will like shrink from the present 500,000 to 100,000 km² (or disappear entirely) by the year 2035*.” (IPCC, 2009; the slides with these lines were removed after my notice on 16 June 2010).

3.1 The case of extreme weather damage

An interesting case is represented by Figure 1 in the Supplementary Material of Working group 1, displayed her as Figure 3. It seems that ”*IPCC created a graph that did not exist in the peer reviewed literature or in the grey literature to suggest a relationship between increasing temperatures and rising disaster costs*.” (Pielke, jr. 2009).

The material seems not be further discussed, in particular not in the supplementary material; the diagram raised the impression that damages due to extreme weather would causally depend on the global temperature. The diagram on the left was in an earlier draft of the report, but several reviewers raised critical comments, such as ”*I’m wondering if too much space is devoted to Miller, given the inference one draws from Fig 1.5 is sensitive to the inclusion of individual outliers (as pointed out in the text) and that it is acknowledged that early data are incomplete. Some additional comment on data quality, beyond just completeness, is probably in order (I’m not expert, but this type of data would presumably be influenced by all kinds of factors, including varying political*

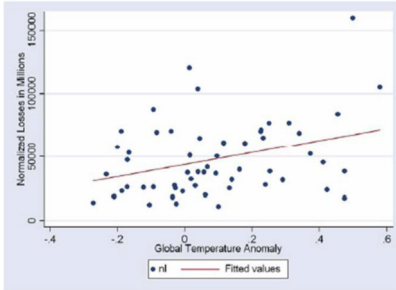

Figure 1.5: Normalized losses in US$ millions compared with global temperature anomalies (Miller *et al.* 2006).

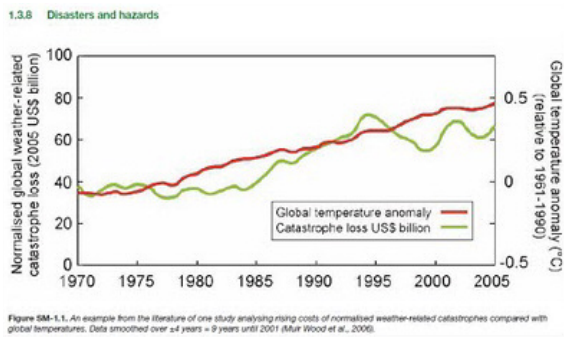

Figure 3 – a representation of (normalized) damages due to extreme weather and global temperature anomalies in the Supplementary Material of Working Group II of the 4th Assessment report of the IPCC (2008) – ~~left~~: original version; ~~right~~: published version, redrawn after reviewers comments (Pielke, jr., 2009)

influences and changes in reporting practices, that might confound any climate signal)." (see

http://ipcc-wg2.gov/AR4/SOD_COMMS/Ch01_SOD_ Expert.pdf

at p. 121-122); the result was that the left diagram was constructed by the authors (and not, as indicated, taken from the literature) – with the explanation: "*Figure moved to Supplementary Figure and employed a different plot that smoothes catastrophe losses and*

shows these alongside temperature. After smoothing (that thereby removes the peaks noted) the correlation remains. The text[3] *now provides a balanced commentary on this*." (Pielke, jr, 2009)

Some would argue that all this would just be a sloppy approach; however, it is a severe error as it at least violates the rule "*Differing viewpoints existing within the scientific community are reflected in the IPCC reports."* The different viewpoints have been expressed in a consensus, named Hohenkammer-consensus, agreed upon on the Climate Change and Disaster Losses Workshop on Understanding and Attributing Trends and Projections (25 and 26 May 2006, in Hohenkammer, Germany). The final report (Höppe and Pielke, 2006), which included the consensus among a broad variety of scientists and stakeholders from re-insurance industry, included these statements:

> *1) Analyses of long-term records of disaster losses indicate that societal change and economic development are the principal factors responsible for the documented increasing losses to date.*
> *2) Because of issues related to data quality, the stochastic nature of extreme event impacts, length of time series, and various societal factors present in the disaster loss record, it is still not possible to determine the portion of the increase in damages that might be attributed to climate change due to GHG emissions*
> *3) In the near future the quantitative link (attribution) of trends in storm and flood losses to climate changes related to GHG emissions is unlikely to be answered unequivocally.*

In conclusion, the figure in the supplementary material indicated that there was a link, while among a large group of diverse scientists, brought together at the Munich Re-Insurance

3 Which text the reference is made to, remains a mystery.

premises in Hohenkammer, there was consensus that definite statements about a possible link were not possible and likely would not become possible in the foreseeable future.

