

Sustainable climate science¹

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Abstract

To do climate science sustainably, a number of constraints in practicing research and communicating science need to be implemented. Among them are the admission of uncertainty and the possibility for future revision, the recognition that scientific knowledge is challenged and influenced by cultural constructions, and the usage of accurate language, which is not conflicting with every-day language. That scientific knowledge does not directly lead to political conclusions must also be recognized. A few elements needed for a successful science-public dialogue are listed and discussed.

1 The social institution "science"

Doing science, creating new knowledge, in German: *Wissen schaffen*, is a social activity. As all social activities, it can be done sustainably. Or not.

The Brundtland Commission, convened by the United Nations (UN) in 1983, used the term “sustainability” in its 1987 report as ‘*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*’ Since then its use has been mostly used in the context of sustainable policy or sustainable use of natural resources – with a similar breadth as words like “ecological”, which are now common in the language of advertising. It was no surprise that I was confronted with opposition when I used the word in a somewhat different context, namely in the context of science and research. As scientists, I am interested that my profession is done “sustainably”. In Webster’s word-book (<http://www.merriam-webster.com/dictionary/sustainability>) a meaning of the word “to sustain” is given by “being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged” for the example of “sustainable agriculture”. Insert for the term “resource” the term “trust in the ability of science of generating reliable knowledge”, and the meaning of

¹ This paper is an update of earlier papers, in particular: von Storch, H., 2010: Protagonists on the Market of Climate Change Knowledge. In Max Boykoff (ed.): *Politics of Climate Change*. Rutledge, London New York, ISBN 978-1-85743-496-5, 303 pp, 62-76; von Storch, H., 2009: Klimaforschung und Politikberatung - zwischen Bringeschuld und Postnormalität. *Leviathan, Berliner Zeitschrift für Sozialwissenschaften* 2009, 37:305–317, DOI 10.1007/s11578-009-0015-8; von Storch, H., 2009: Climate Research and Policy Advice: Scientific and Cultural Constructions of Knowledge. *Env. Science Pol.* 12, 741-747 <http://dx.doi.org/10.1016/j.envsci.2009.04.008>

“sustainable science” becomes clear. Or, in a simpler manner: A scientific institution or a professor is doing science sustainably, when some decades later the public and stakeholders will assign to their former students the same authority for unraveling and explaining complex phenomena.

Studying classical Chinese language or the dramatic living of Abraham Lincoln is most likely done sustainably. Sustainability here means that the present science will have a bearing on future science, in an enriching way, but not in a limiting manner. The present science will not inhibit the legitimacy of future science. The public will be excited about future knowledge as it is about present newly constructed insights.

Research about the forest die back in Germany may serve as an example at the other end of the spectrum. This research was not done sustainably. The science of forest damages was in the 1980s heavily politicized, and used as support for a specific preconceived "good" policy of environmental protection. The resulting overselling and dramatization broke down in the 1990s, and news about adverse developments in German forests is now a hard sell in Germany. An observer² wrote in 2004: "The damage for the scientists is enormous. Nobody believes them any longer."³ Of course, the damage was not only limited to the forest researchers, but also to other environmental scientists and politicians as well.

And climate research? Often it is done sustainably, but sometimes not. Some institutions and some publicly visible scientists are known for simplifying and dramatizing statements of what one would expect from NGOs, e.g., "Coal-fired power plants are death factories."⁴ A communication of drama is intended to "move", to initiate "action". The science is supposed to support a preconceived political agenda of something "good".

Overselling takes place in the triangle between policy, media and science. It goes with a risk⁵: The risk for policy-makers is in the possibility that the goals set in this manner cannot be achieved, the “loss of legitimacy due to taking on too much.” The media primarily fear the “loss of public attention,” due to concepts and conceptual fields becoming worn out. For science, the principal risk is the “loss of credibility due to the particular dynamic of the catastrophe metaphor”, or other characteristic misleading concept.

Exploiting short-term "advantages" in the public-political discourse by simplification and dramatization for furthering a pre-conceived agenda helps generating attention and short-lived support for this agenda. But this attention and support but can hardly be maintained for a long time as required in case of climate change policies. Attributing the hurricane Katrina to climate change made

² Günter Keil, 2004: Chronik einer Panik. Ein Vierteljahrhundert Waldsterben - oder wie ein deutscher Mythos entstand, sich verfestigte und allmählich zerbröckelt. Beobachtungen aus dem Bundesforschungsministerium. DIE ZEIT 51/2004.

