Conceptual challenges of climate servicing

Hans von Storch

Institute of coastal Research, Helmholtz Zentrum Geesthacht, Germany, hvonstorch@web.de

1. Introduction

The idea of setting up climate services is to establish a framework, which manages the flow of knowledge between climate science and stakeholders (Jones et al., 2014). In most cases, the concept is reduced to the concept of informing stakeholders about regional details of possible future climatic conditions, as described in scenarios constructed with regional climate models, which downscale global scenarios forced with assumed developments of GHG emissions. In some cases, this information is done through internet-portals.

It is claimed that this concept of a one-way "teaching" approach fails to really generate scientifically legitimized and practically useful knowledge of the side of stakeholders; also it misses the chance to feed-back on the scientific practice and of defining useful scientific goals.

2. Scientific knowledge about climate change

Key elements of scientific knowledge about climate change and climate impact relate not only to possible developments in the future. Instead, other issues are also needed, such as

- Past developments, which allow assessing how ongoing and expected future changes compare to past experiences- Such analyses of past developments are also needed for detecting anthropogenic climate change and for attributing plausible causes (e.g., Barkhordarian et al., 2016)
- The character of scenarios in contrast to predictions; these two terms are often misunderstood, even in scientific quarters (Bray and von Storch, 2009)
- The time-dimension of climate change and the emergence of persistently non-stationary conditions – climate change is not a change from one stationary state to another.
- The limitation of temporal and spatial resolution, which is coarser than that of the space-time grid used in the simulations.
- The fact that differences between different sets of scenarios are not related to errors of models but an unavoidable aspect of the art of scenario building. The smaller the spatial scales, and the shorter the time scales, the larger the uncertainty.
- Convergence of scenarios across models is not evidence for realism of scenarios.

3. Challenges

The major challenge of climate servicing is the recognition that those, who want to understand climate change and impact for adapting their own activity, be they political, economic or educational, have already an understanding about climate change and climate impact. This understanding constitutes also "**knowledge**" – which is the ability to act in an informed way, in a way which makes the decider believing that his or her action will lead to expected results. The term "knowledge" does not imply anything about "truth".

Scientific knowledge is just one type of knowledge, albeit a type which has been constructed with the scientific method, i.e., with testing alternative explanations, which challenging the suggested explanation and, ideally without being influenced by vested interests (Merton's norms; Bray and von Storch, 2015). Scientific knowledge is considered not "truth" but the best explanation for the time being, which is consistent with experiences and present theory.

The other knowledge claims have other sources, for instance outdated scientific claims, culturally constructed interpretations of sin and punishment or explanations which are favorable for certain political or economic interests (von Storch, 2009).

The existence of such alternative knowledge claims, which compete with the scientifically constructed knowledge claims, is ubiquitous – and also scientists are influenced in their practice by these claims. And indeed, in many case they may be more "practical", as they may support decisions which are consistent with local values, preferences and interests (but less skillful in realistically anticipating consequences of decisions). There is no apriori reason for science to win the competition of acceptance as best explanation and as valid guidance for political and economic decisions.

In the process of "teaching" the "scientific facts" to stakeholders, the scientific knowledge claims are interpreted in the context of the already present alternative knowledge claims; they undergo metamorphoses and may be transformed to useless variants. At the same time, brokers of other knowledge claims, mostly lead by political or economic interests try to bring their "truth" also into decision processes.

Thus, natural scientists without an understanding of the social knowledge and decision dynamics will in many cases fail in transferring their valid or best-for-the-timebeing explanations.

The issue of knowledge competition is closely related to the presence of a "**post-normal**" situation within which climate science operates. In such a situation, societal decisions are urgent and risky, societal values are involved and the uncertainty of the analysis significant.

Then, the knowledge competition becomes fierce, and stakeholders try to engage scientific actors ascombatants in their effort of winning the competition and decision process. Within science, some people attain dual identities, as scientists following the scientific method and as activists pursuing specific interests. The dialogical processes of transferring knowledge claims from science to society, and knowledge needs from society to science are affected.

Another challenge represents the option of **oversimplification**, of framing scenarios (possible futures) to certain or very probable futures, of presenting only one or a very limited set of scenarios, of indicating that the grid-resolution would be the phenomenological resolution; of projecting gridded data sets on high-resolution geographical maps. In all these case, the stakeholders will initially be pleased as such knowledge would considerably ease most planning work. However, after a while, possibly only after many years, it will turn out that the "information" given was just a rather arbitrary guess without explanatory skill.

It seems that some commercial "climate service" efforts are engaged in such practices.

4. Tools of climate services

An efficient climate service must be based on the recognition of the need for dialogue. Scientific knowledge is not automatically useful for decision-making, and in many cases scientific studies must be conditioned by the issue to be decided. Thus, the feed-back from the stakeholders constitutes a valuable element in the science-society interaction.

The task is not to "teach" un-informed stakeholders some "truth", but the task is to maintain an exchange of knowledge needs and options (von Storch and Meinke, 2009). This needs personal contacts and exchanges in workshops and meetings, built over often long times – internet portals like Klimamonitor (http://www.norddeutscherklimamonitor.de/impressum.html) or Norddeutscher Klimaatlas (http://www.norddeutscher-klimaatlas.de/; Meinke et al., 2011) can support this effort. A "regional climate office" may serve this purpose (von Storch and Meinke, 2009).

An important resource for setting up an efficient dialogue is to know about the competing knowledge claims; a topology of alternative knowledge claims is needed (von Storch, 2009), which may turn out being different in different times and regions.

On the technical side, homogeneous and extended climatologies for the recent past with high spatial and temporal resolution are needed – and assessments (e.g., Barkhordarian et al., 2016) if recent changes are within the range of normal variations or are of a kind which need an external explanatory factor, such as GHGs or changed aerosol loads as explanatory factors ("detection and attribution"). Similarly, suggestions for possible future developments (i.e., scenarios or projections) are needed.

Another need, which requires ambitious efforts, is to assemble and assess the available scientifically legitimate knowledge (as published in the scientific literature) about regional (or local) climate, climate change and impact. Such reports represent a robust knowledge base, similar to the reports of the IPCC. The BACC-project of BALTEX (and now: Baltic Earth) has generated two such reports (BACCauthors, 2008, 2010).

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