Thus, this case was not a sloppy error, which was done in the name of Working Group II; reviewers had pointed to the problem; the unknown authors choose a misleading representation even though the issue was, and still is, scientifically contested. Significant literature (not only the Hohenkammer report) was disregarded, and a self-produced figure displayed as being taken from a third person's publication. For me, this means that IPCC authors have decided to violate the mission of IPCC, by presenting disinformation.

Unfortunately, the IPCC secretariat is not giving answers, why the issue is not rectified.

4. Postnormality and Competition of Knowledge

If science must remain uncertain in its concrete statements, if scientific statements are of great practical import to formulating policies and making urgent decisions while affecting societal values, then that kind of science is less and less driven by pure "curiosity" but rather by the usefulness of its possible statements to decision-making and politics. It becomes "post-normal" (Funtowicz and Ravetz, 1985).[4] Methodological quality no longer occupies centre stage, but rather societal acceptance and political utility.

Science in its post-normal stage relies on its consistence with cultural constructs. Knowledge claims are not only raised by recognised scientists, but also by other experts serving specific interests.

4 This term has undergone some metamorphoses – some people, in particular in the blogosphere claim that it would be a concept, which would legitimize scientists to act as stealth advocates; that it would be choice of scientists to engage in normal or postnormal science; that it would be science by popular vote; also that postnormal science would be abnormal science. It should be stressed that it is meant – at least here – as a description of a science which is taken place in a specific socio-political context, not as a recipe of how to do science.

Climate research is presently in a post-normal state (Bray and von Storch, 2000; von Storch and Stehr, 2010). Its inherent uncertainties are enormous since future projections must be made, and such futures can only be presented in the form of models and under conditions which have yet to be observed. This lack of knowledge has nothing to do with incapacity on the part of the scientists. Rather the problem lies in the scarcity of available facts and the incomplete nature of instrumental data − it spans much too short a period necessary for describing climatic variations changes across decades and centuries. Naturally, arguments exist, which favour an answer over an other; some considerations of plausibility allow us to exclude certain developments as unlikely or even impossible. However, there remains a degree of uncertainty which may take decades to become substantially diminished.

At the same time, various forms of socio-culturally constructed knowledge exist (von Storch, 2009), like outdated climate knowledge such as climatic determinism, like the conviction that man must live in harmony with ”his climate”, everyday knowledge according to which weather is getting more extreme, less predictably, with storms getting more violent in particular, or that God (or nature) would use climate as a measure to steer human societies. Scientific knowledge is merely one form of a publicly accepted explanation systems.

The existence of powerful alternative knowledge systems contributes considerably to develop a post-normal situation. Indeed, two fundamentally different systems compete in the public arena for acceptance, namely the (dominantly) scientifically constructed knowledge, and (dominantly) culturally constructed knowledge (von Storch, 2009). Clearly these two types of knowledge interact, and the media-culturally construction enters the easier the scientific construction the more values and preconceived ideas play a role. It is indeed easier to persuade fellow scientists that our (baroclinic) storms become worse – which is actually not the case – because this is already a fact in the media-

cultural construct. It is easier to convince a scientist, as anybody else, of something described by the cultural construct, then of something which contradicts this construct. The addition of contested knowledge, described for alarmists in the introduction of this paper, may be understood as an intrusion of this media-cultural construct. The consistency with the latter makes this mix, a solid scientific core and a socio-cultural halo, so successful in the public-political communication.

In a post-normal state, science is not always done for reasons for curiosity but is asked for as support for preconceived value-based agendas. Avoiding the danger of being instrumentalized needs the understanding of the dynamics of the different knowledge systems – needs the engagement of and interaction with cultural scientists.