³ "Der Schaden für die Wissenschaftler ist enorm. Nun glaubt ihnen keiner mehr.", op. cit.

⁴ J. Hansen, 2009: Coal-fired power stations are death factories. Close them. *The Observer*, Sunday 15 February 2009 - quoted after <http://www.guardian.co.uk/commentisfree/2009/feb/15/james-hansen-power-plants-coal> (30. January 2010, 00.00 UTC)

⁵ 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

successfully headlines, and depicting global warming as an uninterrupted continuous upward trend made the understanding of the concept of global warming easier. But, later, we have to pay a prize. There were no more Hurricane-disasters like Katrina's since 2005, and warming is stagnating in the last years. Both facts are not surprising for the climate researcher. They are consistent with the scientific understanding of the phenomenon named "Global Warming". However they are at odds with the simplifying-dramatizing communication strategy and with the resulting medial construction.

The maximization of short-term utility goes with a prize: The public will understand that it has been manipulated, and that it had not honestly been advised by its publicly funded social institution "science". Admittedly, manipulated for something, which has been perceived by certain elites as "good" – but what is the principal difference in this respect between Greenpeace and Exxon? The dramatic decay of trust into the IPCC, following the illegal publication of e-mails at CRU in November 2009, the unacceptable sloppiness in preparing some statements, for instance about the future of Himalayan glaciers, in a report of the 4th Assessment report of the IPCC, was not really surprising.

The effect is twofold. First, the public will no longer believe in the "story", or consider it merely entertainment – and people will effectively become sceptics. Certainly the contrary of the originally intended effect! Second, the public will be unable to distinguish the social institution science⁶ and value-based NGOs – with the latter being considerably cheaper in delivering the same politically useful knowledge claims!

2 Conditions for a sustainable practise of climate science

Thus, for the sake of the credibility of our now young PhD students, for maintaining the role of science as a useful social service and resource for society – we scientists have the obligation to do our act sustainably, and not to subordinate it as auxiliary tool to a broader politically defined "good"?

This obligation for acting sustainably requires:

- 1) *Admitting that scientific knowledge is uncertain and often in need of future revision. This admission does not mean that this lack of certainty would prevent the knowledge to be used. The public as well as decision makers are used to act under uncertainty.*

In case of climate science it has been estimated that about 10% of all scientists harbour some doubts whether it is really the emission of greenhouse gases which causes the present warming.⁷ On the other hand, about 80% subscribe to this explanation, which is a high percentage and may be taken as evidence for significant good arguments pointing towards these emissions as

⁶ which in the spirit of the US National Research Council is supposed to impartially sort out complex questions about the functioning and dynamics of our natural and social systems.

⁷ Bray, D. and H. von Storch, 2007: Climate Scientists' Perceptions of Climate Change Science. GKSS-Report 11/2007, Geesthacht, http://coast.gkss.de/staff/storch/pdf/GKSS_2007_11.pdf

dominant driver of the ongoing changes, and to the perspective of future further warming. Among the sceptics are many driven by secondary motives⁸ but some have purely scientific reservations. There is nothing bad about such scientific reservations.

- 2) *Understanding that the public discourse about climate change driven by two different knowledge claims – a scientific and a medial construction.*⁹

The *scientific* construct of human-made climate change is widely supported within the relevant scientific communities¹⁰, and has been comprehensively formulated particularly thanks to the collective and consensual efforts of the UNO climate council IPCC. According to this construction¹¹ human beings are changing the global climate. Climate is the statistics of the weather. In almost all localities, at present and in the foreseeable future, the frequency distributions of the temperature are shifting to higher values and will continue to do so; sea level is rising; amounts of rainfall are changing. Some extremes such as heavy rainfall events will change. The driving force behind these alterations is above all the emission of greenhouse gases, in particular carbon dioxide and methane, into the atmosphere, where they interfere with the radiative balance of the Earth system.

Of course, there is no complete consensus in the scientific community, so that speaking of “the scientific construct” is a simplification, which is applied here for describing the contrast to the media construct, which is equally not just one construct but features many different variants.