When framing the problem, of how to respond to the specter of man-made climate change, cost-benefit concepts for identifying the right mix of adaptation to change and efforts to diminish change have been introduced (Hasselmann, 1990; Nordhaus, 1991). The system is described in Figure 4 – an environment-economy system interacts, and generates economic output and environmental damages. Living with the environmental damages goes along with adaptation costs, reigning into the economic processes which cause the change, are associated with mitigation costs. After having determined the social optimum, which is a value-related societal decision, then it is in principle possible to determine that mix of policies and market instruments which leads to a minimum of total, mitigation plus adaptation, costs. This is essentially a ”linear model”, according to which science can in principle solve the problem, once society has found out which metric is to be optimized.

This concept suffers from a number of problems, mainly a disregard of socio-cultural dynamics, which is related to the process of understanding complex phenomena. Society is not directly experiencing climate change, but relies on the interpretation by scientific (in former times: religious) authorities. They explain the changes to the public, but then this ”information” undergoes in the

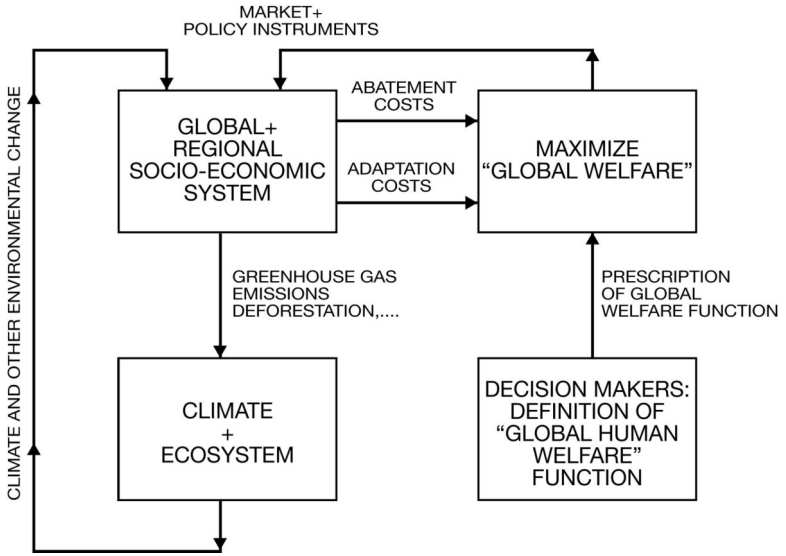

Figure 4: "Globale Environment and Society" model of Hasselmann (1990) – once the dynamics of the coupled society-climate system are understood, and "global human welfare" metric is given by society, the optimal solution can in principle be provided by science,

public arena a metamorphosis – it is made consistent with the media-cultural constructions; these feed back to the scientific authorities, so that the overall analysis is very much guided by culture, which is of course in China different than in Norway. As sketched in Figure 5, it is then the costs of perceived damages, and the perceived costs of mitigation, which lead the cost-benefit analysis. The determination of these costs is purportedly just a matter of science, but vested interests do their best to make sure that their estimates dominate the result, as was demonstrated by the government of the United Kingdom and the deployment of Dr. Nicolas Stern (Tol and Yohe, 2006; Pielke, 2007b).

The sketch in Figure 5 demonstrates that the role of society in the process of finding an answer to the specter of man-made climate

change is not only the provision of a metric, but is as with all political problems – a debate based on values, interests and competing knowledge claims. The linear model is not a suitable abstraction of the real decision process, of the real science-society interaction.

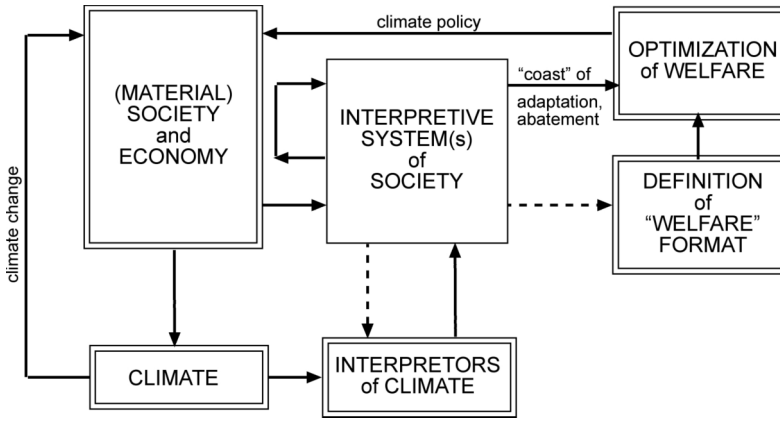

Figure 5: Alternative to the sketch in Figure 4 (Stehr and von Storch, 2010), according to which societal beliefs and knowledge claims lead to a metamorphosis of the scientific knowledge, before societal decisions are taken in a political decision process.

In summary, a number if issues should be taken into account, when analyzing the postnormal interaction of science and policy, namely

1. The situation, climate science finds itself in, compares to some extent with various environmental cases, such as nuclear power, BSE etc. Comparative studies dealing with climate change and these cases would be helpful.
2. The science-policy/public interaction is not an issue of „knowledge speaks to power". Many implicitly apply the "linear model", but this model fails.

3. The problem is not that the public is stupid or uneducated, but that the problems are complex and very many issues, most of them far away from traditional physical problems, are involved.
4. Science has failed to respond to legitimate public questions and has instead requested. "Trust us, we are scientists". Science itself has created it "skeptics".
5. 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 – but scientific representatives belittle these competitors.
6. The social process „science" is influenced by these other knowledge forms, and the little autonomy which exists needs to be defended.

In this situation, the IPCC could play an outstanding role as an impartial and honest broker (Pielke, Jr., 2007a), which would however require an understanding of the postnormal situation and its implications. Obviously, this understanding is not present within the IPCC, and given the usual arrogant natural science attitude among many key people ~~will not allow~~ the needed development of a trans-disciplinary cooperation with cultural scientists.

5. Crisis of Trust

When the content of the ClimateGate e-mails became known, they were widely distributed; the response was divided – some made clear that because of the illegal publication they would not read them nor comment on them[5] – while another group eagerly used the material to support extensive hypotheses about fraud; data manipulations, conspiracies to avert publication of unwanted results

5 It would be interesting to learn if the same people would in these days (end of July 2010) decline to learn from the secret NATO-reports about the Afghanistan war, published by WikiLeaks.

and by shunned scientists. One would have thought that this would have become a short term skirmish, but it became a really big wave, which was amplified by the failure of COP-15 and prior efforts to enhance the public's attention (Copenhagen report), reports about possible conflicts of interest of the chairman of IPCC, and eventually by the publication of errors in the IPCC report (see above).

The result shows Figure 6: the number of articles about climate peaked in December 2009/January 2010 at new record height, all over the world. ~~Now, about half a year later~~, the attention for the topic is down to levels corresponding to the time prior to the publication of the Fourth Assessment report of IPCC. Many of these articles were not positive, not reinforcing the concerns expressed in the IPCC report (as in 2007), but critical about the IPCC as an organization and about the way, the science was done. The evolving crisis of climate science and the IPCC was not about the core scientific construct (man-made greenhouse gas emissions change climate towards warmer conditions; see above) but about the crisis of the trust into the societal institution "climate science".

In a post-normal situation such a development is not surprising,

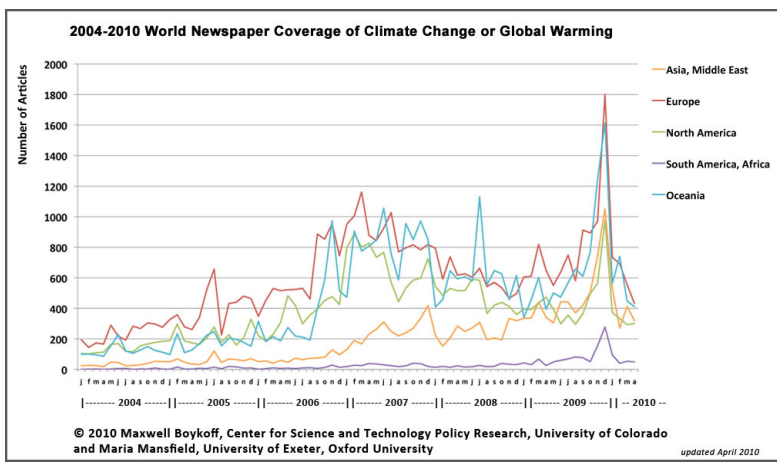

Figure 6: see caption

but climate science was (unknown of and thus) unprepared with the challenges of post-normality, in particular to deal with the ongoing politicization of its utility and actors.