This medial construct may be summarized in this way: Climate is changing because of human activity. The weather is less reliable than it was before, the seasons more irregular, the storms more violent. Weather extremes are taking on catastrophic and previously unknown forms. The cause? Human greed and stupidity. The mechanism: the justice, or the revenge, of a nature that is striking back. For large chunks of the population, at least in Central and Northern Europe, the mechanism is obvious.¹² In old times, the adverse climatic developments were the just response to a God angered by human sins; this

⁸ Lahsen, M., 2008: Experience of modernity in the greenhouse: A cultural analysis of a physicist "trio" supporting backlash against global warming. *Global Env. Change* 18: 204-219

⁹ von Storch, H., 2009: Climate Research and Policy Advice: Scientific and Cultural Constructions of Knowledge. *Env. Science Pol.* 12, 741-747 <http://dx.doi.org/10.1016/j.envsci.2009.04.008>

¹⁰ See Bray and von Storch, op cit.

¹¹ The term "construction" is not meant to belittle the scientific process or to hint to manipulation but merely to the fact that the knowledge has been obtained in a building process, exploiting different forms of knowledge; see also Müller, P., and H. von Storch, 2004: *Computer Modelling in Atmospheric and Oceanic Sciences - Building Knowledge*. Springer Verlag Berlin - Heidelberg - New York, 304pp, ISN 1437-028X

¹² On 14 August 2002, the reputable Swedish daily newspaper „Dagens Nyheter“ wrote: „Naturen slår tillbaka våldsamt.“ (Nature strikes back violently), when reporting about a disastrous flooding in the Czech Republic.

approach is also today, in particular in the US and possibly in the UK, sometimes invoked.¹³

- 3) *Accepting that consensual political conclusions about required or meaningful measures can not be drawn from the understanding of the dynamics of climate change and of future perspectives alone.*¹⁴

From the diagnosis that humans are changing climate, and that the time-integrated global emissions are determining the magnitude of the change, there is no immediate conclusion about the political implications to be drawn. Climate science is not "telling us what to do", but science is telling us, what the effect of which political conclusion would be. To do so, climate science should do research on the range of options, on their efficiency and costs, drawbacks and advantages. When results of this sort are available, the social decisions should be left to the democratic system. There should be a separation between scientific analysis and political decision making.

An interesting detail is that research for Northern Germany found out that people have hardly an idea about the regional or even local needs and options concerning required adaptation measures strategies to deal with the unavoidable part of future climate change.¹⁵

- 4) *Accepting that accurate language is needed – and that scientific terminology may conflict with every day language.*¹⁶

An important example is the usage of the term "prediction" or "forecast". In climate we have not yet predictions, which would be a description of the most probable future development. We do not have such predictions, because we can not predict the future emissions and we have not yet developed methods to determine the present state sufficiently accurately. We have "scenarios" or "projections", which are descriptions of a series of possible futures. The latter are considerably less certain than the former, but useful nonetheless – if applied adequately.

For instance, a trend labeled as "statistically significant" does not necessarily extend into the future, or must be of anthropogenic origin. A counter example is

¹³ An example is provided by a former Chair of a IPCC Working Group who expressed his conviction that God would speak to the public through disasters (Welch, F., 1995: Me and My God. *Sunday Telegraph*, 10.9.1995). Or, as it is put on the back cover of an alarmistic book "Our drowning world" (Milne, A., 1989: *Our drowning world*, London: Prism Press): "...we shall be engulfed by the consequences of our greed and stupidity. Nearly two thirds of our world could disappear under polar ice cap water ... For this will be the inevitable outcome of industrialization, urbanization, overpopulation and the accompanying pollution." An enlightened variant is suggested by Lovelock in the framework of his Gaia-hypothesis, when he speaks about "The revenge of Gaia - why Earth is fighting back ..." (Lovelock, J., 2006: *The revenge of Gaia – Why Earth is fighting back – and How we can still save humanity*. Penguin Group, London, 177 pp.).

¹⁴ Pielke Jr., R., 2007: *The Honest Broker*. Cambridge University Press.

¹⁵ Ratter, B., M. Lange und C. Sobiech, 2009: Heimat, Umwelt und Risiko an der deutschen Nordseeküste. Die Küstenregion aus Sicht der Bevölkerung. *GKSS 2009/11*. ISSN 0344-9629, 110 pp

¹⁶ E.g., Bray, D., and H. von Storch, 2009: 'Prediction' or 'Projection'? The nomenclature of climate science. *Sci. Comm.* 30, 534-543, doi:10.1177/1075547009333698

the seasonal warming: The February-July temperature trend is significant, natural and does not extent into September.