The crises went along with an erosion of public trust in climate. For instance, SPIEGEL magazine questioned people as to whether they were personally fearful of climate change. In 2006, 62% agreed, while in 2010 only 42% agreed (Figure 7); in the US, Gallup asked people whether they believed the dangers of climate change were exaggerated; in 2006, 30% agreed, while in 2010 this figure had risen to 48% (Figure 7). Ratter and Kruse (2010) surveyed ordinary people in the city of Hamburg, how concerned they would be about climate change, in three consecutive years 2008, 2009 and 2010. A marked shift towards the assessment ”threat does not exist” was found. An interesting detail, in both GALLUP and Ratter and Kruse (2010) was that the large change from 2009 to 2010 was part of a longer trend towards a more critical condition. This may mean that the turn towards more sceptical views was not caused by the events in the turn of the years 2009 and 2010 but merely amplified.

Since the core of climate science is healthy, as is the IPCC, measures are needed to reinforce the trust into climate science and the IPCC. Apart of issues discussed above, I suggested in media interviews as well as expert witness for the International Academy Council the following measures to re-establish the reputation of the IPCC:

1. Science needs measures to fend of the influence of interested parties (mainly green political and economic interests).
2. Dominant (“best”) authors are no longer responsible for describing consensus (as “lead authors”) – otherwise they assess their own work.
3. Political and economic interests are not informing the process of assessing the legitimate scientific knowledge.
4. An independent “ombudsman”-system takes care of complaints about factual errors (in determining consensus) and conflicts of interest.

5. Assessment by IPCC is independent of acting persons. Dominant authors must be frequently replaced.
6. IPCC is providing an overview of the contested issues. In particular it describes dis-sensus. IPCC encourages falsification.
7. Political and scientific functions within IPCC must be strictly separated.

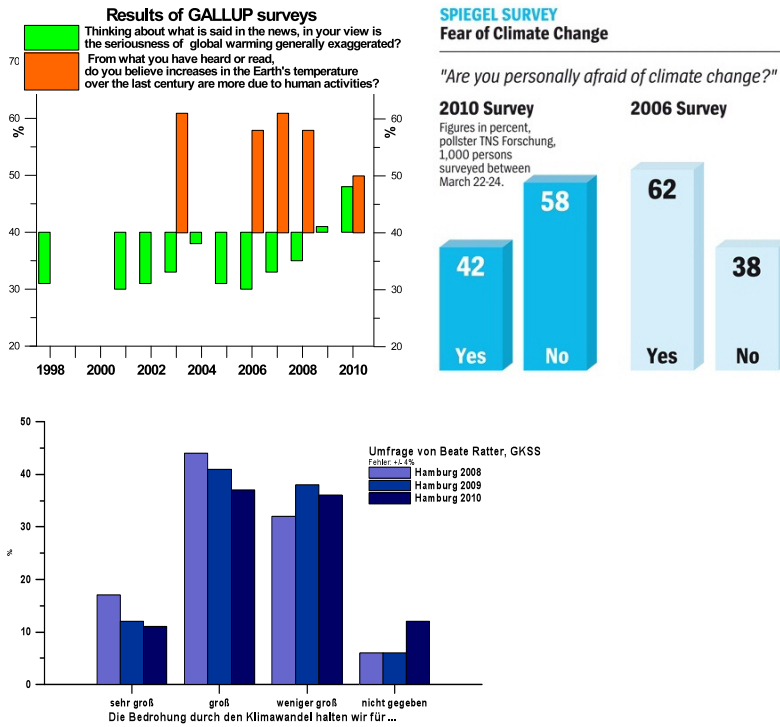

Figure 7: Results of surveys on the public trust in climate science.
Top left: Survey done by GALLUP in 2010; questions are given in the legend. The frequencies of positive answers is given as deviation from an arbitrary level of 40%.
Top right: Survey done by SPIEGEL in 2010.
Bottom: Survey among citizens in Hamburg in 2008, 2009 and 2010 (Ratter and Kruse, 2010).

6. **Outlook**

Society expects science to create knowledge in order to aid understanding of a complex environment. Why do we entrust "science" with this role? The answer lies in the methods used by science. Scientific methods ensure that we are usually offered "coherent" interpretations allowing for actions which lead to the desired outcomes. "Incorrect" interpretations do occur, but tend to be rare. They are usually discovered sooner or later and replaced by a "coherent" interpretation. In case of climate, after the 2009/2010 crisis, the trust in the scientists to act in this way was damaged. Now, after shrill tones have toned down, new approaches are needed to rebuild the trust of the public and of stakeholders. Different avenues are available; among them the establishment of "climate services" for building a dialogue on concrete issues of climate mitigation and climate adaptation (Section 6.1); the set-up of a new societal contract between society and climate science, based for instance on a revisiting a traditional concepts (Section 6.2); and finally bottom-up approaches to complete and support the top-down IPCC approach (Section 6.3). The outlook ends with a "take home" list.

6.1 Climate Services

To provide options, open up perspectives and enhance the understanding by the public and by stakeholders for the dynamics of climate, as well as enabling scientists to understand the needs of public and stakeholders is a task named *climate service* (von Storch et al., 2010c); Typical elements of climate servicing on the regional level comprise the establishment of regional climate offices, assessment of knowledge about regional climate change (see Section 6.3), and the provision of detailed regional climate data for the recent past as well as for possible futures (scenarios) (von Storch and Meinke, 2008)

Any such efforts need to be liaised with cultural sciences; the dynamics of media and of communication (Weingart et al., 2000;

Neverla and von Storch, 2010) must be taken into account. Advises such as these of Mooney's (2010) should be taken seriously:

> *Heterogeneity. It is important to remember that both the "public" and the "scientists/technologists" are heterogeneous. ·*
>
> *Trust. The scientific community must build and maintain the public's trust.*
>
> *Education. Just as the public must be educated on scientific topics, so must the scientific community be educated on public attitudes and opinions.*
>
> *Communication. There is a need to improve the forums for public communication.*

6.2 Science ethics

As trust in science is build on the performance of the scientific actors, we need to reconsider the rules for such performance. According to science theorist Robert K. Merton (Merton, 1973; Stehr, 1978; Grundmann, 2010), there are a few significant principles, which present an idealisation which can never be fully realised. These principles are summarized by Grundmann (2010):

> *Universalism: Truth claims are to be subjected to pre-established impersonal criteria.*
>
> *Communism: is the nontechnical and extended sense of common ownership of goods; the products of competition are communized („public domain"); there is an imperative for communication of data and research findings.*
>
> *Disinterestedness: The virtual absence of fraud in the annals of science has to be attributed to a distinctive pattern of institutional control; it is in the interest of scientists to conform on pain of sanctions.*

Organized Skepticism: Research is checked by rigorous, structured scrutiny of peers. This principle pervades into other spheres of society, unfolding its critical powers.

So, where does climate research stand when seen in the light of Merton's criteria? – It does not stand very well: *Do self-serving interests influence research results?* There is no agreement on this matter: Two camps, the "sceptics" and the "alarmists", vehemently argue with each other over the political usefulness of their statements, while both groups only partly accept results as "correct" if they contradict their fundamental convictions. *Do knowledge claims undergo critical analysis and attempts of falsification by professional critical colleagues?* – This area also has its deficits. Gradual scepticism is accepted, while radical scepticism is punished by exclusion from the science community. In publicly debated cases over the past months, falsification has been obstructed by withholding the data material required for redoing the analysis.

6.3 Regional "bottom-up" efforts

The Assessment Reports of the IPCC may be completed and supported by similar regional efforts. While the IPCC features regional assessments, with very many issues involved, and relatively few people as assessors, genuinely regional efforts may be preferable: they may involve more people and, more importantly, may be set-up according to the regional specifics, regional science organization and regional stakeholder needs (Visbeck, 2008; von Storch and Meinke, 2008). As such they mimicking the IPCC; in principle one could introduce an accreditation of such efforts; if some of them fail, it would not be the fault of IPCC; on the other hand, IPCC could learn from these smaller examples, for instance how to fend of the intrusion of vested interests, or how to use grey material.