- 5) *Explaining that reality is really complex and not simple. There are various examples, when simplifications lead to incorrect and misleading conclusions.*

Sometimes the argument was brought forward that the warming of the atmosphere would necessarily bring about an intensification of mid-latitude storms – because of elevated water vapor levels. If the argument would be correct, we would not have winter but summer storms. And indeed, we can not identify an intensification of "our storms"¹⁷ in Northern Europe in spite of a clear regional warming since 1873.¹⁸

Interested economic quarters argue that the dramatic increase in damages to land-falling storms along the US coast would be evidence for intensifying hurricanes, but an alternative, better explanation is that economic value along the coasts has dramatically increased in recent decades.¹⁹

The fact that Mozart's song "Come, dear month of May, and make the trees flowering again" is no proof of late flowering of trees in Mozart's Vienna in the late 18th century, and thus cool conditions, but due to the usage of lines written by a Lübeck major.²⁰ More generally, the assessment of data needs the expert knowledge to sort out issues of inhomogeneity²¹ (contamination of large-scale climate signals by other origins, such as the process of observing, processing etc.).

3 Science communication and service

Based on these general insights, concrete measures for a sustainable communication between science, the public, media, political and economic decision makers are needed.

On the **global** and **continental** scale, Working Group I of the Intergovernmental Panel of Climate Change IPCC provides reasonable communication, even if the IPCC suffers from some limitations. Examples are a partial politicization, the fact that frequently dominant authors rely on their own work, or the failure of Working Group 2 to accept the assessment of Working Group 1 about the dynamics and change of climate when assessing the impacts of climate.

¹⁷ E.,g., Bärring, L. and H. von Storch, 2004: Northern European Storminess since about 1800. *Geophys. Res. Letters* 31, L20202, doi:10.1029/2004GL020441, 1-4

¹⁸ Cappelen, J, 2008: Vejret som det gik i 2007 - i Danmark, i Nuuk på Grønland og i Tórshavn på Færøerne, *Vejret* 115

¹⁹ Pielke, Jr., R.A., Gratz, J., Landsea, C.W., Collins, D., Saunders, M., and Musulin, R., 2008: Normalized Hurricane Damages in the United States: 1900-2005. *Natural Hazards Review* , 9: 29-42

²⁰ Böhm, R., 2009: *Heiße Luft – Reizwort Klimawandel*. Vabene Publisher, Vienna

²¹ E.g., 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

On the **regional and local** scale, however, the IPCC is much less efficient, but different regional and local bodies provide services. An early excellent example was the Rosby-Center in Norrköping. The Helmholtz-Association has set up a number of Regional Climate Offices in different parts of Germany²²; also a national Climate Service Center is beginning its operation in that country.

What needs to be done is:²³

- 1) *The establishment of contacts for enabling a public-science dialogue. Here, the term "public" refers to the society at large, the media and political and economic decision makers.*

For the direction science-to-public this implies that users of climate knowledge and information qualitatively and quantitatively understand scientific knowledge about climate, climate change and impact – and do not need to rely on unreliable media reporting and claims-making by interested parties. This includes the understanding of uncertainty, limitation in spatial and temporal resolution, the character of scenarios, and the non-existence of prognoses as such (apart from a few exceptions so far), the role of natural variability, and the presence of ensemble spread.

For the direction public-to-science, the need is the understanding of concerns and questions in the public realm as well as among decision makers²⁴; it includes also the analysis of the media construction of climate change.

The linear concepts of "informing", "teaching" or other types of "knowledge speaks to power/lay people" should be avoided, as they can not provide the needed qualified feedback, nor can they deal with the ubiquitous alternative knowledge claims. They also fail to acknowledge the limitations of the scientific actors in understanding the social, cultural and political context.

- 2) *The determination of possible future climate changes needs worst-case scenarios²⁵ as well as best-case scenarios. The latter would describe the regional and local climate changes, which would have to be expected in case of successful, or even very successful international climate protection measures – and would thus represent "unavoidable" climate changes, which would require in any case adaptive responses.*

Additionally, knowledge about *options* to deal with expected adverse change is needed. Such options may include changes in urban planning²⁶, including undoing of urban heat island effects, or different hydrodynamic regimes in

²² Schipper, J.W., I. Meinke, S. Zacharias, R. Treffeisen, Ch. Kottmeier, H. von Storch, und P. Lemke, 2009: Regionale Helmholtz Klimabüros bilden bundesweites Netz. *DMG Nachrichten* 1-2009, 10-12

²³ von Storch, H. and I. Meinke, 2008: Regional climate offices and regional assessment reports needed. *Nature geosciences* 1 (2), 78, doi:10.1038/ngeo111