An example of a regional assessment is the BALTEX Assessment of Climate Change for the Baltic Sea Basin (BACC;

Reckermann et al., 2008), which was compiled by a consortium of 84 scientists from 13 countries around the Baltic Sea (BACC Author Team, 2008 – see Figure 8). The assessment covers various disciplines related to climate research and related impacts. The Baltic Sea Basin represents an old cultural landscape, and the Baltic Sea itself is among the most studied sea areas of the world. Thus, there is a wealth of information, in thousands of publications, concerning past climate conditions in the region. A large part of the information is not in English and also had not been available for western researchers until the early 1990s. Besides looking at past and current climate change, the BACC report presents climate projections until the year 2100 using regional climate models, and an assessment of climate change impacts on terrestrial, freshwater, and marine ecosystems of the Baltic Sea basin.

The results of the BACC assessment process were not biased by political or economic interest groups, and it relies exclusively on published scientific evidence. The BACC report brings together consolidated knowledge which has broad consensus in the scientific community. At times, though, this consensus takes the form of "consensus on dissensus", meaning that for certain points contradicting opinions could not be resolved, as for instance in case of the degree of the past warming of Baltic Sea surface waters.

The BACC report made no recommendations for how to deal with the ongoing and expected future changes. Instead the BACC project liaised with the intergovernmental Baltic Marine Environment Protection Commission (Helsinki Commission, HELCOM), which used the BACC report as the basis for the "HELCOM Thematic Assessment 2007" on Climate Change in the Baltic Sea area which was officially adopted by representatives of Baltic Sea riparian states in March 2007.

The BACC assessment report has led to the launch of other, similar initiatives, for example, a climate report for the greater Hamburg area, Germany, ~~which will be~~ published in November 2010, and on the climate of the North Sea (NOSCCA). A 2nd

BACC climate report, again compiled under the auspices of BALTEX, is due in 2014.

Figure 8: Cover of the BACC report (left; BACC Author Team, 2008) and HELCOM Thematic Assessment "Climate Change in the Baltic Sea Area" compiled on the basis of the BACC report.

6.4 Take-home

1. IPCC is an indispensable effort. IPCC processes need to be improved. Mechanisms to deal with claims about errors and conflicts of interest are needed as well as mechanisms to avoid group dynamics within IPCC.
2. Needed is the discrimination between scientifically legitimate knowledge and culturally constructed (value-based) knowledge claims. The intrusion of vested interests in the scientific processes should be fended of.

3. Climate services need to be established to building trust and dialogues between public and stakeholders and science. Learning from regional efforts may represent examples and possibilities for testing different approaches.

7. References

BACC author team, 2008: *Assessment of Climate Change in the Baltic Sea Basin*., Springer Verlag Berlin - Heidelberg; ISBN 978-3-540-72785, 473 pp

Bray, D., 2010: The scientific consensus of climate change revisited. *Env. Sci. Pol*. 13, 340-350.

Bray, D. and H. von Storch, 1999: Climate Science. An empirical example of postnormal science. *Bull. Amer. Met. Soc.* 80: 439-456

Chrichton, M., 2004: *The State of Fear*. HarperCollins, 641 pp.

Climategate, 2010, http://www.eastangliaemails.com/

Funtowicz, S.O. and J.R. Ravetz, 1985: Three types of risk assessment: a methodological analysis. In C. Whipple and V.T. Covello (eds): *Risk Analysis in the Private Sector*, New York, Plenum, 217-231

Grundmann, R., 2010: "Climategate" and the Scientific Ethos. *Social Studies of Science*. Submitted

Hasselmann, K., 1990: How well can we predict the climate crisis? In: H. Siebert (ed) *Environmental Scarcity - the International Dimension*. JCB Mohr, Tübingen, 165 - 183

Höppe P., and R.A. Pielke, Jr., (Eds), 2006: Workshop on Climate Change and Disaster Losses: Understanding and Attributing Trends and Projections Final Workshop Report. http://cstpr.colorado.edu/sparc/research/projects/extreme_events/munich_workshop/workshop_report.html (as of 29. July 2010)

IPCC, 2010: http://www.ipcc.ch/organization/organization.htm, as of 29. July 2010

IPCC, 2009: Policy-relevance of the Working Group II Contribution to the IPCC AR4 (Fourth Assessment Report) *(as of 1. April 2010; corrected on 16 June 2010 by removing two slides relating to the Himalayan glaciers*)

Lindenberg, J., ~~and~~ H.-T. Mengelkamp, 2010: Representativity of near surface wind measurements from coastal stations at the German Bight, ~~submitted~~.