²⁴ E.g., Kempton, W., J.S. Boster and J. A. Hartley, 1995: *Environmental values in American Culture*. MIT Press, Cambridge MA and London, ISBN 0-262-11191-8, 320 pp

²⁵ For instance the work of the Dutch "Delta-Commissie" in 2008 on worst-case flooding and storm surge scenarios along the Dutch coast; see <http://www.deltacommissie.com/en/advies>

²⁶ Gill, S.E., J.F. Handley, A.R. Ennos and S. Paulett, 2007: Adapting cities for climate change: The role of the green infrastructure, *Built Environment* 33, 115-133

estuaries²⁷. Also, it needs to make clear that even very efficient local emission reductions do not provide shelter from the effect of global warming.

- 3) *The legitimate scientific knowledge about the ongoing climate change and its relationship to different drivers (urbanization, global change, land-use etc.) needs to be reviewed and assessed.*

Here, "legitimate" relates to publicly available publication originating from institutions operating with a "good scientific practice" standard. The idea should not be to describe "best" knowledge, as the "best"-claim is often a social construction, but consensus, including the consensus on disagreement, should be described. In a sense, such reports mimic the IPCC reports for specific regions.

One such regional consensus-reports has been prepared in Europe – for the Baltic Sea region²⁸; another one is about to be concluded – for the metropolitan region of Hamburg²⁹. Both reports describe clear changes in regional temperatures and plant phenology, provide many regional climate change scenarios – but also a general lack of detailed knowledge about impacts and options.

- 4) *Finally, detailed data sets are needed, which after suitable quality control and homogenization describe regional and local climate change in past decades. Such data are needed to determine to what extent anthropogenic or other drivers (such as urbanization) have already had an effect on regional and local conditions.³⁰ They are also needed to determine present risks of extreme events.*

Such data sets may be constructed from various observations, local³¹ and satellite³², regional re-analyses or downscaled global re-analysis³³.

This task is unfortunately often overseen, when the emphasis of the work is put mostly or even entirely on possible future developments. Indeed, the assessment of the recent past and of the ongoing change should be considered equally important than the design of scenarios of possible futures.

²⁷ von Storch, H., G. Gönner, and M. Meine, 2008: Storm surges – an option for Hamburg, Germany, to mitigate expected future aggravation of risk. *Env. Sci. Pol.* 11: 735-742 doi 10.1016/j.envsci.2008.08.003

²⁸ The so-called BACC report: The BACC author team, 2008: *Assessment of Climate Change in the Baltic Sea Basin.*, Springer Verlag Berlin - Heidelberg; ISBN 978-3-540-72785, 473 pp

²⁹ A first draft is made public on November 2009 in the city hall of Hamburg; the final publication in a book is expected during 2010.

³⁰ E.g., Bhend, J., and H. von Storch, 2009: Is greenhouse gas forcing a plausible explanation for the observed warming in the Baltic Sea catchment area?, *Boreal Env. Res.*, 14:81-88

³¹ E.g., the CRU data sets: Jones, P. D. and Moberg, A., 2003: Hemispheric and largescale surface air temperature variations: An extensive revision and an update to 2001. *Journal of Climate*, 16(2):206–223

³² E.g., from the Global Precipitation Climatology Centre: Schneider, U., T. Fuchs, A. Meyer-Christoffer, and B Rudolf, 2008: Global precipitation analysis products of the GPCC. *Technical report, Global Precipitation Climatology Centre (GPCC)*, Deutscher Wetterdienst

³³ Weisse, R., H. von Storch, U. Callies, A. Chrastansky, F. Feser, I. Grabemann, H. Günther, A. Plüss, T. Stoye, J. Tellkamp, J. Winterfeldt and K. Woth, 2009: Regional meteo-marine reanalyses and climate change projections: Results for Northern Europe and potentials for coastal and offshore applications, *Bull. Amer. Meteor. Soc.* 90: 849-860. <http://dx.doi.org/10.1175/2008BAMS2713.1>

4 Epilogue

The present essay calls for a sustainable practice of climate science. Such a sustainability requires that science is not degenerating to a sort of politics and policymaking; instead science is supposed to provide coldly, impassionedly, knowledge about the options of policymaking. For doing so, it needs first of all to do "good science", which needs openness, reproducibility, falsification, publication. And the acceptance that science the pursuit of satisfying curiosity is a part of our western culture.