Merton, Robert K. (1973) 'The Normative Structure of Science', in N.W. Storer (ed.), *The Sociology of Science* (Chicago, IL: University of Chicago Press): 267–273

Mooney, C., 2010: *Do Scientists Understand the Public?* American Academy of Arts and Sciences, Cambridge, MA, 15 pp.

Neverla, I., und H. von Storch, 2010: Wer den Hype braucht. *Die Presse*, 24. Juli 2010

Nordhaus, W.D., 1991: To slow or not to slow: the economy of the greenhouse effect. *Econ. J.* 101, 920-937

PBL, 2010: http://www.pbl.nl/en/publications/2010/Assessing-an-IPCC-assessment.-An-analysis-of-statements-on-projected-regional-impacts-in-the-2007-report.html, as of 29. July 2010

Peterson, T.C., D.R. Easterling, T.R. Karl, P. Groisman, N. Nicholls, N. Plummer, S. Torok, I.Auer, R. Boehm, D. Gullett, L. Vincent, R. Heino, H. Tuomenvirta, O. Mestre, T. Szentimrey, J. Saliner, E. Førland, I. Hanssen-Bauer, H. Alexandersson, P. Jones and D. Parker, 1998: Homogeneity adjustments of in situ atmospheric climate data: A review. *Intern. J. Climatol.* 18: 1493-1517

Pielke, jr., R.A., 2007a: The Honest Broker: Making Sense of Science in Policy and Politics. Cambridge University Press

Pielke, jr., R. A., 2007b: Mistreatment of the economic impacts of extreme events in the Stern Review Report on the economics of climate change, *Global Environmental Change* 17, 302–10.

Pielke, jr. R.A., 2009: http://rogerpielkejr.blogspot.com/2010/01/hot-on-trail-of-ipcc-mystery-graph.html (as of 29. July 2010)

Pielke, sr., R.A., 2010: http://klimazwiebel.blogspot.com/2010/07/roger-pielke-sr-claims-to-have-found.html

Ratter, B. und N. Kruse, 2010: Die nächste Sturmflut kommt bestimmt? Risiko und Risikobewusstsein in Hamburg in Zeiten des Klimawandels. In: Böhner, J. (Hg.): *Klimawandel und Klimawirkung - Hamburger Symposium Geographie* (Band 2). Institut für Geographie, Hamburg (in press)

Reckermann, M., H.-J. Isemer and H. von Storch, 2008: Climate Change Assessment for the Baltic Sea Basin. *EOS Trans. Amer. Geophys. U.*, 161-162

Stehr, N. 1978: The norms of science revisited: social and cognitive norms. *Sociological Inquiry* **48**:172

Stehr, N. and H. von Storch, 2010: *Climate and Society. Climate as a Resource, Climate as a Risk* World Scientific, Singapore

Tol, R.S.J., and G. W. Yohe, 2006: A Review of the Stern Review, *World Economics* 7, 2006, 233-250

Visbeck, M., 2008: From climate assessment to climate services, *Nature Geoscience* 1, 2-3

von Storch, H., 2009: Climate Research and Policy Advice: Scientific and Cultural Constructions of Knowledge. *Env. Science Pol.* 12, 741-747

von Storch, H. and I. Meinke, 2008: Regional climate offices and regional assessment reports needed. *Nature geosciences* 1 (2), 78, doi:10.1038/ngeo111

von Storch, H., and N. Stehr, 2010a: Klimaforschung und Klimapolitik – Rollenverteilung und Nachhaltigkeit . *Naturwissenschaftliche Rundschau* 63, 301-307

von Storch, H., F. Feser and M. Barcikowska, 2010b: Downscaling tropical cyclones from global re-analyses and scenarios: Statistics of multi-decadal variability of TC activity in E Asia. ~~Proceeding ICCE, submitted~~

von Storch, H., I. Meinke, N. Stehr, B. Ratter, W. Krauss, R.A. Pielke jr., M. Reckermann and R. Weisse, 2010c: Regional ~~Climate Service. Manuscript, IPWE congress 2011~~

Weingart, P., A. Engels and P. Pansegrau, 2000: Risks of communication: Discourses on climate change in science, politics and the mass media. Public Understanding of Science 9, 261-283